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(54) **GARMENT FOR USE IN OPERATIONS OF FIRE EXTINGUISHING**

(57) Garment (10) for use in fire extinguishing operations and the like which comprises a body (11) made of fireproof material and thermally insulating and a safety apparatus incorporated in the body (11) of said garment (10) and comprising:

- a container (12) in fireproof material;
- electrical supply means (13);
- an electronic device (13) housed in the container (12);
- a light signalling device (14) comprising a support (15),

a screen (16) and optical fibres (17) fixed to the screen (16) so as to form luminous symbols on it;

- a thermal sensing device (19) comprising two temperature sensors (20a, 20b).

The electronic device (13) is configured to operate the light emitting means (18) to generate a light signal on the screen (16) depending on the occurrence of pre-defined temperature conditions detected by the temperature sensors (20a, 20b).

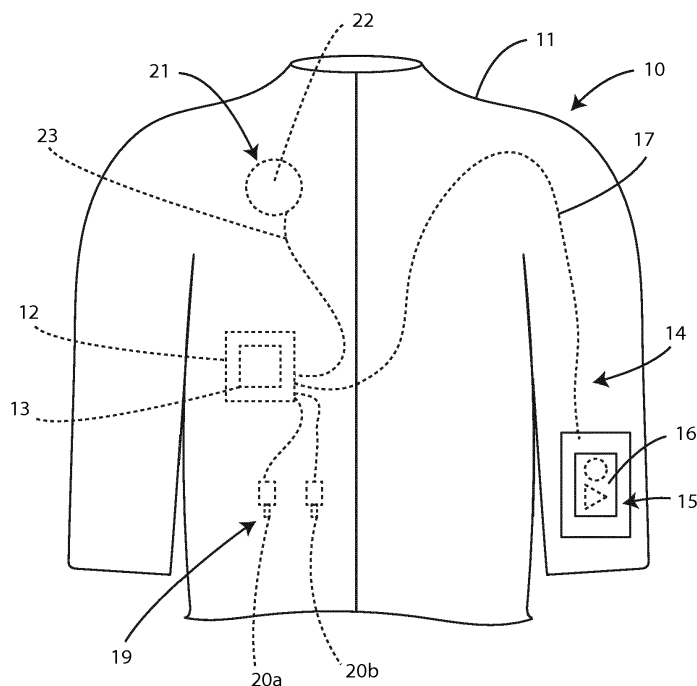


Fig. 1

Description

[0001] The present invention relates to a garment for use in fire extinguishing operations and the like, especially intended for use by firefighters, which allows the user and/or an operating centre to be notified of either environmental or psycho-physical critical conditions of the operator.

[0002] A structural garment for intervention by firefighters is typically composed (not limited to) by at least three overlapping functional textile layers, of which (from the outside towards the inside) an external layer for mechanical protection and heat by contact and conduction, one waterproof and breathable inner layer for protection against penetration of water and chemicals and convective heat, and an even more internal layer (thermal barrier) for protection from radiant heat.

[0003] In particular, a garment for firefighters according to the present invention allows detecting and signalling the user, critical ambient temperature conditions in an easily and effectively perceptible manner even in conditions of very limited visibility.

[0004] Furthermore, a garment according to the present invention allows to easily and reliably signal, automatically or manually an operating centre of a critical condition for the user, allowing to minimize the possibility of false alarms, in order to improve the safety of the firefighters during fire extinguishing operations.

[0005] Nowadays, garments for firefighters are made of fireproof and thermally insulating material so as to minimize the encumbrance and the obstacle to the user's mobility.

[0006] A requirement strongly felt in the sector by users is to be able to detect when the external environment is reaching a critical temperature for the user.

[0007] Nowadays a firefighter, in fact, can become aware of the reaching of critical temperatures from the distortion of the view he experiences due to a partial fusion of the helmet visor screen but may not warn in time the progressive deterioration of the safety conditions if not in Critical conditions (lack of the so-called "warning time" or "escape time").

[0008] Sometimes, some operators, in order to be able to perceive critical temperature increases autonomously relieves the insulation of their clothes in correspondence with less critical parts of the body.

[0009] The present invention proposes to satisfy this requirement left unmet today, proposing a garment in a way reliable, effective and safe for the user, allows to signal the latter and/or to a remote operating centre, critical environmental conditions for the user itself, where such signalling is effectively perceivable by the user even in extremely adverse environmental conditions and with poor visibility.

[0010] The aim of the present invention is to provide a garment for use in fire-extinguishing operations and the like that provides a solution to the problem.

[0011] Within the scope of this aim, it is an object of

the present invention to provide a garment for use in fire extinguishing operations and the like which allows effective light signalling to be obtained for the user even though it is substantially free of electrical cables.

[0012] Another object of the present invention is to provide a garment for use in fire-extinguishing operations and the like, which allows the operator to signal, at the same time a reliable and simple situation, a dangerous situation to a remote operating centre.

[0013] This task, as well as these and other objects which will become better apparent hereinafter, are achieved by a garment for use in fire-extinguishing operations and the like according to the appended Claim 1. Detailed features of the garment for use in fire extinguishing operations and the like according to the invention are reported in the corresponding dependent claims.

[0014] Further characteristics and advantages of the invention will become better apparent from the description of a preferred but not exclusive embodiment of a garment for use in fire extinguishing operations and the like according to the invention, illustrated by way of non-limiting example in the accompanying drawings, in which:

- figure 1 shows a garment for use in fire extinguishing operations and the like according to the present invention, schematized;
- figure 2 illustrates a garment safety apparatus for use in fire extinguishing operations and the like of figure 1;
- figure 3 shows a detail of the safety apparatus of figure 2.

[0015] With particular reference to the above figures, it is globally indicated with 10 a garment for use in fire extinguishing operations and the like which comprises a body 11, wearable by an operator, made of fireproof material, thermally insulating and able to protect from the penetration of liquids, beyond that is able to mechanically protect the operator from heat and direct contact with flames and/or contaminants in solid, liquid, aerosol and vapour form.

[0016] Preferably said garment is a jacket.

[0017] Said garment advantageously comprises at least three overlapping functional layers, of which (from the outside towards the inside) an external layer for mechanical and heat protection by contact and conduction, a first waterproof and breathable inner layer for protection against penetration of water and chemical substances and from convective heat, and a second inner layer even more internal to the first inner layer and acting as a thermal barrier for protection from radiant heat. According to the present invention, a garment 10 has a particular peculiarity in the fact that it comprises a safety apparatus, incorporated in the body 11 of said garment, which comprises:

- a container 12 in fireproof material;
- electrical supply means housed in the container 12;
- an electronic device 13 housed in the container 12 and connected to the electric supply means 13 to be electrically powered;
- a light signaling device 14 comprising a support 15 fixable to the body 11, a screen 16 permeable to the light fixable to the support 15 and optical fibers 17 having first ends 17a fixed to the electronic device 13 and second 17b fixed to the screen 16 so as to form on it, under operating conditions, luminous symbols; the electronic device 13 comprising light emitting means 18 facing the first ends 17a, to receive from these light;
- a thermal sensing device 19 comprising two temperature sensors 20a, 20b, fixed to the body 11 such that a first 20a of the temperature sensors 20a 20b is adapted to detect the temperature outside the garment 10 and a second 20b of the sensors of temperature 20a, 20b is suitable for detecting the temperature inside the body 11.

[0018] Advantageously, the safety apparatus comprises:

- any additional sensors;
- fireproof cable gland structures, fixed to the external part of the third textile layer, which acts as a thermal barrier, suitable for housing and protecting the optical fibres, thermocouples and connections of the pressure sensor both in operating condition and during maintenance operations.

[0019] In accordance with the present invention, moreover, the electronic device 13 is configured to operate the light emission means 18 to generate on the screen 16 a light signal according to the occurrence of predefined temperature conditions detected by the temperature sensors 20a, 20b.

[0020] In particular, the electronic device 13 controls the light emitting means 18, which activate or deactivate the information on the screen 16 of the signalling device 14 in the form of static predefined icons. The aforementioned signalling device 14 is thus of a purely optical type, i.e. made without any electronic or electrical circuit.

[0021] The aforesaid predefined temperature conditions can, for example, consist of reaching a predefined temperature threshold outside the garment 10 and/or reaching a predefined temperature threshold within the garment 10.

[0022] Furthermore, said predefined temperature conditions can be represented by the achievement of a predefined difference between the outside and inside tem-

perature of the garment 10.

[0023] The light emitting means 18 preferably comprises at least one RGB led.

[0024] The screen 16 advantageously comprises a sheet, often, for example having a thickness between 3 mm and 10 mm, made of silicone material in which the second ends 17b are embedded, so as to form at least one symbol.

[0025] Advantageously, the silicone material is translucent or partially opaque in order to generate a diffusion effect of the light inside it so as to increase the visibility of the symbol or the symbols generated.

[0026] Preferably, the support 15 comprises a frame made of polychloroprene and stitched to the body 11 of the garment 10.

[0027] More preferably, the support 15 is constituted by a polychloroprene layer having the two opposite faces covered with a fabric, commercially known better as Neoprene®, where the support 15 has a bottom 15a and a frame 15b which projects from the bottom 15a and which, with this defines a seat for the screen 16 which preferably has a thickness substantially equal to that of the frame 15b so as not to project with respect to it when it is laid down on the bottom 15a.

[0028] The electronic device 13 advantageously comprises transmission means suitable for emitting and/or receiving a remote electromagnetic signal, in particular, said transmission means can comprise a radio-frequency transmission system, in this way the electronic device can send signals to an operating centre remotely or receive them.

[0029] The garment safety apparatus 10 also includes an alarm device 21, which preferably comprises a pneumatic actuator for generating a remote alarm; the alarm device 21, in particular, comprises:

- a pushbutton 22 having an elastically deformable body 11 provided with an internal cavity 22a;
- a conduit 23 having a first extreme 23a connected to the internal cavity 22a;
- a pressure sensor 24 connected to a second extreme 23b of the conduit 23 and forming part of the electronic device 13.

[0030] Pushbutton 22 can be pressed to generate a pressure impulse transmissible by conduit 23.

[0031] The pushbutton 22 and the conduit 23 are preferably positioned between the second layer (the impermeable and breathable membrane) and the third layer (the thermal barrier) and at the point of positioning the pushbutton the outer fabric will be flexible in such a way as to preserve the sensitivity of the system at the touch of the operator and advantageously will have a contrasting colour to highlight the positioning of the pushbutton 22.

[0032] The electronic device 13 is advantageously

configured to transmit a signal through the transmission means upon detection, by means of the pressure sensor 24, of a predefined sequence of pressure pulses generated by pressing the pushbutton 22.

[0033] For example, it will be possible to set that following a sequence of, for example, 3 successive pulses, the electronic device 13 will emit a signal directed to a remote operating centre, aimed at signalling a critical condition for the user of the garment 10, which in this case, for example, requires help.

[0034] The body of the pushbutton 22 is preferably made of silicone material so as to be resistant to high temperatures and flame retardant while being soft and therefore such as not to cause difficulties in movement or discomfort to the user of the garment 10.

[0035] Advantageously, also the conduit 23 comprises a tube made of silicone material which will preferably be in communication with the internal cavity 22a of the body of the pushbutton 22.

[0036] The electronic device 13 advantageously further comprises at least one accelerometer.

[0037] In particular, the electronic device 13 preferably configured in motion such as to:

- light up following the detection of a movement of the electronic device 13, so as to automatically turn on for example when the garment 10 is worn;
- transmit an alarm signal, by means of said transmission means, following detection of a movement of the electronic device 13 compatible with a fall to the ground of the user of the garment 10 so as to emit the so-called "man-down" alarm;
- turn off in case of detection of a quiet state of the device for a predefined time interval, except in the case where said alarm signal has been transmitted; in other words, the device is automatically shut off when the garment is removed by the user and left to rest.

[0038] In detail, in a preferred embodiment, advantageously at least one of the temperature sensors 20a, 20b comprises a thermocouple and preferably a probe K, that is having a pair of metals or metal alloys, for example Chromel-Alumel, such as to make temperature measurements in a range between -200 ° C and 1260 ° C with a sensitivity of about 41 $\mu\text{V} / ^\circ\text{C}$.

[0039] Said probes will be advantageously protected by a textile layer of the same outer fabric of the jacket, able to guarantee mechanical protection, from humidity and chemical contamination, leaving the possibility of convective heat exchange with the external environment for correct temperature detection.

[0040] In a preferred but not exclusive embodiment of the garment 10 according to the present invention, this forms a jacket for firefighters.

[0041] The electronic device 13, advantageously, will

be incorporated in the body of the jacket where the push-button will be placed, at chest height so as to be easily operated by the user's right or left hand, while preventing accidental activation.

[0042] In general, the electronic device 13 will be positioned in a way not to interfere with the remaining equipment in use and in particular with the self-protective belts and/or any slings and not to interfere with the radio-pocket which, typically, is positioned on the left of the chest side.

[0043] The screen will preferably be fixed on a sleeve of the jacket so as to be easily brought into the user's field of view.

[0044] The electronic device 13 and the container 12, correspondingly, in a preferred embodiment of the present invention will consist of two parts, respectively, of which:

- a first part of the container 12a is fixable inside the garment and houses a first part of the electronic device 13a;
- a second part of the container 12b, which houses a second part of the electronic device 13b.

[0045] The first parts 12a and 13a are coupled in a removable way to the second parts 12b and 13b by means of a plug-socket connection.

[0046] Advantageously, the second part of the electronic device 13b advantageously comprises:

- the thermal sensing device 19;
- a terminal fixed to the second extreme 23b of the conduit 23 and fixable to the pressure sensor 24;
- a connector fixed to the first ends 17a of the optical fibres 17 and fixable to the light emitting means 18.

[0047] The first part of the electronic device 13a preferably comprises

- a battery 100 which defines said electric power supply means, preferably from a rechargeable 800mAh and a USB interface for connection to a charging apparatus;
- a 2.4 GHz 10mW transmitter;
- the light emitting means 18 preferably comprising a pair of RGB LEDs;
- the pressure sensor 24 provided with a pneumatic coupling apt to couple with the terminal of the first part of the electronic device 13a.

[0048] Advantageously, the electronic device 13 will also have a protected on and off pushbutton, which can

be activated by the user and advantageously integrated into the first part of the electronic device 13a.

[0049] By way of a non-limiting example, in a preferred embodiment of the present invention, the association between symbols and colours of light by which to illuminate them will be configurable according to the events to be signalled.

[0050] For example, it can envisage the training on the screen 16 of:

- a flashing red triangle representing the exceeding of a predefined first temperature threshold, and in this case an alarm signal will be transmitted to the operation centre; at central the alarm can not deactivate;
- a flashing blue triangle in the case of a call being sent to the operations centre by the operator, an alarm will be activated in central which will be able to deactivate.

[0051] In an embodiment of the present invention, the screen 16 can be fixed externally to the garment 10, for example by sewing the support 15 on the latter in correspondence with the frame 15a.

[0052] Alternatively, in an embodiment not shown in the figures, the screen can be inserted inside the body of the garment, for example in its thickness and a window can be obtained in the outer layers of the thickness to make the screen visible from the outside.

[0053] In this case, a transparent protection element can be fixed to the garment in order to cover the screen to protect it without compromising its visibility.

[0054] Preferably, in this case, the screen is made of a diffractive material, for example of rubber, preferably of partially opaque silicone rubber.

[0055] The screen itself can be shaped to form an icon.

[0056] In this case, the optical fibres will have the second end fixed to the diffractive material of the screen in such a way that in use this is invaded by the light radiation carried by the optical fibres and therefore it is completely illuminated.

[0057] Alternatively, the second ends of the optical fibres may have the side surface abraded or otherwise rough so as to diffuse the light through it when they are in use.

[0058] Advantageously, the second ends, in this case, will be inserted within the diffractive material which, in use, will be illuminated from the inside through the lateral surface of the optical fibres.

[0059] The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of protection of the appended claims.

[0060] Furthermore, all the details may be replaced by other technically equivalent elements.

[0061] In practice, the materials used, as well as the contingent shapes and dimensions, may be varied according to the contingent requirements and the state of the art.

[0062] Where the constructional features and tech-

niques mentioned in the following claims are followed by signs or reference numbers, such reference marks or numbers have been affixed with the sole purpose of increasing the intelligibility of the claims themselves and, consequently, they do constitute no restriction on the interpretation of each element identified, purely by way of example, by such signs or reference numbers.

10 Claims

1. Garment (10) for use in fire extinguishing operations comprising a body (11) wearable by an operator made of fireproof material and thermally insulating to protect the operator from heat and a safety apparatus incorporated in the body (11) of said garment (10), which includes

- a container (12) in fireproof material;
- electrical supply means housed in said container (12);
- an electronic device (13) housed in said container (12) and connected to said electrical supply means to be electrically powered;
- a light signalling device (14) comprising a support (15) fixable to said body (11);
- a thermal sensing device (19) comprising two temperature sensors (20a, 20b), fixed to said body (11) in such a way that a first of said temperature sensors (20a, 20b) is adapted to detect the external temperature to said garment (10) and a second of said temperature sensors (20a, 20b) is apt for detecting the temperature inside said body (11);

characterized in that said safety apparatus comprises an alarm device (21), which includes a pneumatic actuator apt to generate a remote alarm, a screen (16) of said light signaling device (14), which is permeable to the light and which is fixed to said support (15), and optical fibers (17) having first ends (17a) fixed to said electronic device (13) and second ends (17b) fixed to said screen (16) so as to form on it luminous symbols in operating conditions; said electronic device (13) comprising light-emitting means (18) facing said first ends (17a) and being configured to operate said light-emitting means (18) to generate a light signal in operation on said screen (16), a luminous signal in function of the occurrence of predefined temperature conditions detected by said temperature sensors (20a, 20b) and said electronic device (13) being also apt for controlling said light emission means (18) so as to activate or deactivate static information on said screen (16) of said light signalling device (14) in the form of predefined icons, said light signalling device (14) thus being of a purely optical type.

2. Garment (10) according to claim 1 **characterized in that** said light-emitting means (18) comprise at least one RGB LED.

3. Garment (10) according to one of the preceding claims, **characterized in that** said screen (16) comprises a sheet of silicone material in which said second ends (17b) are embedded in such a way to form at least one symbol.

4. Garment (10) according to one of the claims 1 and 2, **characterized in that** said screen (16) is realized by means of a diffractive material shaped to form said predefined icons; said optical fibres (17) having a choice:

- said second ends (17b) are faced and connected to said screen (16) to introduce, in use, a light radiation; or
- said second ends (17b) have their own abraded or rough side surface and are inserted inside said diffractive material so as to illuminate it from the inside through the lateral surface of the second ends (17b) of said optical fibres (17).

5. Garment (10) according to one of the preceding claims, **characterized in that** said screen (16) is inserted inside the thickness of the body of said garment (10) which is provided with a window suitable for making the screen (16) visible from the outside.

6. Garment (10) according to one of the preceding claims, **characterized in that** said support (15) comprises a frame made of polychloroprene and stitched to the body (11) of said garment (10).

7. The garment (10) according to any of the preceding claims, **characterized in that** said electronic device (13) comprises transmission means suitable for emitting and/or receiving a remote electromagnetic signal.

8. Garment (10) according to claim 1 **characterized in that** said alarm device (21) comprises:

- a pushbutton (22) having an elastically deformable body (11) provided with an internal cavity (22a);
- a conduit (23) having a first extreme (23a) connected to said internal cavity (22a); said electronic device (13) comprising a pressure sensor (24) connected to a second extreme (23b) of said conduit (23);

said pushbutton (22) being able to be pressed to generate a pressure pulse transmissible by said conduit (23);

said electronic device (13) being configured to trans-

mit a signal through said transmission means upon detection, by said pressure sensor (24), of a predefined sequence of pressure pulses generated by pressing said pushbutton (22).

9. Garment (10) according to claim 8 **characterized in that** the body (11) of said pushbutton (22) is made of silicone material and that said conduit (23) comprises a tube made of silicone material.

10. Garment (10) according to one of the preceding claims, **characterized in that** said electronic device (13) comprises at least one accelerometer; said electronic device (13) being configured in motion such as:

- to light up following detection of a movement of said electronic device (13);
- to transmit an alarm signal, by means of said transmission means, following the detection of a movement of said electronic device (13) compatible with a fall to the ground of the user of said garment (10) capable of detecting a fall to the ground of the user of said garment (10);
- turn off in case of detection of a quiet state of the device for a predefined time interval, except in the case where said alarm signal has been transmitted.

11. Garment (10) according to one of the preceding claims, **characterized in that** the ends of both said temperature sensors (20a, 20b) are protected by a textile protection adapted to guarantee mechanical, moisture and chemical contamination protection, leaving the possibility of convective heat exchange with the external environment for correct temperature detection.

12. Garment (10) according to one of the preceding claims, **characterized in that** said optical fibers (17) and the connections between said electronic device (13) and said temperature sensors (20a, 20b) are housed in fireproof sheaths where said garment has an external layer for mechanical and heat protection by contact and conduction, a waterproof and breathable inner layer for protection against penetration of water and chemicals and convective heat, and an even more internal layer (thermal barrier) for protection from radiant heat; said flame-retardant sheaths being positioned under the first layer inner layer to be protected from exposure to water and possible chemical contaminations, but on the second inner layer to avoid interference with the operator's body and its movements ensuring maximum protection and stability of positioning both in operating conditions and during maintenance operations.

13. Garment (10) according to one of the preceding

claims, **characterized in that** said garment (10) is a jacket and that said safety apparatus is completely positioned on the left semi-front of said jacket except for said light signalling means which are placed on the front part of the left sleeve in order to avoid possible interference wearing and removing the equipment quickly.

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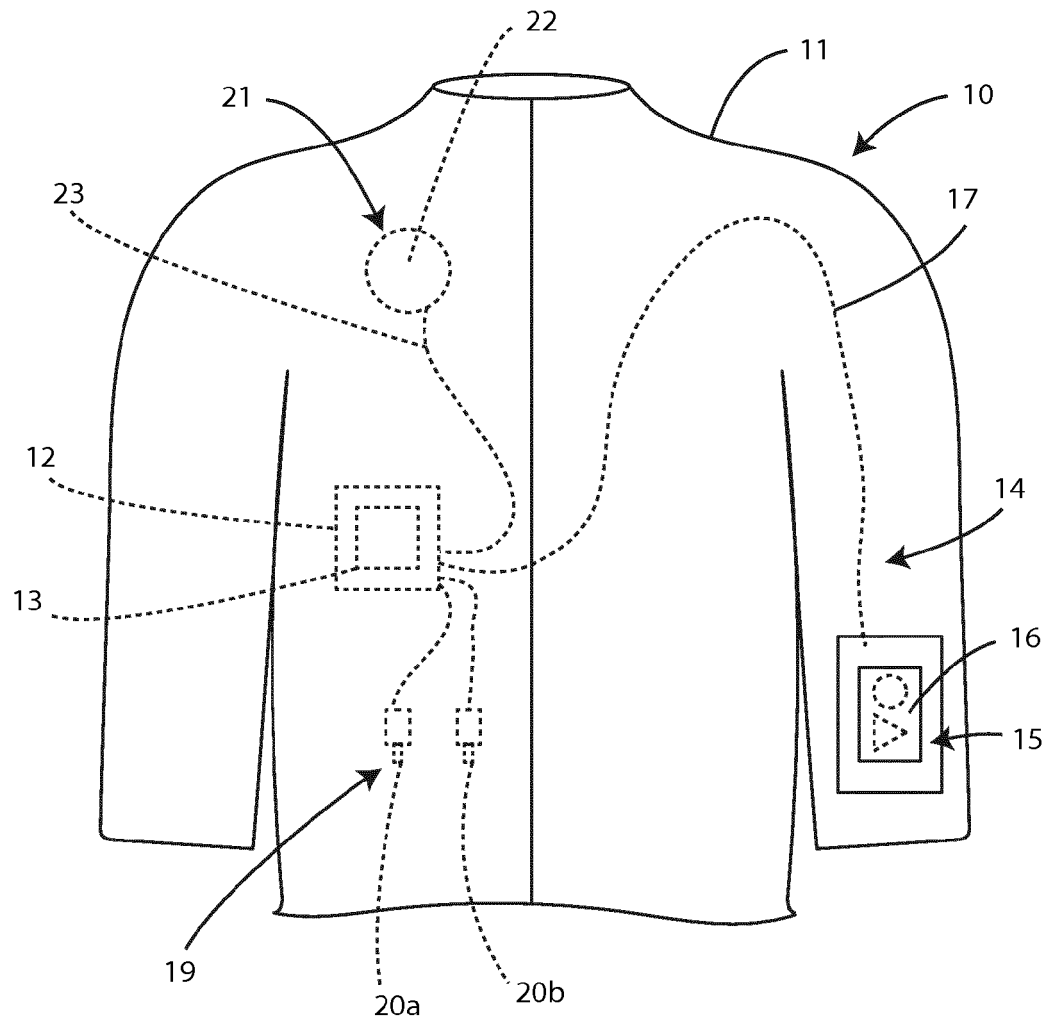


Fig. 1

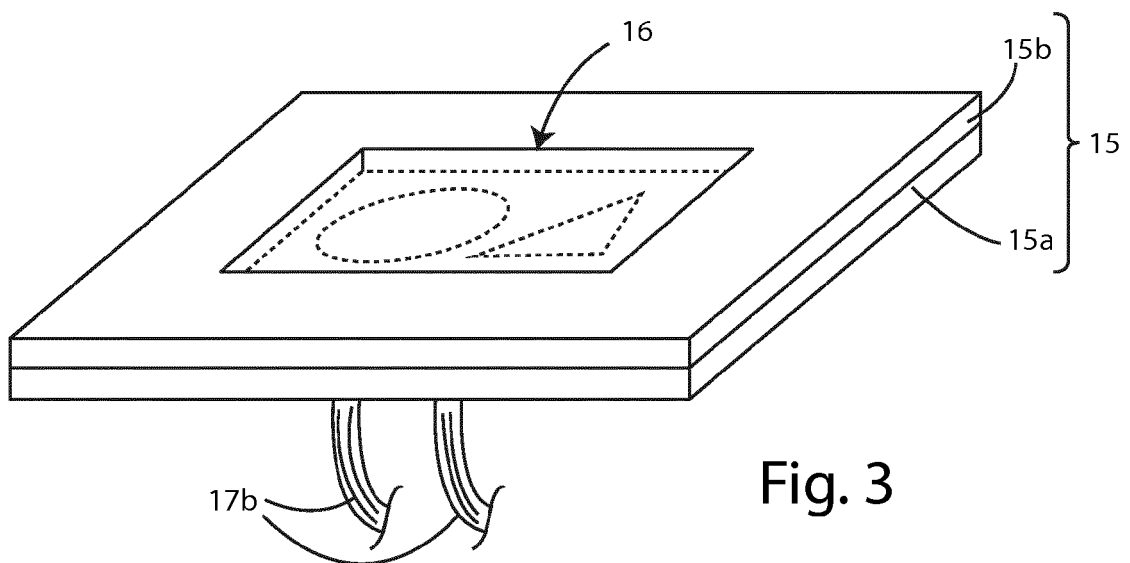


Fig. 3

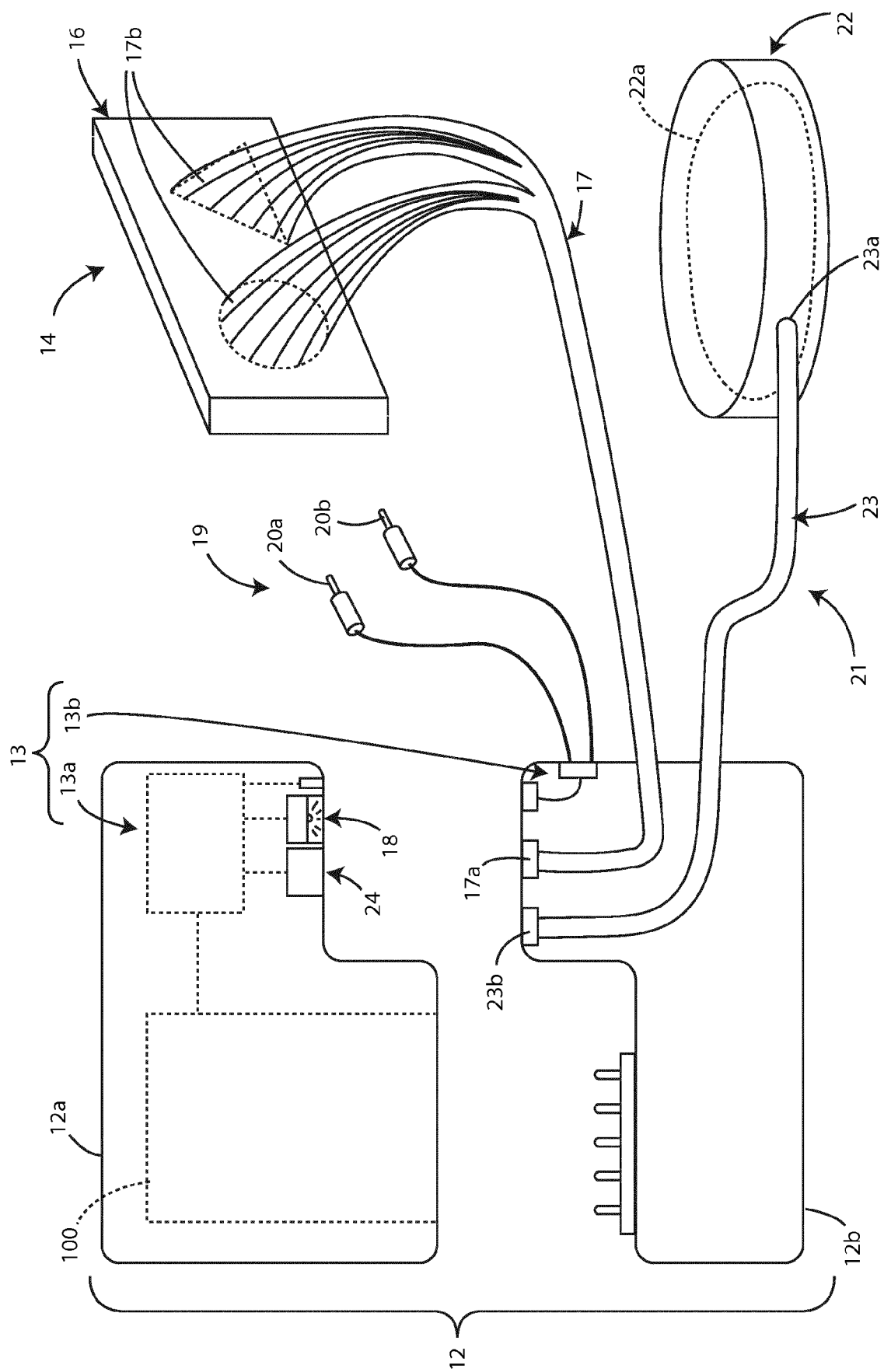


Fig. 2



EUROPEAN SEARCH REPORT

Application Number
EP 18 18 3636

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 23 October 2018	Examiner da Silva, José
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 18 18 3636

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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