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(54) A DEVICE FOR CONVERTING A MOVEMENT OF A USER INTO A VOLTAGE

VORRICHTUNG ZUR UMWANDLUNG DER BEWEGUNG EINES NUTZERS IN EINE SPANNUNG
DISPOSITIF DE CONVERSION DE MOUVEMENT D'UN UTILISATEUR EN TENSION ÉLECTRIQUE

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The invention relates to a device that converts a movement of a user into a voltage.

BACKGROUND TO THE INVENTION

[0002] Devices that convert movement of a user into a voltage may be used for energy harvesting. Energy harvesting is a process by which energy is derived from external sources and converted to electrical energy. An example of an external source is the kinetic energy of a moving person. Piezoelectric materials have the ability to transform mechanical strain energy into electrical charge distribution and are used to convert motion from the human body into electrical energy. For example "Energy Scavenging with Shoe-Mounted Piezoelectrics", by Nathan S. Shenck and Joseph A. Paradiso, MIT Media Laboratory, Responsive Environments Group, http://www.rst2.edu/njheps/resources/energy_scavenging.pdf, discloses energy scavenging with shoe mounted piezoelectric materials.

[0003] EP 2 549 228 A1 discloses a method of enhancing the detectability of a height change with an air pressure sensor and a sensor unit for determining a height change, particularly a fall detector comprising a pressure sensor and printed circuit board in a pendant attached to a person with a neck cord.

[0004] JP 2002-140776 A describes a human body motion detector comprising a piezoelectric coaxial cable sensor which constitutes a neck cord that is connected to a pendant including sensor circuitry.

SUMMARY OF THE INVENTION

[0005] It is an object of the invention to provide an alternative wearable device that converts the movement of the user wearing the device into a voltage.

[0006] The object of the device is achieved with the device according to claim 1. The neck cord allows the user to wear the device around its neck. Movements of the user such as walking will cause a fluctuating pulling force on the piezoelectric sensor. The weight of the printed circuit board (PCB) causes a gravity force to act on the piezoelectric sensor as well. The pulling force and the gravity force act on different portions or locations of the piezoelectric sensor and in different directions causing a fluctuating strain. When external forces mechanically strain the piezoelectric sensor, polarized unit cells in its material shift and align in a regular pattern in the material's crystal lattice. As a result the discrete dipole effects accumulate, developing an electrostatic potential or voltage.

[0007] In an embodiment the piezoelectric sensor is shaped as a rectangular element. The rectangular element bends as a result of the pulling and gravity force

acting on it in different directions. The pulling force passed on by the neck cord may be acting on the end portions of the rectangular shaped element whereas the gravity force caused by the mass of the PCB acts on the middle portion. In a further embodiment the pulling force is acting on the middle portion and the gravity force is acting on the end portions of the element. In this embodiment the PCB is coupled to the end portions and the neck cord is coupled to the middle portion of the rectangular element. In both embodiments movement of the user will cause a fluctuating strain on the piezoelectric sensor such that a movement of the user is converted in a voltage.

[0008] The piezoelectric sensor may comprise a plurality of rectangular elements each of them being coupled to the neck cord and PCB similar as described in the previous embodiments. Each of the rectangular shaped elements will provide a voltage in response to movements of the user, resulting in an enhanced energy conversion of kinetic energy in electrical energy.

[0009] For comfort the device should be relative flat not protrude too much when worn as pendant. Therefore in an embodiment the PCB is positioned in a same plane as the neck cord, which is perpendicular to a bending plane in which the pulling and gravity force cause the rectangular shaped element to bend.

[0010] According to a further aspect of the invention there is provided a device for monitoring a user. This device comprises the device for converting a movement of a user into a voltage. The kinetic energy is converted in electrical energy such that the piezoelectric sensor may be used as a supply source for an electrical component. The voltage generated by the piezoelectric sensor may be filtered and buffered, for example with a capacitor, and the filtered and buffered voltage may be used as a voltage supply.

[0011] In a further embodiment of the device for monitoring a user the voltage generated by the piezoelectric sensor is used to wake up an electronic component from a standby to an operating state. The device may comprise a battery to supply energy to the electronic component when it is in the operating state. This provides the advantage that energy consumption by the electronic component is limited to the time periods that the user is moving. In the time periods the user is not moving the energy consumption is limited to the standby power. Hence the piezoelectric sensor is not used for energy harvesting but rather as a movement sensor that draws no supply current and awakes the electronic component once movement of the user is detected.

[0012] In a further embodiment the device for monitoring a user sends a control signal upon waking up. The control signal indicates that both user and device are active. Absence of the control signal for a predetermined period of time may indicate battery depletion or immobility of the user.

[0013] According to a further aspect of the invention there is provided a fall detector comprising a device for

monitoring a user. The fall detector includes a movement sensor for measuring the movements of the user and a processor for analyzing and interpreting the measurements from the movement sensor to detect a potential fall of the user. The voltage generated by the piezoelectric sensor is used to wake up the movement sensor and the processor.

[0014] In a further embodiment the generated voltage is used to wake up the movement sensor, which on its turn upon measured movements meeting predetermined criteria may wake up the processor. The processor interprets the sensed movements and may cause the transmission of an alarm signal when a possible fall of the user is detected. In an embodiment the movement sensor is an accelerometer.

[0015] According to a further aspect of the invention there is provided a system for monitoring a user. The system comprises a device for monitoring a user or a fall detector and a base station for the control signal that may be sent by the monitoring device or fall detector. When no control signal is received for a predetermined period of time the base station sends a warning signal to a caregiver to indicate that the monitoring device or fall detector may need service, or that the user has not been active.

[0016] According to a further aspect of the invention there is provided a method of converting a movement of a user into a voltage according to claim 12. The method comprises the steps of causing with a neck cord a pulling force on a piezoelectric sensor and causing with the weight of a printed circuit board a gravity force to act on the piezoelectric sensor. The neck cord passes on the movements of the user to the piezoelectric sensor and the gravity force caused by the weight of the printed circuit board counteracts the pulling force provided by the neck cord causing a strain on the piezoelectric sensor. In use the movement of the user causes a change in the shape of the piezoelectric sensor resulting in energy conversion and the generating of a voltage.

[0017] According to a further aspect of the invention there is provided a method of monitoring a user. The method includes in addition to the steps of the method of converting a movement of a user into a voltage the further steps of filtering the generated voltage, comparing the filtered generated voltage with a threshold and switching an electronic component from standby to operating when the generated voltage exceeds the threshold. In this method the generated voltage which results from a detected movement of the user is used as a wake up signal for the electronic component. The electronic component may be used to monitor the activity of the user. This method provides the advantage of a reduced power consumption from a battery supply when the user is not active or has not been active for a period of time.

[0018] In an embodiment the method may further include the step of transmitting a control signal when the electronic component has switched from the standby to the operating state after having received the wake up signal. The control signal indicates that the electronic

component is active. When the control signal has not been transmitted for a period of time this may indicate that a battery supply has been depleted or that the user has not been active.

[0019] According to a further aspect of there is provided a method of detecting a potential fall of a user. The method includes the method of monitoring a user and further includes the steps of monitoring with a movement sensor the movements of the user; and analyzing the measurements from the movement sensor with a processor to detect a potential fall of the user. When the user moves there is a risk of falling. Therefore when a movement of the user is detected with the piezosensor the electronic components such as the movement sensor and the processor wake up to start analyzing the monitored movements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Exemplary embodiments of the invention will now be described, by way of example only, with reference to the following drawings, in which:

Fig. 1 shows a user wearing a device for monitoring a user;

Figs. 2, 3a, 3b, 4a, 4b, 5a and 5b embodiments of a device for converting a movement of a user into a voltage;

Fig. 6 shows an embodiment of a circuit for use in a device for generating a voltage;

Fig. 7 shows an embodiment of a system according to an embodiment of the invention;

Fig. 8 is a block diagram of an embodiment of a fall detector according to an embodiment of the invention;

Fig. 9 is a functional flow chart illustrating the operation of an embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] Fig. 1 shows a user 5 wearing a device 10 for converting a movement of a user into a voltage. The device is worn as a pendant with a neck cord 20 around the neck. When the user is active body movements will cause movements of the device. These movements cause a mechanical strain on a piezoelectric sensor 30 included in the device, see Fig. 2. Due to the mechanical strain the piezoelectric sensor 30 will generate a voltage which is used in the device. The generated voltage may be used to supply (low power) electronic components in the device.

[0022] In an embodiment of the device for converting a movement of a user into a voltage the generated voltage is used as a wake up signal for an electronic component. The wake up signal causes the electronic component to switch from a standby or sleep state, in which power consumption is minimal, to an operating state in

which the electronic component is active. The electronic component may be for example be a movement sensor such as an accelerometer which measures accelerations in the movements of the user, or a barometric pressure sensor which measures height changes in the movements of the user.

[0023] Fig. 2 shows more details of the device 10 for converting a movement of a user into a voltage. The device includes the neck cord 20 which is coupled (or detachably coupled) via the housing 51 and connection elements 21 with the end points of a bendable strip 30 of piezoelectric material such as polyvinylidene difluoride (PVDF) or polyolefin material. The strip may be rectangular shaped but may also have other shapes. A printed circuit board (further referred to as PCB) 40 with one or more electronic components mounted thereon is connected with a further connection element 22 to a middle portion of the strip. The shape of the piezoelectric sensor 30 changes in response to movements of the user: when the user 5 moves (e.g. stands up from a chair) the neck cord 20 will cause an upward pulling force on the strip and due to the downward gravity force caused by the weight of the PCB the strip will bend relative to a plane 31. The PCB carries the electronic component 41 which is electrically coupled to the piezoelectric sensor. When the user 5 wearing the device 10 moves the electronic component 41 receives a voltage. The voltage provided by the piezo electric sensor 30 may need to be rectified, filtered and/or buffered before it is supplied to the electronic component 41 or is used as a supply or wake up signal as will be explained later in more detail with Figs. 6 and 7.

[0024] Figs. 3a, 3b, 4a, 4b, 5a and 5b show further embodiments of the device 10 for converting a movement of a user into a voltage. The housing and neckcord are not shown in these drawings.

[0025] Further when it is stated that the neck cord 20 is coupled to the piezoelectric sensor 30 or strip of piezoelectric material the neck cord may be directly as well as indirectly connected to the piezoelectric sensor or strip of piezoelectric material. With indirectly connected is meant that the neck cord may be connected to the housing which may be connected via a connection element to the piezoelectric sensor or strip of piezoelectric material such that a pulling force of the neck cord is transferred via the housing 51 and the connection element to the piezoelectric sensor or strip of piezoelectric material such as explained in the discussion of Fig. 2.

[0026] In the embodiments shown in Figs. 3a and 3b the piezoelectric sensor 30 comprises a piezoelectric rectangular strip 30 having end portions 30a, 30b and a middle portion 30c. The strip is bendable relative to plane 31 which is in parallel with a 'rest position' of the strip. The 'rest position' represents the position of the strip in absence of pulling force F_p and gravity force F_m when there is no mechanical strain acting on it. In use mechanical strain will be caused by the weight of the PCB which is connected via the further connection element 22 to the

strip resulting in a gravity force F_m acting on the middle portion 30c, as shown in Fig. 3a, or on the end portions 30a, 30b as shown in Fig. 3b. The pulling and gravity force have different directions. In the embodiment shown in Figs. 3a and 3b opposite directions. The neck cord provides a pulling force acting on the piezoelectric sensor via the housing and the connection element 21. In the embodiment of Fig. 3a the end portions 30a, 30b are coupled via connection elements 21 to the neck cord and in the embodiment shown in Fig. 3b the middle portion 30c is coupled via connection element 21 to the neck cord. The movements of the user cause a change in the pulling force F_p acting on the piezoelectric sensor while the gravity force resulting from the mass m of the PCB will provide a counter force F_m resulting in change of the mechanical strain. The change in the mechanical strain will cause a change in the bending of the piezoelectric strip relative to its rest position 31 and result in a voltage generation.

[0027] In the embodiments shown in Figs. 4a and 4b the piezoelectric sensor comprises two piezoelectric rectangular strips 30, 35, each strip having end portions 30a, 30b, 35a, 35b. In both embodiments each strip has an end point 30b, 35b that is coupled with a further connection element 22 to the PCB 40 and the other end point 30a, 35a of each strip is coupled with a connection element 21 to the neck cord 20. The operation of the device for converting a movement of a user into a voltage in these embodiments is similar as discussed with Figs. 3a and 3b. Due to movement of the user 5 wearing the device 10 the piezoelectric strips 30, 35 will bend relative to their rest position which is illustrated with line 31. Both piezoelectric strips 30, 35 generate a voltage due to the bending and the generated voltage is coupled to the (at least one) electronic component 41 that is mounted on the PCB.

[0028] The end points of the strips can be connected in different configurations via connection elements and further connection elements to the PCB and the neck cord. Another configuration is shown in Figs. 5a and 5b. In the embodiments of Figs. 5a and 5b the most opposite end points 30a, 35a of the pair of piezoelectric strips are coupled via the further connection elements 22 to the PCB and the end points 30b, 35b of the pair that are most close to each other are coupled via a connection element 21 to the neck cord. The device 10 is worn as a pendant and for comfort preferably should be flat. Therefore in the device the PCB is positioned perpendicular to the bending plane 31 of the strips such that in use when the user stands the PCB is positioned vertical.

[0029] Each of the bendable piezoelectric rectangular strips in the embodiments shown in Figs. 4a, 4b, 5a and 5b may for example be made of PVDF, have a length in the range of 15mm - 20mm, a width in the range of 0.5mm - 1 mm and a thickness in the range of 40 μ m - 60 μ m. The PCB with the electronic devices mounted thereon may have a weight in the range of 5 to 15 grams.

[0030] Fig. 6 shows an embodiment of a filter 59 for

use in a device for generating a voltage. The filter is electrically coupled with its input to the piezoelectric sensor, which may for example comprise at least one rectangular shaped piezoelectric strip, each strip having a portion coupled to the PCB and another portion via the housing to the neck cord. The user movement induced voltage generated by the piezoelectric sensor 36 is rectified by element 60 which comprises at least one diode. The rectified voltage is filtered and buffered with a capacitor 62 and clamped with clamping element 64, for example a Zener diode, resulting in an output voltage at the output 66 of the circuit. The output voltage 66 may be used as a supply voltage for low power electronic components 41 mounted on the PCB 40. As long as the user moves pulling forces F_p will be exerted on the piezoelectric sensor resulting in the charging of capacitor 62. Hence the movement energy of the user is transduced by the piezoelectric sensor to an electrical energy which is used by the electronic component on the PCB.

[0031] A device for converting a movement of a user into a voltage (indicated with in Figs. 7 and 8 with reference 36) may be included in a device 90 for monitoring a user. Examples of devices for monitoring a user are an activity meter and a fall detector 2, which will be discussed in more detail later when discussing Fig. 8. A monitoring system 100, shown in Fig. 7, may comprise a device 90 for monitoring a user. The device for monitoring a user further comprises an electronic component such as a processor 72 and a sensor 78 (for example an accelerometer). The processor is coupled to a supply source 74, such as a battery, to a transmitter 80 and to the filter 59. The output voltage 66 of the filter is used as a wake up signal 68 for the processor. In response to the wake up signal going from 'low' (indicative for no user movement and thus no generated voltage by the piezoelectric sensor) to 'high' (indicative for user movement resulting voltage generation by the piezoelectric sensor) the processor switches from a standby or sleep state (in which its supply current drawn from the supply source is minimal) to an operating state (in which the processor operates according to its programmed functions). When the user moves the piezoelectric sensor causes the processor to become active. The processor 72 may cause other electronic components such as the sensor 78 to be activated. The measurement data of the sensor is analyzed and interpreted by the processor. The monitoring system 100 further comprises a base station 110. When the processor is activated by the wake up signal 68 it causes the transmitter to send a control signal 82 to the base station. The control signal indicates that the device for monitoring a user, for example a fall detector, is operational. When the control signal is not received for a predetermined period of time the device for monitoring a user may not be functional, for example due to an exhausted battery. The transmitter may further be used to send relevant sensor data and/or an alarm signal to the base station.

[0032] In an embodiment the device for monitoring a

user comprises also a receiver which may be combined with the transmitter to form a transceiver 80. The base station may comprise circuitry for enabling communications between the user and a remote call centre (such as the emergency services) via a public switched telephone network and/or a mobile communications network, and/or may provide a connection to the Internet.

[0033] Optionally, the device for monitoring a user can include a user interface 16 that provides information to the user and/or allows the user to interact or control the device for monitoring a user. The user interface 16 can comprise user input components, such as buttons, keys, switches, trackballs, touch screens or a microphone; and/or user feedback components, such as a speaker, lights, LEDs, a display or a vibration device (for providing tactile feedback to the user). In some embodiments, the user interface 16 comprises at least a dedicated button for the user to press to request help in an emergency (this button is sometimes known as a personal help button).

[0034] In some embodiments, a remotely-located clinician or other healthcare provider can interact with the user via the device 90 for monitoring a user. For example, the clinician or healthcare provider may contact the user via the transceiver circuitry 80 in the device 90 for monitoring a user and advise the user they should perform a fall risk assessment or take some medication.

[0035] In an embodiment the device for monitoring a user is a fall detector. Fig. 8 shows a block diagram of an embodiment of a fall detector 2 according to an embodiment of the invention. In this embodiment of the invention, fall detector 2 is designed to be worn or carried by a user. The fall detector 2 is preferably in the form of a pendant that is worn on a cord or chain around the user's neck. The fall detector 2 comprises the device for generating a voltage (indicated with reference signal 36), a filter 59, and one or more movement sensors for obtaining measurements of the movements of the user. The one or more movement sensors 6, 8 typically includes at least an accelerometer 6 for measuring the accelerations experienced by the user, and in this exemplary embodiment, the fall detector 2 also comprises an air pressure sensor 8 that obtains measurements of air pressure that can be processed to determine the height (altitude) or change in height of the user. The one or more movement sensors 6, 8 are connected to a processing unit 10 which receives a wake up signal from the piezoelectric sensor via filter 59. The processing unit 10 receives measurements from the movement sensors 6, 8, and processes the measurements to determine if the user of the fall detection system 2 has suffered a fall. The processing unit 10 also controls the operation of the fall detector 2. It will be appreciated that the accelerometer 6 measures the accelerations experienced by the fall detector 2, and the processing unit 10 can analyse the accelerations to identify impacts, determine the speed, change in orientation and/or change in position or height of the fall detector 2. The signal from the air pressure sensor can be analysed

by the processing unit 10 to determine the height and/or change in height of the fall detector 2. It will be appreciated that although two movement sensors are shown in this embodiment, fall detection systems according to alternative embodiments may comprise only one movement sensor (for example just the accelerometer 6 with the air pressure sensor 8 being omitted). In yet further embodiments, the fall detector 2 can comprise a gyroscope and/or magnetic field sensor(s) in addition or alternatively to the air pressure sensor 8. The fall detector 2 also comprises transmitter or transceiver circuitry 12 that allows the fall detector 2 to transmit an alarm signal to a remote call centre or the emergency services in the event a fall is detected. The transmitter or transceiver circuitry 12 can be configured to communicate with a base station 110 associated with the fall detector 2 (which can then issue an alarm or summon help from a healthcare provider or the emergency services) or via a public telephone network (such as a mobile telecommunications network) to a remote station (for example located in call centre of a healthcare provider). Where the transmitter or transceiver circuitry 12 is configured to communicate with a base station, the circuitry 12 may be configured according to any known wireless technology, for example Wi-Fi, Bluetooth, Zigbee, Near Field Communication (NFC), etc. Where the transmitter or transceiver circuitry 12 is also or alternatively provided to enable communications with a public telephone network, such as a mobile telephone network, the circuitry 12 may be also or alternatively configured for use with any suitable type of second-, third- or fourth-generation communication network, including GSM, WCDMA, LTE, etc. Also, although not shown in Fig. 8, the fall detector 2 may comprise a loudspeaker and/or microphone for enabling a user to communicate with the healthcare provider or the emergency services. The fall detector 2 also comprises a memory module 14 that is connected to the processing unit 10 and that can store measurement data from the movement sensors 6, 8, and/or computer readable code for use by the processing unit 10. It will be appreciated that the memory module 14 may only store the latest measurement data or the measurement data from pre-defined periods of time. The fall detector 2 also comprises a power source 18, such as a battery that provides power to the components of the fall detector 2. In some implementations of the fall detector 2, the processing and operations according to the invention can be performed by the processing unit 10 in the fall detector 2, with the base unit being provided merely to facilitate communications with the remote call centre/emergency services/Internet. In alternative implementations, the fall detector 2 can communicate the measurements obtained by the movement sensors 6, 8 to the base unit 110, and a processing unit in the base unit can perform the processing and operations using the measurements. This latter embodiment has the advantage that the power consumption of the fall detector 2 can be substantially reduced.

[0036] In some implementations the processing unit

10 in the fall detector 2 determines if the user has suffered a fall using a fall detection algorithm by extracting values for a feature or various features that are associated with a fall from the movement sensor measurements. For example, the accelerations and air pressure changes experienced by the fall detector 2 are measured using the accelerometer 6 and air pressure sensor 8, and these measurements are analysed by the processing unit 10 to determine whether the user has suffered a fall.

[0037] A fall can be broadly characterised by, for example, a change in altitude of around 0.5 to 1.5 metres (the range may be different depending on the part of the body that the fall detector 2 is to be worn and the height of the user), culminating in a significant impact, followed by a period in which the user does not move very much. Thus, in order to determine if a fall has taken place, the processing unit 10 can process the sensor measurements to extract values for features including one or more of a change in altitude (which can be derived from the measurements from the air pressure sensor 8, but can also or alternatively be derived from the measurements from the accelerometer 6, for example if the air pressure sensor 8 is not present), a maximum activity level (i.e. an impact) around the time that the change in altitude occurs (typically derived from the measurements from the accelerometer 6) and a period in which the user is relatively inactive following the impact (again typically derived from the measurements from the accelerometer 6). A fall by the user can be identified where a subset or all of the above features are identified in the measurements. In other words, a fall may be identified where any one or more of the required height change, impact and inactivity period are detected in the measurements.

[0038] Fig. 9 is a functional flow chart illustrating the operation of an embodiment of the invention. A method of converting a movement of a user into a voltage comprises the steps 210, 220 of pulling with a neck cord a pulling force on a piezoelectric sensor and causing with the weight of a PCB a gravity force to act on the piezoelectric sensor. When the gravity force acting on the PCB and the pulling force have opposite directions the shape of the piezoelectric sensor will change and a voltage is generated. When the piezoelectric sensor comprises one or more strips, such as discussed above and shown in Figs. 3a, 3b, 4a, 4b, 5a and 5b, these strips will bend when the user moves, for example when the user stands up from a chair, or when the user walks. The method may comprise a further filtering step 230 in which the generated voltage is filtered and/or buffered. The buffered voltage may be used as a supply source for electronic components mounted on the PCB. The filtered voltage may in a further step 240 be compared with a predetermined threshold voltage. A filtered voltage exceeding the threshold voltage indicates that the user is moving. In a further step 250 an electronic component such as a processor and/or an accelerometer is put from a standby or sleep state into an active or operating state when the filtered output voltage is larger than the predetermined

threshold voltage.

[0039] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments.

[0040] Variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A single processor or other unit may fulfil the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

Claims

1. A device (10) for converting a movement of a user into a voltage, the device comprising a neck cord (20), a piezoelectric sensor (30) and a printed circuit board (40), **characterized in that** the neck cord is coupled to the piezoelectric sensor and arranged to provide in use a pulling force acting on the piezoelectric sensor in a first direction, the printed circuit board being coupled to the piezoelectric sensor, the weight of the printed circuit board causing in use a gravity force to act on the piezoelectric sensor in a second direction being different from the first direction such that the movement of the user (5) wearing the neck cord results in a change in the shape of the piezoelectric sensor, the piezoelectric sensor generating the voltage in response to the change in the shape.
2. A device (10) according to claim 1, wherein the piezoelectric sensor (30) is shaped as a rectangular element having two opposite end portions (30a, 30b) and a middle portion (30c), the element being bendable relative to a plane (31) crossing the end portions, the neck cord (10) being coupled to the end portions of the element, the printed circuit board (40) being mechanically coupled to the middle portion of the element.
3. A device (10) according to claim 1, wherein the piezoelectric sensor (30) is shaped as a rectangular element having two opposite end portions (30a, 30b) and a middle portion (30c), the element being bendable relative to a plane (31) crossing the end portions, the neck cord (10) being coupled to the middle portion of the element, the printed circuit board (40) being mechanically coupled to the end portions of the element.
4. A device (10) according to claim 1, wherein the piezoelectric sensor comprises two rectangular shaped elements (30, 35), each element having first and second end portions (30a, 30b, 35a, 35b), each element being bendable relative to a plane (31) crossing its end portions, the neck cord being coupled to the first end portions and the printed circuit board being mechanically coupled to the second end portions.
5. A device (10) according to claims 2, 3 or 4, wherein the printed circuit board (40) is positioned perpendicular relative to the plane (31).
6. A device (90) for monitoring a user comprising the device according to any one of claims 1 to 5, wherein the device for monitoring a user further comprises a filter (59) arranged for filtering the generated voltage, the device further comprising an electronic component (72) being arranged to switch from a standby state to an operating state in dependence of the filtered generated voltage exceeding a threshold.
7. A device (90) for monitoring a user according to claim 6, wherein the device is further arranged to transmit a control signal (82) in response to the electronic component (72) switching from the standby state to the operating state.
8. A device (90) for monitoring a user according to claim 6 or 7, wherein the electronic component is a processor and/or a movement sensor for measuring the movements of the user.
9. A device (90) for monitoring a user according to claim 6 or 7, wherein the electronic component (72) is further arranged to switch from the operating state to the standby state a predetermined time after the voltage is below a further threshold.
10. A fall detector comprising the device (90) for monitoring a user according to claim 6 or 7, wherein the electronic component is a movement sensor for measuring the movements of the user, the device further comprising a processor (72), the processor being arranged to switch from a standby state to an operating state in dependence of a wake up signal received from the movement sensor, the processor being further arranged to process the measurements from the movement sensor to detect a potential fall of the user, the fall detector being further arranged to transmit an alarm signal in response to the processor having detected a possible fall.
11. A system (100) for monitoring a user comprising a base station (110) arranged for receiving the control signal transmitted by the device (90) for monitoring

a user according to claim 9 or a fall detector according to claim 10, the base station being further arranged to send a warning signal when no control signal has been received for a predetermined time period.

12. A method of converting a movement of a user into a voltage, the method being **characterized in** comprising the steps of

- causing with a neck cord a pulling force to act on a piezoelectric sensor in a first direction;
- causing with the weight of a printed circuit board a gravity force to act on the piezoelectric sensor in a second direction not being the same as the first direction such that in use, the weight of the printed circuit board acting on the piezoelectric sensor and the pulling force passed on by the neck cord to the piezoelectric sensor cause a change in the shape of the piezoelectric sensor resulting in the generating of a voltage.

13. A method of monitoring a user comprising the method of converting a movement of a user into a voltage according to claim 12, the method of monitoring a user further comprising the steps of

- filtering the generated voltage;
- comparing the filtered voltage generated by the piezoelectric sensor (30) with a threshold;
- switching an electronic component from standby to operating when the filtered voltage exceeds the threshold.

14. A method of monitoring a user according to claim 13, further comprising the step of:

- transmitting a control signal (82) in response to electronic component (72) switching from the standby state to the operating state.

15. A method of detecting a potential fall comprising the method of monitoring a user according to claim 13 or 14 and further, after the electronic component is switched to operating, comprising the steps of:

- monitoring with a movement sensor the movements of the user;
- processing the measurements from the movement sensor with a processor to detect a potential fall of the user.

Patentansprüche

1. Vorrichtung (10) zum Umwandeln einer Bewegung eines Benutzers in eine Spannung, wobei die Vorrichtung eine Halskordel (20), einen piezoelektri-

schen Sensor (30) und eine Leiterplatte (40) umfasst, **dadurch gekennzeichnet, dass** die Halskordel mit dem piezoelektrischen Sensor gekoppelt und eingerichtet ist, um beim Gebrauch eine Zugkraft bereitzustellen, die auf den piezoelektrischen Sensor in eine erste Richtung einwirkt, wobei die Leiterplatte mit dem piezoelektrischen Sensor gekoppelt ist, wobei das Gewicht der Leiterplatte beim Gebrauch verursacht, dass eine Schwerkraft auf den piezoelektrischen Sensor in eine zweite Richtung, die von der ersten Richtung unterschiedlich ist, derart einwirkt, dass die Bewegung des Benutzers (5), der die Halskordel trägt, in einer Änderung der Form des piezoelektrischen Sensors resultiert, wobei der piezoelektrische Sensor die Spannung als Reaktion auf die Änderung der Form erzeugt.

2. Vorrichtung (10) nach Anspruch 1, wobei der piezoelektrische Sensor (30) als ein rechteckiges Element geformt ist, das zwei entgegengesetzte Endabschnitte (30a, 30b) und einen Mittenabschnitt (30c) hat, wobei das Element in Bezug auf eine Ebene (31), die die Endabschnitte kreuzt, biegsam ist, wobei die Halskordel (10) mit den Endabschnitten des Elements gekoppelt ist, wobei die Leiterplatte (40) mechanisch mit dem Mittenabschnitt des Elements gekoppelt ist.

3. Vorrichtung (10) nach Anspruch 1, wobei der piezoelektrische Sensor (30) als ein rechteckiges Element geformt ist, das zwei entgegengesetzte Endabschnitte (30a, 30b) und einen Mittenabschnitt (30c) hat, wobei das Element in Bezug auf eine Ebene (31), die die Endabschnitte kreuzt, biegsam ist, wobei die Halskordel (10) mit dem Mittenabschnitt des Elements gekoppelt ist, wobei die Leiterplatte (40) mechanisch mit den Endabschnitten des Elements gekoppelt ist.

4. Vorrichtung (10) nach Anspruch 1, wobei der piezoelektrische Sensor zwei rechteckig geformte Elemente (30, 35) umfasst, wobei jedes Element einen ersten und einen zweiten Endabschnitt (30a, 30b, 35a, 35b) umfasst, wobei jedes Element in Bezug auf eine Ebene (31), die seine Endabschnitte kreuzt, biegsam ist, wobei die Halskordel mit den ersten Endabschnitten gekoppelt ist, und die Leiterplatte mechanisch mit den zweiten Endabschnitten gekoppelt ist.

5. Vorrichtung (10) und nach den Ansprüchen 2, 3 oder 4, wobei die Leiterplatte (40) senkrecht in Bezug auf die Ebene (31) positioniert ist.

6. Vorrichtung (90) zum Überwachen eines Benutzers, die die Vorrichtung nach einem der Ansprüche 1 bis 5 umfasst, wobei die Vorrichtung zum Überwachen eines Benutzers ferner ein Filter (59) umfasst, das

- zum Filtern der erzeugten Spannung eingerichtet ist, wobei die Vorrichtung ferner ein elektronisches Bauteil (72) umfasst, das eingerichtet ist, um aus einem Standby-Zustand auf einen Betriebszustand in Abhängigkeit von der gefilterten erzeugten Spannung, die einen Schwellenwert überschreitet, umgeschaltet zu werden.
7. Vorrichtung (90) zum Überwachen eines Benutzers nach Anspruch 6, wobei die Vorrichtung ferner eingerichtet ist, um ein Steuersignal (82) als Reaktion darauf, dass das elektronische Bauteil (72) von dem Standby-Zustand auf den Betriebszustand umgeschaltet, zu übertragen.
8. Vorrichtung (90) zum Überwachen eines Benutzers nach Anspruch 6 oder 7, wobei das elektronische Bauteil ein Prozessor und/oder ein Bewegungssensor zum Messen der Bewegungen des Benutzers ist.
9. Vorrichtung (90) zum Überwachen eines Benutzers nach Anspruch 6 oder 7, wobei das elektronische Bauteil (72) ferner eingerichtet ist, um von dem Betriebszustand auf den Standby-Zustand eine vorbestimmte Zeit, nachdem die Spannung unter einem weiteren Schwellenwert ist, umzuschalten.
10. Sturzdetektor, der die Vorrichtung (90) zum Überwachen eines Benutzers nach Anspruch 6 oder 7 umfasst, wobei das elektronische Bauteil ein Bewegungssensor zum Messen der Bewegungen des Benutzers ist, wobei die Vorrichtung ferner einen Prozessor (72) umfasst, wobei der Prozessor eingerichtet ist, um von einem Standby-Zustand auf einen Betriebszustand in Abhängigkeit von einem Wecksignal, das von dem Bewegungssensor empfangen wird, umzuschalten, wobei der Prozessor ferner eingerichtet ist, um die Messungen von dem Bewegungssensor zu verarbeiten, um einen potentiellen Sturz des Benutzers zu erfassen, wobei der Sturzdetektor ferner eingerichtet ist, um als Reaktion darauf, dass der Prozessor einen möglichen Sturz erfasst hat, ein Alarmsignal zu übertragen.
11. System (100) zum Überwachen eines Benutzers, das eine Basisstation (110) umfasst, die eingerichtet ist, um das Steuersignal zu empfangen, das von der Vorrichtung (90) zum Überwachen eines Benutzers nach Anspruch 9 oder eines Sturzdetektors nach Anspruch 10 übertragen wird, wobei die Basisstation ferner eingerichtet ist, um ein Warnsignal zu senden, wenn während einer vorbestimmten Zeitspanne kein Steuersignal empfangen wurde.
12. Verfahren zum Umwandeln einer Bewegung eines Benutzers in eine Spannung, Verfahren **gekennzeichnet dadurch, dass** es die Schritte des
- Veranlassens mit einer Halskordel einer Zugkraft zum Einwirken auf einen piezoelektrischen Sensor in eine erste Richtung;
 - Veranlassens mit dem Gewicht einer Leiterplatte, dass eine Schwerkraft auf den piezoelektrischen Sensor in eine zweite Richtung, die nicht dieselbe ist wie die erste Richtung, derart einwirkt, dass das Gewicht der Leiterplatte beim Gebrauch auf den piezoelektrischen Sensor einwirkt und die Zugkraft, die von der Halskordel zu dem piezoelektrischen Sensor weitergegeben wird, eine Änderung der Form des piezoelektrischen Sensors verursacht, die in dem Erzeugen einer Spannung resultiert, umfasst.
13. Verfahren zum Überwachen eines Benutzers, das das Verfahren des Umwandeln einer Bewegung eines Benutzers in eine Spannung nach Anspruch 12 umfasst, wobei das Verfahren zum Überwachen eines Benutzers ferner folgende Schritte umfasst
- Filtern der erzeugten Spannung;
 - Vergleichen der gefilterten Spannung, die von dem piezoelektrischen Sensor (30) erzeugt wird, mit einem Schwellenwert;
 - Umschalten eines elektronischen Bauteils von Standby auf Betrieb, wenn die gefilterte Spannung den Schwellenwert überschreitet.
14. Verfahren zum Überwachen eines Benutzers nach Anspruch 13, das ferner die folgenden Schritte umfasst:
- Übertragen eines Steuersignals (82) als Reaktion darauf, dass das elektronische Bauteil (72) von dem Standby-Zustand auf den Betriebszustand umschaltet.
15. Verfahren zum Erfassen eines potentiellen Sturzes, das das Verfahren des Überwachens eines Benutzers nach Anspruch 13 oder 14 umfasst, und ferner, nachdem das elektronische Bauteil auf Betrieb umgeschaltet wurde, die folgenden Schritte umfasst:
- Überwachen der Bewegungen des Benutzers mit einem Bewegungssensor;
 - Verarbeiten der Messungen aus dem Bewegungssensor mit einem Prozessor, um einen potentiellen Sturz des Benutzers zu erfassen.

Revendications

1. Dispositif (10) pour convertir un mouvement d'un utilisateur en une tension, le dispositif comprenant un collier (20), un capteur piézo-électrique (30), et une carte de circuits imprimés (40), **caractérisé en ce que** le collier est couplé au capteur piézo-électrique

et agencé pour fournir, en utilisation, une force de traction agissant sur le capteur piézo-électrique dans un premier sens, la carte de circuits imprimés étant couplée au capteur piézo-électrique, le poids de la carte de circuits imprimés provoquant, en utilisation, une force de gravité pour agir sur le capteur piézo-électrique dans un deuxième sens qui est différent du premier sens de sorte que le mouvement de l'utilisateur (5) portant le collier engendre un changement de la forme du capteur piézo-électrique, le capteur piézo-électrique générant la tension en réponse au changement de forme.

2. Dispositif (10) selon la revendication 1, dans lequel le capteur piézo-électrique (30) est formé en tant qu'un élément rectangulaire comportant deux portions d'extrémité opposées (30a, 30b) et une portion centrale (30c), l'élément pouvant être plié par rapport à un plan (31) en intersection avec les portions d'extrémité, le collier (10) étant couplé aux portions d'extrémité de l'élément, la carte de circuits imprimés (40) étant couplée mécaniquement à la portion centrale de l'élément.
3. Dispositif (10) selon la revendication 1, dans lequel le capteur piézo-électrique (30) est formé en tant qu'un élément rectangulaire comportant deux portions d'extrémité opposées (30a, 30b) et une portion centrale (30c), l'élément pouvant être plié par rapport à un plan (31) en intersection avec les portions d'extrémité, le collier (10) étant couplé à la portion centrale de l'élément, la carte de circuits imprimés (40) étant couplée mécaniquement aux portions d'extrémité de l'élément.
4. Dispositif (10) selon la revendication 1, dans lequel le capteur piézo-électrique comprend deux éléments de forme rectangulaire (30, 35), chaque élément comportant des première et deuxième portions d'extrémité (30a, 30b, 35a, 35b), chaque élément pouvant être plié par rapport à un plan (31) en intersection avec ses portions d'extrémité, le collier étant couplé aux premières portions d'extrémité et la carte de circuits imprimés étant couplée mécaniquement aux deuxièmes portions d'extrémité.
5. Dispositif (10) selon la revendication 2, 3 ou 4, dans lequel la carte de circuits imprimés (40) est positionnée perpendiculairement au plan (31).
6. Dispositif (90) de surveillance d'un utilisateur comprenant le dispositif selon l'une quelconque des revendications 1 à 5, dans lequel le dispositif de surveillance d'un utilisateur comprend en outre un filtre (59) agencé pour filtrer la tension générée, le dispositif comprenant en outre un composant électronique (72) qui est agencé pour commuter d'un état de veille à un état de fonctionnement en fonction du dépassement d'un seuil par la tension générée filtrée.

sement d'un seuil par la tension générée filtrée.

7. Dispositif (90) de surveillance d'un utilisateur selon la revendication 6, dans lequel le dispositif est en outre agencé pour transmettre un signal de commande (82) en réponse à la commutation du composant électronique (72) de l'état de veille à l'état de fonctionnement.
8. Dispositif (90) de surveillance d'un utilisateur selon la revendication 6 ou 7, dans lequel le composant électronique est un processeur et/ou un capteur de mouvement pour mesurer les mouvements de l'utilisateur.
9. Dispositif (90) de surveillance d'un utilisateur selon la revendication 6 ou 7, dans lequel le composant électronique (72) est en outre agencé pour commuter de l'état de fonctionnement à l'état de veille un temps prédéterminé après que la tension est inférieure à un autre seuil.
10. Détecteur de chute comprenant le dispositif (90) pour surveiller un utilisateur selon la revendication 6 ou 7, dans lequel le composant électronique est un capteur de mouvement pour mesurer les mouvements de l'utilisateur, le dispositif comprenant en outre un processeur (72), le processeur étant agencé pour commuter d'un état de veille à un état de fonctionnement en fonction d'un signal de réveil reçu en provenance du capteur de mouvement, le processeur étant en outre agencé pour traiter les mesures du capteur de mouvement afin de détecter une chute potentielle de l'utilisateur, le détecteur de chute étant en outre agencé pour transmettre un signal d'alarme en réponse à la détection d'une chute possible par le processeur.
11. Système (100) de surveillance d'un utilisateur comprenant une station de base (110) agencée pour recevoir le signal de commande transmis par le dispositif (90) de surveillance d'un utilisateur selon la revendication 9 ou un détecteur de chute selon la revendication 10, la station de base étant en outre agencée pour envoyer un signal d'avertissement lorsqu'aucun signal de commande n'a été reçu pendant une période de temps prédéterminée.
12. Procédé de conversion d'un mouvement d'un utilisateur en une tension, le procédé étant **caractérisé en ce qu'il** comprend les étapes consistant à :
 - provoquer, avec un collier, une force de traction pour agir sur un capteur piézo-électrique dans un premier sens ;
 - provoquer, avec le poids d'une carte de circuits imprimés, une force de gravité pour agir sur le capteur piézo-électrique dans un deuxième

sens qui est différent du premier sens, de sorte que, en utilisation, le poids de la carte de circuits imprimés agissant sur le capteur piézo-électrique et la force de traction transmise par le collier au capteur piézo-électrique provoquent un changement de la forme du capteur piézo-électrique engendrant la génération d'une tension.

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13. Procédé de surveillance d'un utilisateur comprenant le procédé de conversion d'un mouvement d'un utilisateur en une tension selon la revendication 12, le procédé de surveillance d'un utilisateur comprenant en outre les étapes consistant à :

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- filtrer la tension générée ;
- comparer la tension filtrée générée par le capteur piézo-électrique (30) à un seuil ;
- commuter un composant électronique d'un état de veille à un état de fonctionnement lorsque la tension filtrée dépasse le seuil.

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14. Procédé de surveillance d'un utilisateur selon la revendication 13, comprenant en outre l'étape consistant à :

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- transmettre un signal de commande (82) en réponse à la commutation d'un composant électronique (72) de l'état de veille à l'état de fonctionnement.

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15. Procédé de détection d'une chute potentielle comprenant le procédé de surveillance d'un utilisateur selon la revendication 13 ou 14, et comprenant en outre, après la commutation du composant électronique à l'état de fonctionnement, les étapes consistant à :

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- surveiller, avec un capteur de mouvement, les mouvements de l'utilisateur ;
- traiter les mesures du capteur de mouvement avec un processeur pour détecter une chute potentielle de l'utilisateur.

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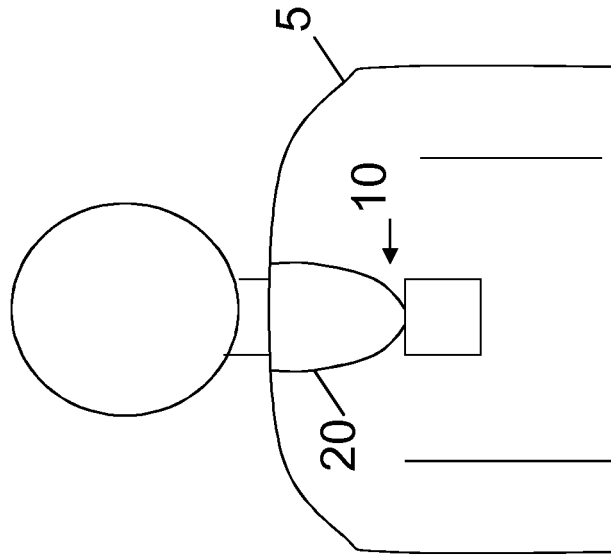


Fig. 1

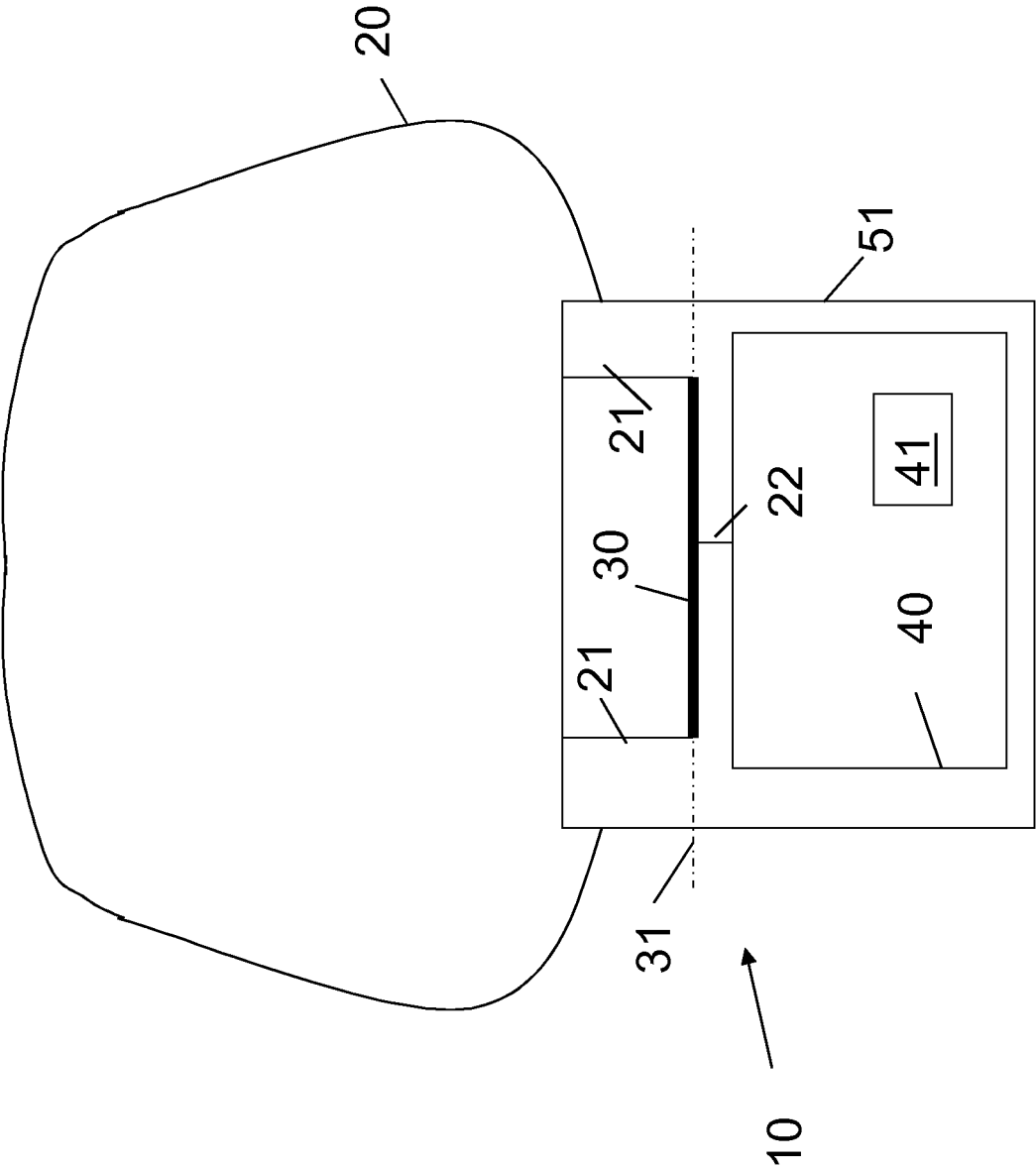


Fig. 2

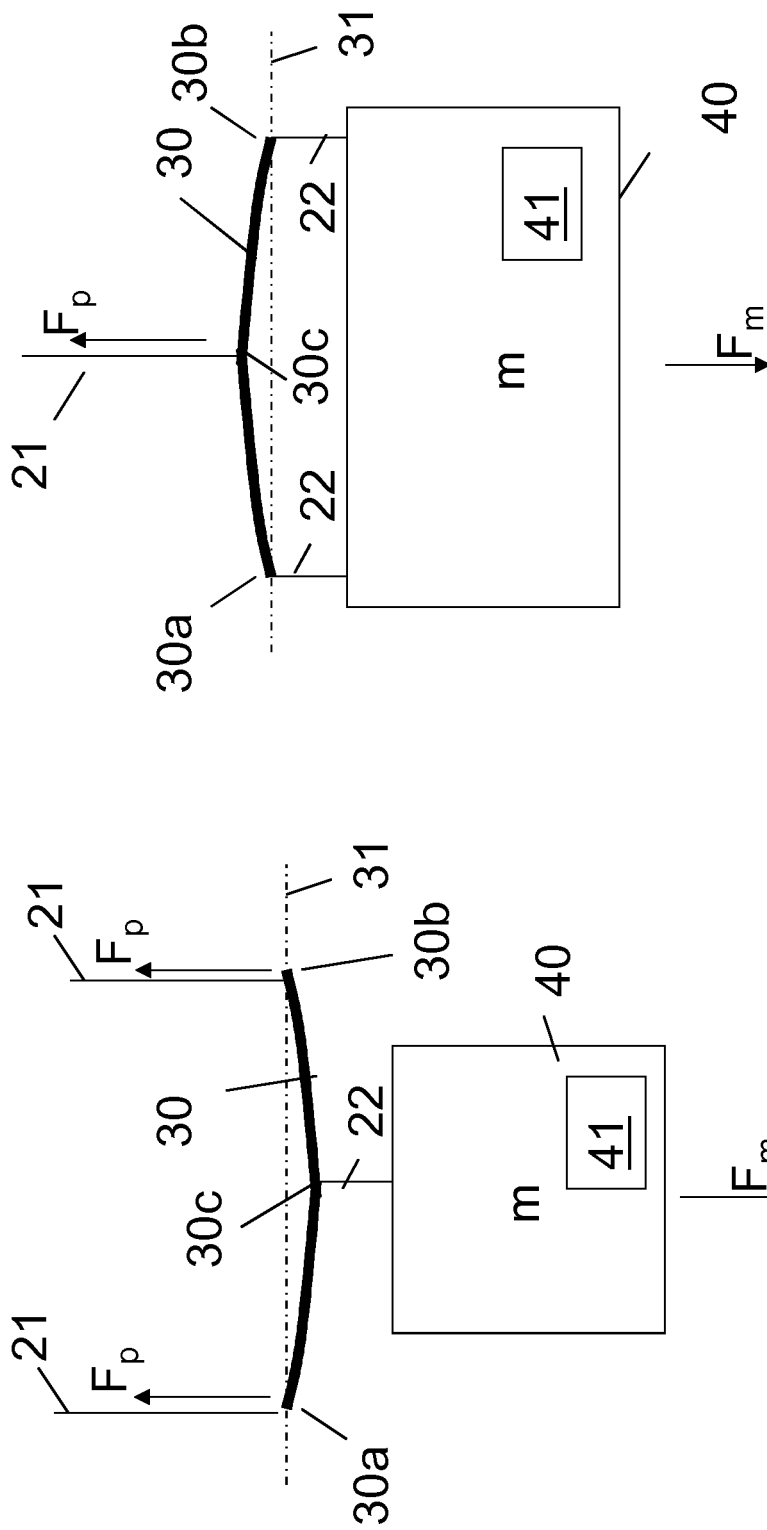


Fig. 3a

Fig. 3b

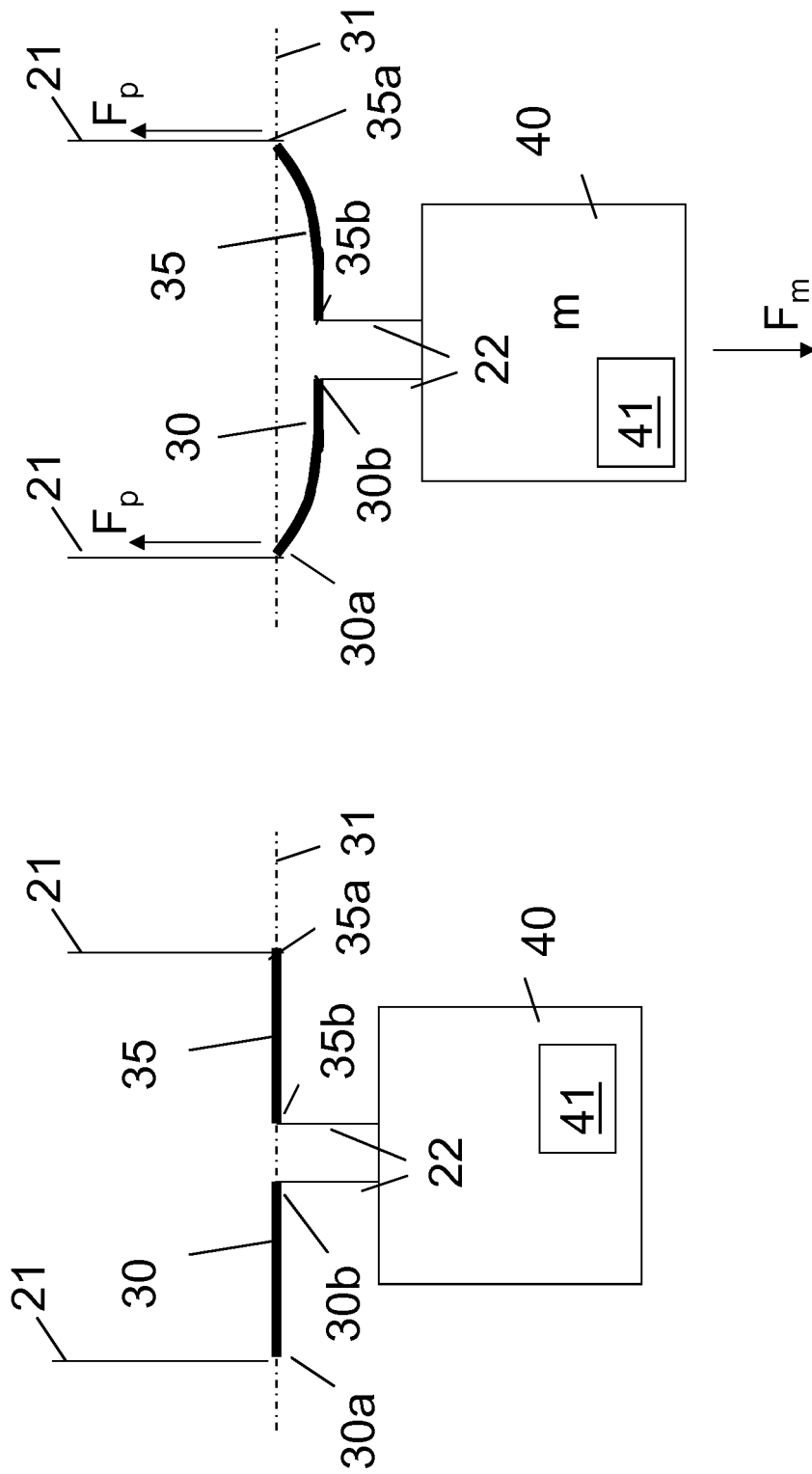


Fig. 4b

Fig. 4a

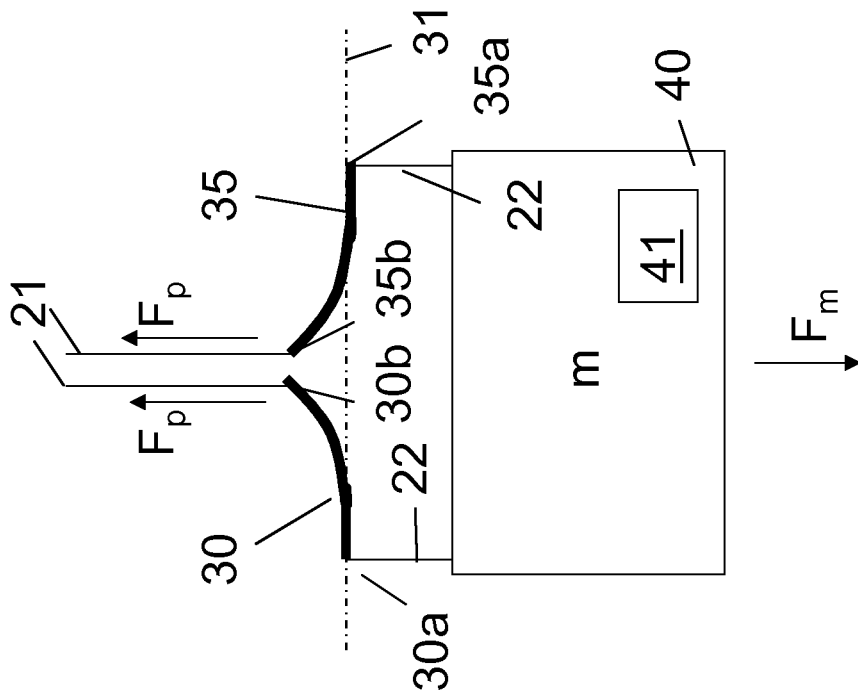


Fig. 5a

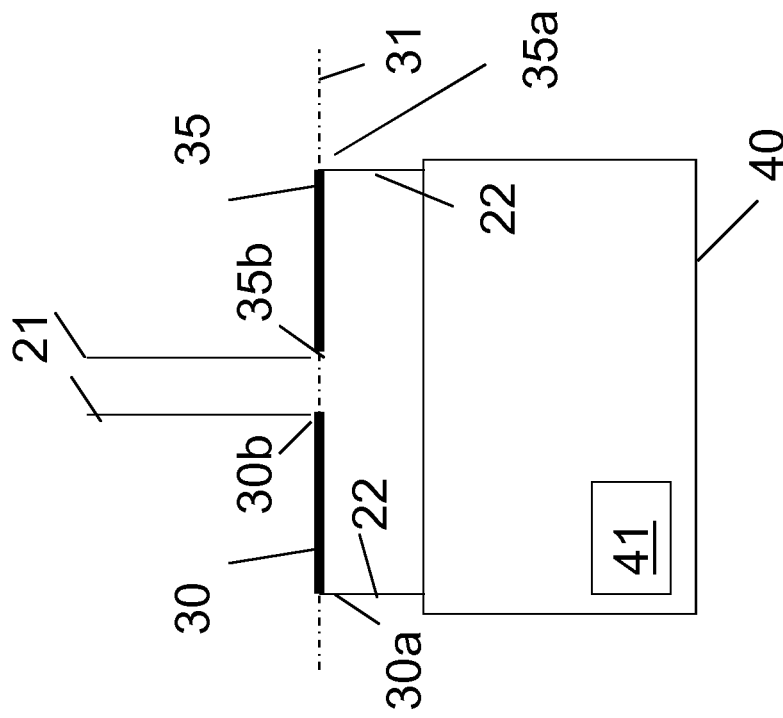


Fig. 5b

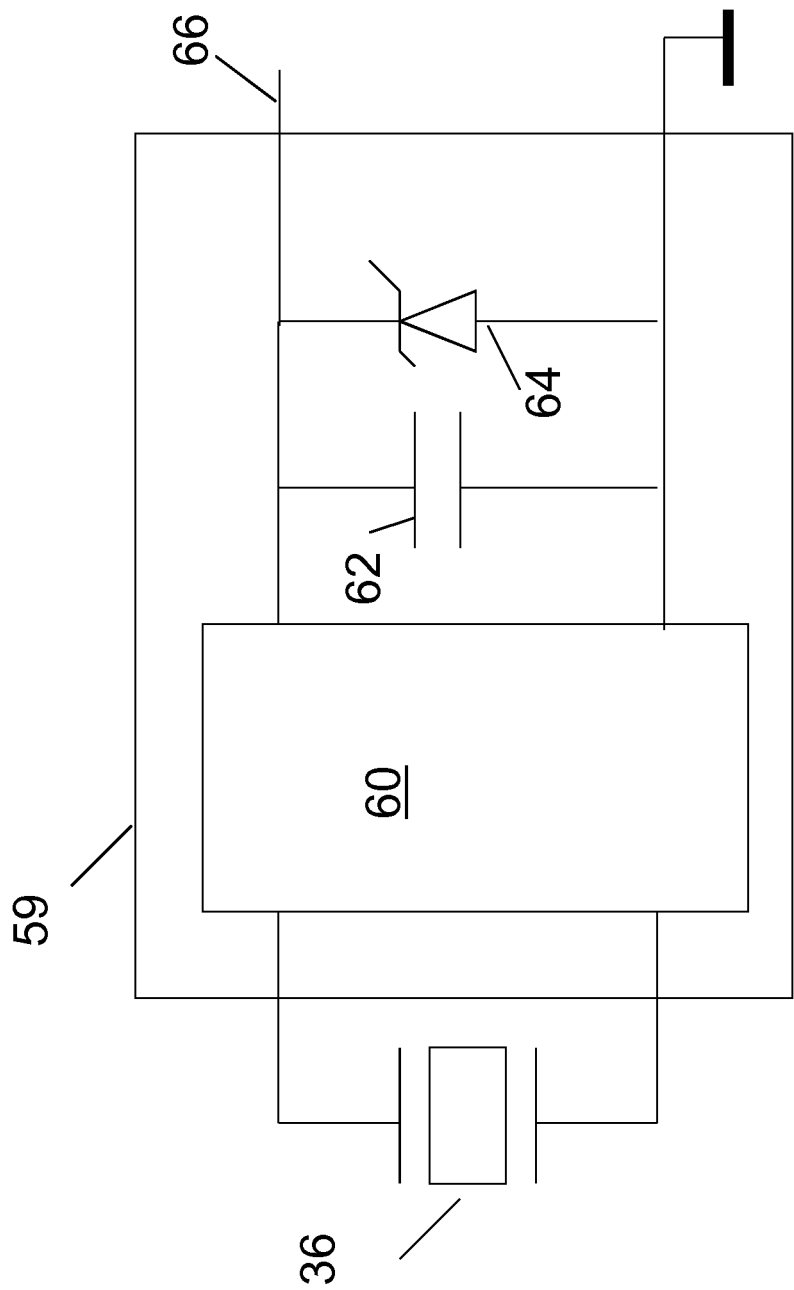


Fig. 6

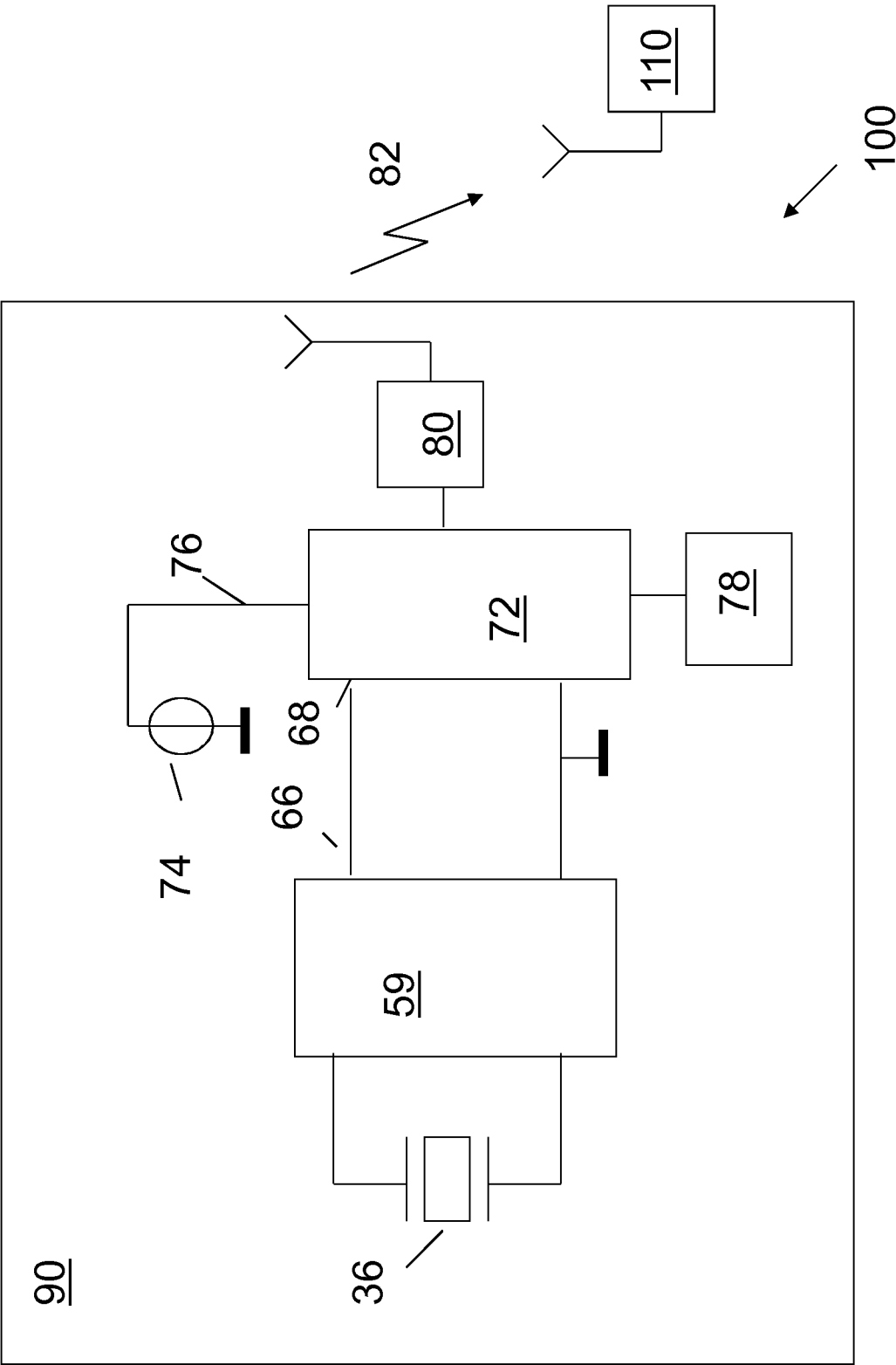


Fig. 7

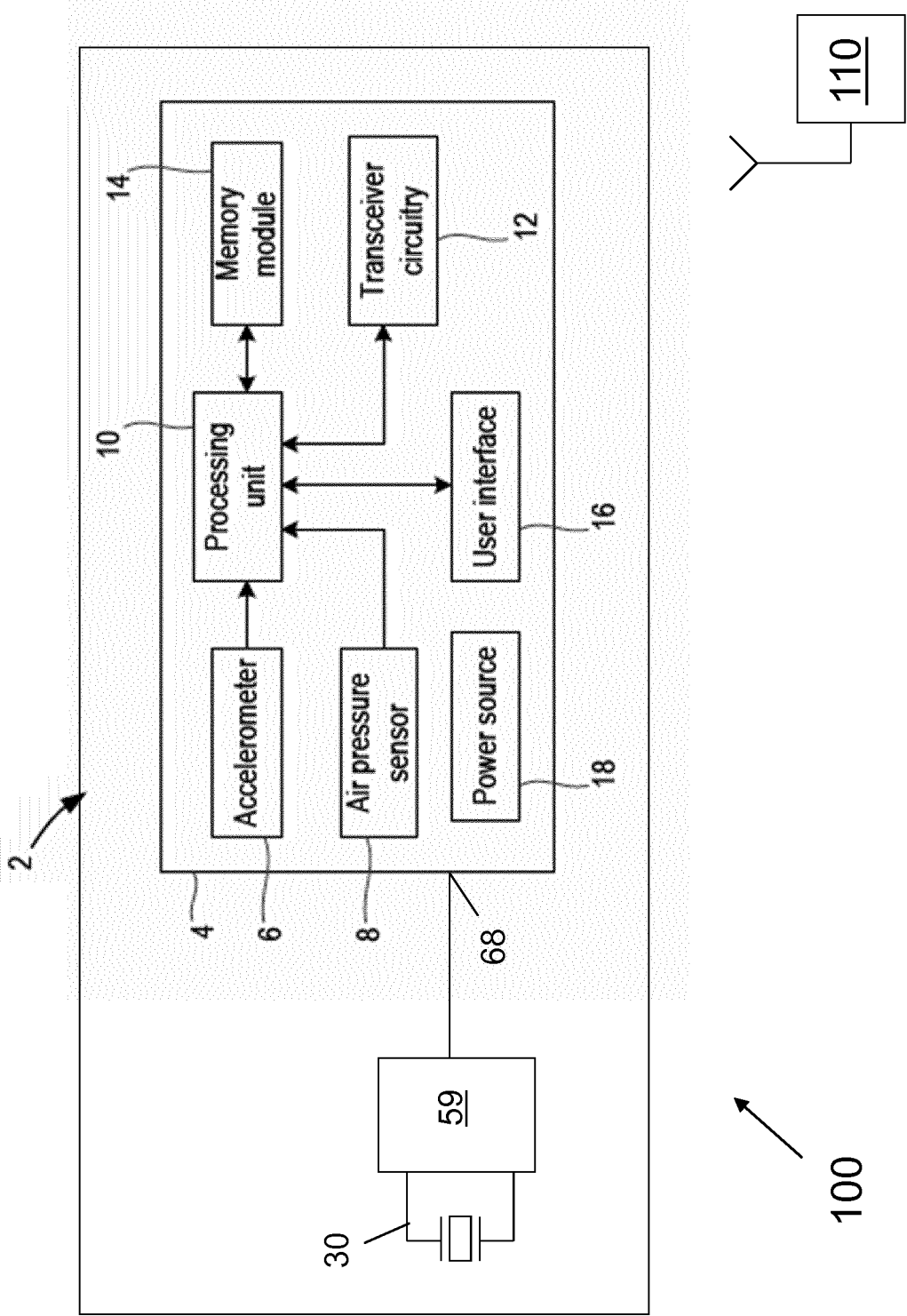


Fig. 8

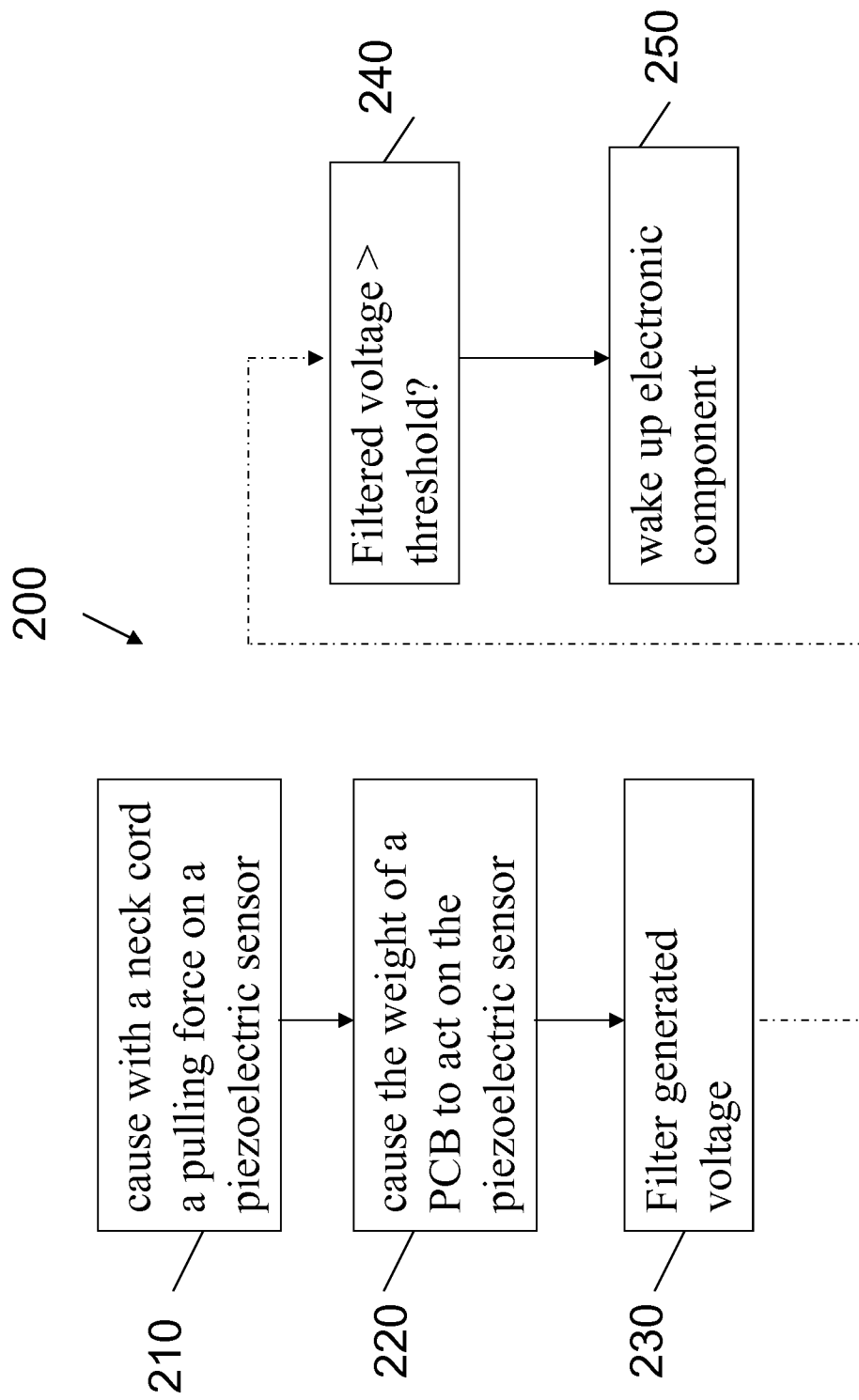


Fig. 9

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 2549228 A1 [0003]
- JP 2002140776 A [0004]

专利名称(译)	一种用于将用户的运动转换为电压的装置		
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优先权	2013188799 2013-10-16 EP		
其他公开文献	EP3058601B1		
外部链接	Espacenet		

摘要(译)

用于将用户的运动转换成电压的装置 (10) 包括颈线 (20) , 压电传感器 (30) 和印刷电路板 (40) 。颈绳耦合到压电传感器并在使用中提供沿第一方向作用在压电传感器上的拉力。印刷电路板电气和机械地耦合到压电传感器。印刷电路板的重量导致使用重力沿第二方向作用在压电传感器上, 该第二方向与第一方向不同, 使得佩戴颈绳的使用者 (5) 的运动引起形状的变化。压电传感器响应于此产生电压。电压可以用作安装在PCB上的电气部件 (41) 的电源, 或者可以用作诸如处理器 (41) 或加速度计的电气部件的唤醒信号。