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(71) Applicant: **Benecke-Kaliko AG**
**30419 Hannover (DE)**

(72) Inventors:
- **Kleiber, Arthur**
  **21079 Hamburg (DE)**
- **Hidalgo Lucio, Gabriel Cristian**
  **34346 Hannoversch Münden (DE)**
- **Richard, Philippe**
  **92631 Gennevilliers Cedex (FR)**
- **Lakhal, Lahssan**
  **69300 Caluire-et-Cuire (FR)**
- **Lindner, Felix**
  **Montvale, NJ New Jersey 07645 (US)**

(74) Representative: **Preusser, Andrea**
**Continental Aktiengesellschaft**
**Intellectual Property**
**Postfach 169**
**30001 Hannover (DE)**

## (54) INSOLE FOR A SHOE

(57) The present invention relates to a insole (2) for shoes, comprising a top layer (4), a bottom layer (6), an intermediate layer (8), which is arranged between the top layer (4) and the bottom layer (6), a processing unit (10), an energy unit (12) configured for providing electrical energy, at least one sensor unit (14) configured for sensing force, acceleration, rotation rate, angular position, temperature and/or humidity, and a wireless data interface (16), wherein each of the processing unit (10), the energy unit (12), the at least one sensor unit (14) and the wireless data interface (16) is completely embedded in the intermediate layer 8, wherein the processing unit (10) is connected to the energy unit (12), such that the processing unit (10) is supplied with electrical energy by the energy unit (12), wherein each sensor unit (14) is connected to the processing unit (10) for transferring sensor data to the processing unit (10), wherein the processing unit (10) is configured to determine work data based on the sensor data, such that a work data amount of the work data is smaller than a sensor data amount of the sensor data, wherein the wireless data interface (16) is connected to the processing unit (10) for transmitting the work data or a work signal representing the work data to the wireless data interface (16), and wherein the wireless data interface (16) is configured to wirelessly transmit a communication signal, which represents the work data.

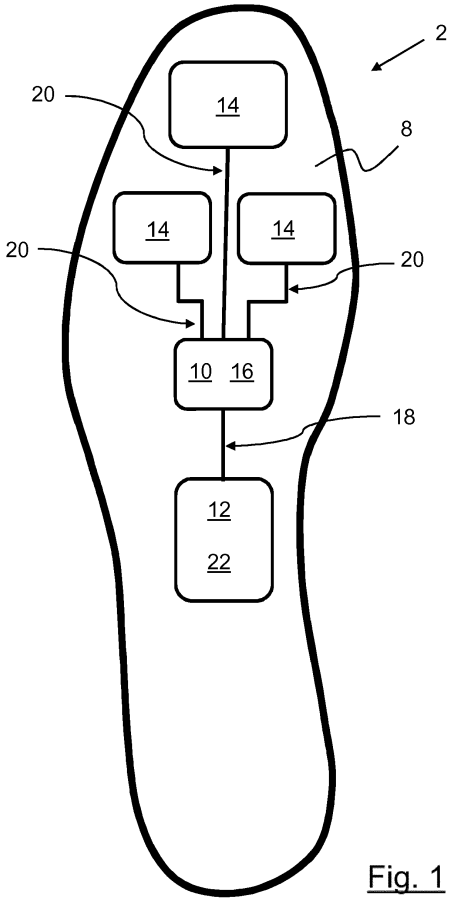


Fig. 1

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## Description

**[0001]** The present invention relates to an insole for a shoe. Shoes as well as insoles are generally known from the prior art. Furthermore, sensors embedded in the sole of a shoe are also known, wherein the shoe also comprises a wireless communication unit in order to transmit the sensor data received from the sensors embedded in the sole of the shoe to a receiver. The insole of the shoe does not comprise any electronics, but is configured to ensure a high wearing comfort. If the shoe reaches the end of lifetime, the shoe is usually considered as trash. The same applies to the sensor and communication unit, which are embedded in the sole of the shoe.

**[0002]** An object of the present invention is to provide a sustainable solution for detecting physical parameters related to the shoe without reducing the wearing comfort of the shoe.

**[0003]** The object of the present invention is solved by an insole for a shoe according to claim 1. The present invention therefore relates to an insole for a shoe. The insole comprises a top layer, a bottom layer, an intermediate layer, which is arranged between the top layer and the bottom layer, a processing unit, an energy unit, which is configured for providing electrical energy, at least one sensor unit configured for sensing force, acceleration, rotation rate, angular position, temperature and/or humidity, and a wireless data interface. Each of the processing unit, the energy unit, the at least one sensor unit and the wireless data interface is completely embedded in the intermediate layer. The processing unit is connected to the energy unit, such that the processing unit is supplied with electrical energy of the energy unit. Preferably, the energy unit is the only supply for electrical energy to the processing unit. Each sensor unit is connected to the processing unit for transferring sensor data to the processing unit. Each of the sensor units may also be connected directly or indirectly to the energy unit, such that each of the sensor units is supplied with electrical energy by the energy unit. The processing unit is configured to determine work data based on the sensor data, such that a work data amount of the work data is smaller than a sensor data amount of the sensor data. The wireless data interface is connected to the processing unit for transmitting the work data or a work signal representing the work data to the wireless data interface. The wireless data interface is configured to wirelessly transmit a communication signal, which represents the work data.

**[0004]** The insole for the shoe can be inserted into any shoe. The insole can therefore be used for different shoes, if the insole is exchanged between the shoes. Even if a shoe reaches the end of lifetime, the insole can be extracted from the shoe and inserted in a new shoe. The insole therefore has a high sustainability. The arrangement of the different layers of the insole ensures a high wearing comfort since the processing unit, the energy unit, the at least one sensor unit and the wireless data interface are embedded completely in the intermediate layer. This intermediate layer is arranged between the top layer and the bottom layer of the insole. As a result, the top layer prevents that, for instance, the at least one sensor unit or the processing unit can be noticed via a foot. According to a preferred embodiment, the insole comprises a set of three layers, namely the top layer, the bottom layer and the intermediate layer, which is arrange between the top layer and the bottom layer. However, according to another embodiment, the insole may comprise a further intermediate layer, such that the intermediate layers may be arranged between the top layer and the bottom layer.

**[0005]** The intermediate layer preferably extends over only part of a base area of the top layer and/or extends over only part of the base area of the bottom layer. Preferably the intermediate layer is formed exclusively in a foot arch area of the insole. However, it may also be provided that the processing unit and/or the energy unit is/are arranged in the intermediate layer in the foot arch area of the insole, wherein the sensors are arranged outside the foot arch area.

**[0006]** The at least one sensor unit is configured to detect a physical interaction between the foot and the insole. For instance, the at least one sensor unit may be configured for sensing a force acting on the insole as this force indirectly acts on the sensor unit, too. Thus, at least one sensor may be configured as a force sensor. If a person wears shoes, wherein at least one of the shoes has the insole inside, the acceleration of the shoe may be detected, if at least one sensor is configured for sensing the acceleration. Thus, this sensor may be an acceleration sensor.

**[0007]** According to further preferred embodiments, at least one sensor may be a rotation rate sensor, at least one sensor may be an angular position detection sensor, at least one sensor may be a temperature sensor and/or at least one sensor may be a humidity detecting sensor. The insole may comprise more than one sensor, such that a plurality of sensors may be embedded in the intermediate layer. However, the sensors may be configured, such that the sensors form a single sensor unit. As a result, such a sensor unit may be configured for sensing force, acceleration and humidity as well as temperature. However, the sensor unit may be configured to detect other parameters as well. Preferably, the sensor unit is configured to generate sensor data which represents the force, acceleration, rotation rate, angular position, temperature and/or humidity, which has been sensed or detected by the sensor unit.

**[0008]** The sensor unit is connected to the processing unit for transferring the sensor data to the processing unit. The processing unit can determine work data based on the sensor data. For instance, the processing unit may be configured to evaluate an average force applied to the sensor unit or an average acceleration applied to the sensor unit. As the result, the work data representing the average force or average acceleration has a smaller data amount than the amount of data transferred from the sen-

sor unit to the processing unit. The processing unit is therefore configured to determine work data based on the sensor data, such that a work data amount of the work data is smaller than the sensor data amount of the sensor data.

**[0009]** The wireless data interface is connected to the processing unit. This connection between the wireless data interface and the processing unit may be an external signal connection. However, the wireless data interface may be part of the processing unit, such that this connection may be an internal connection within the processing unit. The work data or signal representing the work data is transmitted to the wireless data interface, such that the wireless data interface can transmit a communication signal, for instance to a receiver, which may be formed by a smartphone, a computer, a wearable device or another device, when the communication signal directly or indirectly represents the work data. As an effect, the work data can be transferred to the receiver, wherein the work data can be evaluated. For instance, if the sensor unit is configured for sensing the force applied to the insole, the work data can represent an average force over a predetermine period of time. After this period, a new average force is transferred via the work data to the receiver. The receiver may evaluate this average force in order to establish further information which may be of interest for the person who is wearing the shoe.

**[0010]** According to a preferred embodiment of the insole, the insole comprises a plurality of sensor units configured as force sensors, wherein the force sensors are distributed, preferably evenly distributed, in the intermediate layer, wherein each force sensor is configured to measure a force and/or a pressure. The distribution of the force sensors allows to generate sensor data which represents the distributed force applied to the insole. Further information may be generated from the distribution of force applied to the insole. For instance, if most of the force is applied to an outer foot region edge of the insole, this may be seen from the distribution of the forces applied to the insole. But the evaluation as such of the sensor data is not subject of the insole.

**[0011]** According to a further preferred embodiment of the insole, the processing unit is configured to determine the work data based on the sensor data of the force sensors, such that the work data represents a distribution of forces and/or pressure acting on the insole. Therefore, the processing unit may be configured to combine the sensor data of the force sensors in order to determine the work data based on the sensor data of the plurality of force sensors. The distribution of forces and/or pressure represented by the work data may be used for further evaluation purpose. But again, the evaluation is not subject of the insole as such.

**[0012]** According to a further preferred embodiment of the insole, the processing unit is configured to determine the work data based on the sensor data of the force sensors, such that the work data represents the highest force or the highest pressure acting on the insole and/or the smallest force or the smallest pressure acting on the insole and/or a mean value of force or pressure acting on the insole. The processing unit may therefore extract the highest, the smallest and/or mean value of the detected forces or pressure, such that the work data would have a reasonable smaller amount of data than the sensor data. For specific cases, it may be sufficient to know the value of the highest force, the highest pressure, the smallest force, the smallest pressure, the mean force or the mean pressure acted on the insole. If this is the case, the previously explained embodiment of the insole can provide this information.

**[0013]** According to a further preferred embodiment of the insole, the insole comprises a plurality of sensor units configured as temperature sensors, wherein the temperature sensors are distributed, preferably evenly distributed, in the intermediate layer, wherein each temperature sensor is configured to measure a temperature, and wherein the processing unit is configured to determine the work data based on the sensor data of the temperature sensors, such that the work data represents the highest temperature of the insole, the lowest temperature of the insole or a mean temperature of the insole. Each of the mean temperature, the smallest temperature and/or the highest temperature may be of interest. The temperature in the shoe may not be the same over the base area of the shoe. Since the temperature sensors are distributed within the intermediate layer, this distribution may very likely allow to detect the lowest and/or highest temperature. The processing unit may be configured to determine from the sensor data of the plurality of sensor data, which of the temperature detected by the temperature sensors is the highest or the lowest, respectively. This may be the basis for determining the work data, if this is supposed to be representing the highest temperature and/or lowest temperature. But the distribution of the temperature sensors may also be used in order to evaluate a reasonable mean temperature of the insole. In this case, the processing unit may be configured to determine the mean value of the temperatures detected by the plurality of temperature sensors.

**[0014]** According to a further preferred embodiment of the insole, the energy unit comprises a harvesting unit, which is configured to convert mechanical energy and/or thermal energy into electrical energy. As a result, the harvesting unit may generate electrical energy resulting from mechanical force or mechanical pressure acting on the insole therefore also on the harvesting unit. In other words, the harvesting unit may be a converter for converting mechanical energy to electrical energy. The harvesting unit therefore may comprise a high durability. In other words, the harvesting unit does not need to be reloaded as a rechargeable battery. The harvesting unit may therefore be able to generate the necessary energy for driving the processing unit, the sensor unit and the wireless data interface for a long lifetime. Whenever the insole is used by a person, the foot of this person will act on the insole resulting in the converting of mechanical

energy to the electrical energy. The energy unit may comprise the harvesting unit. But according to a preferred embodiment, the energy unit may be formed by the harvesting unit only. In this case, no further units for supplying energy of the energy unit are needed.

**[0015]** According to a further preferred embodiment however, the energy unit may be formed by a harvesting unit, which is configured to convert thermal energy into electrical energy. Thermal energy may be received from the foot of the user of the shoe. In other words, the body temperature of the foot of the user may be used in order to convert at least a part of this thermal energy into electrical energy.

**[0016]** According to a further preferred embodiment, the harvesting unit may be configured to convert mechanical energy to electrical energy and to convert thermal energy into electrical energy. In this case, the harvesting unit may be configured to convert both, the mechanical and the thermal energy into electrical energy.

**[0017]** According to a further preferred embodiment of the insole, the harvesting unit is a piezo unit that converts mechanical pressure into electrical energy according to the piezoelectric effect. As a result, whenever the foot of the user of the shoe acts on the insole, electrical energy is generated.

**[0018]** According to a preferred embodiment of the insole, the harvesting unit may comprise an energy buffer, for instance an electrical capacitor. Preferably, the harvesting unit does not comprise a rechargeable battery, as a battery usually needs an installation space larger than available space within the intermediate layer.

**[0019]** According to a preferred embodiment of the insole, the harvesting unit is configured to convert an acceleration of the harvesting unit into electrical energy. As a result, whenever the shoe is moved and therefore accelerated by a user, the harvesting unit converts the resulting acceleration into electrical energy.

**[0020]** According to a preferred embodiment of the insole, the harvesting unit is a pyro unit that converts thermal energy into electrical energy according to the pyro electrical effect. Usually, the foot of the user has a temperature which allows to generate electrical energy. This can be used by the harvesting unit for supplying electrical energy to the processing unit and the remaining units embedded in the intermediate layer of the insole.

**[0021]** According to a preferred embodiment of the insole, each of the sensor units is a printed sensor. Each printed sensor may have only low thickness. This allows to arrange a plurality of sensors within the intermediate layer. Furthermore, the small thickness of the printed sensors ensures a high wearing comfort of the insole, and thus, a high wearing comfort of the shoe.

**[0022]** According to a further preferred embodiment of the insole, the energy unit may comprise or be formed as a foil battery unit. The foil battery unit may be configured as a printed foil battery unit. This battery unit may be a rechargeable battery unit. This foil battery unit may be connected to the harvesting unit of the energy unit in order to buffer electrical energy generated by the harvesting unit.

**[0023]** According to a preferred embodiment of the insole, the processing unit and the wireless data interface may be formed by micro-electric-components. Each of the processing unit and the wireless data interface may be embedded in the intermediate layer. Preferably, the processing unit and the wireless data interface are arranged in the intermediate layer in the foot arch area of the insole only, wherein the sensors are arranged outside the foot arch area. Furthermore, the processing unit and the wireless data interface may be connected via a signal communication line or may be joined together. As a further preferred embodiment, the wireless data interface may be a part of the processing unit.

**[0024]** According to a further preferred embodiment of the insole, a thickness of the intermediate layer is less than 2,5 mm. As a result, the maximum thickness of the intermediate layer is less than 2,5 mm. Since each of the processing unit, the energy unit, the at least one sensor unit and the wireless data interface is embedded completely in the intermediate layer, the thickness of each of mentioned units and the data interface may be less than 2,5 mm, preferably less than 2 mm or even less than 1,5 mm. The low thickness of the intermediate layer ensures a low thickness of the insole. This allows the insole to be inserted in a large variety of different shoes without impacting the wearing comfort of the shoes. Preferably, the mentioned thickness constraints may only relate to the thickness of a part of the intermediate layer arranged in the foot arch area of the insole. The remaining intermediate layer may comprise an even lower thickness.

**[0025]** According to a preferred embodiment of the insole, the energy unit comprises an energy storage unit, which is configured to store electrical energy. The energy storage unit may be configured to be rechargeable. The energy storage unit may be connected to the harvesting unit in order to be recharged. However, the energy storage unit may also be configured to be recharged via an external electrical power supply unit.

**[0026]** According to a preferred embodiment of the insole, the energy storage unit is a printed energy storage unit. As a result, this energy storage unit may comprise a very low thickness, such that the energy storage unit can be easily embedded into the intermediate layer of the insole.

**[0027]** According to a preferred embodiment of the insole, the energy storage unit comprises a wireless charging unit, which is configured to receive electromagnetic waves and to generate electrical energy from the received electromagnetic waves. This electrical energy may be transferred to the processing unit and/or any other unit embedded in the intermediate layer of the insole. However, at least a part of the generated electrical energy may be transferred to the energy storage unit in order to store or buffer electrical energy in the electrical storage unit.

**[0028]** According to a preferred embodiment, each of

the processing unit, the at least one sensor unit and the wireless data interface is directly or indirectly connected to the energy unit, such that each of the processing unit, the at least one sensor unit and the wireless data interfaces are supplied with electrical energy of the energy unit. This is preferably the only supply of electrical energy for the mentioned units.

**[0029]** According to a further preferred embodiment of the insole, the energy unit is configured to store electrical energy from the harvesting unit and/or wireless charging unit in the energy storage unit. Therefore, the processing unit, the at least one sensor unit and/or the wireless data interface may be supplied with electrical energy even in a case, where the harvesting unit is not generating electrical energy.

**[0030]** According to a preferred embodiment of the insole, the top layer is made of elastomers, thermoplastic elastomers (TPE) and/or thermoplastics, in particular PET or TPU. As a result, the top layer may be adapted or covered by the needs and/or wishes of the user with, for instance, natural or artificial materials, like leather, cork, etc.

**[0031]** According to a preferred embodiment of the insole, the bottom layer is made of elastomers, thermoplastic elastomers (TPE), thermoplastics and/or natural or artificial materials, like leather, cork or others. As a result, the bottom layer may be adapted for the needs of the shoe, the wishes of the user and/or according to other environmental requirements.

**[0032]** According to a preferred embodiment of the insole, a matrix material of the intermediate layer is made of (thermo-) plastics and/or thermoplastic elastomers, in particular of PET or TPU wherein, each of the processing unit, the energy unit, the at least one sensor unit and the wireless data interface is embedded in the matrix material of the intermediate layer. It has been found in practice, that at least the mentioned plastic and/or TPE materials ensure a high wearing comfort of the insole and at the same time allow a predetermined arrangement of the processing unit, the energy unit, the at least one sensor unit and the wireless data interface within the insole.

**[0033]** According to a preferred embodiment, the intermediate layer may be made of alternative components, such as elastomers, thermoplastics, thermoplastic elastomers, natural materials or artificial materials. For instance, the matrix material may be made of leather, cork or rubber.

**[0034]** Further features, advantages and application possibilities of the present invention may be derived from the following description of exemplary embodiments and/or the figures. Thereby, all described and/or visually depicted features for themselves and/or in any combination may form an advantageous subject matter and/or features of the present invention independent of their combination in the individual claims or their dependencies. Furthermore, in the figures, same reference signs may indicate same or similar objects.

Figure 1 Schematically illustrates the insole in a cross-sectional view.

Figure 2 schematically illustrates the insole in a different cross-sectional view.

**[0035]** Figure 1 shows a preferred embodiment of the insole 2 in a cross-sectional view through the intermediate layer 8. The insole 2 is an insole 2 for a shoe. As a result, the insole 2 can be inserted into the interior of the shoe. It is preferred that the insole 2 provides a high wearing comfort for the foot of the user of the shoe.

**[0036]** The insole 2 is shown in a further, different cross-sectional view in Figure 2. As illustrated exemplarily in Figure 2, the insole 2 comprises a top layer 4, a bottom layer 6 and the intermediate layer 8. The intermediate layer 8 is arranged between the top layer 4 and the bottom layer 6. The top layer 4 preferably fully covers the upper surface of the intermediate layer 8. The bottom layer 6 preferably fully covers the bottom surface of the intermediate layer 8. As a result, the intermediate layer 8 does not extend sideways above the top layer 4 or the bottom layer 6. Instead, the edge surfaces of the insole 2 may be formed by the top layer 4 and the bottom layer 6, only.

**[0037]** The top layer 4 may be formed of elastomers, thermoplastic elastomers (TPE) and/or thermoplastics, leather or cork. The bottom layer 6 may be formed of elastomers, thermoplastic elastomers (TPE) and/or thermoplastics, for instance of TPU. The intermediate layer 8 may be formed of a matrix material, into which the processing unit 10, the energy unit 12, at least one of the sensor units 14 and the wireless data interfaces 16 are embedded. As schematically illustrated in Figure 1 and 2, the wireless data interfaces 16 may be part of the processing unit 10. The energy unit 12 is configured for providing electrical energy. The processing unit 10 is connected to the energy unit 12, for instance via an electrical cable 18, such that the processing unit 10 is supplied with electrical energy by the energy unit 10. Each of the sensor unit 14 is connected via a signal line 20 to the processing unit 10. As a result, each of the sensor units 14 is connected via the respective signal line 20 to the processing unit 10 for transferring sensor data of the sensor unit 14 to the processing unit 10. The signal lines 20 may have a further function. As the processing unit 10 is connected via the electrical cable 18 to the energy unit 12, the electrical energy provided with the processing unit 10 may be in part further transferred to the sensor units 14 via the signal lines 20. As a result, the energy unit 12 is directly or indirectly connected to the processing unit 10 and the sensor units 14 in order to supply these units with electrical energy. Since the wireless data interfaces 16 is preferably part of the processing unit 10, the wireless data interface 16 may also be supplied with electrical energy of the energy unit 12.

**[0038]** Each of the energy unit 12, the processing unit 10, the wireless data interface 16 and the sensor units 14 are of a low thickness, preferably less than 2,5 mm,

preferably less than 2 mm. As a result, the wearing comfort of the insole 2 is not negatively affected by the energy unit 12, the processing unit 10, the wireless data interface 16 or any of the sensor units 14. Preferably, in order to ensure the low thickness of the intermediate layer 8, the energy unit 12, the processing unit 10, the wireless data interface 16 and each of sensor units 14 are spaced apart from each other or arranged with distance from each other. This ensures the low thickness of the intermediate layer 8.

**[0039]** In order to keep the amount of data, which is to be transmitted via a communication signal from the wireless data interface 16, at a low level, is preferred that the processing unit 10 is configured to determine the work data based on the sensor data of the sensor units 14, such that a work data amount of the work data is smaller than the sensor data amount of the sensor data received from the plurality of sensor units 14. For instance, the processing unit 10 may be configured to determine the highest value, the lowest value or a mean value of the measures to which the sensor units 14 are configured to. For instance, if the sensor units 14 are configured as force sensors, the processing unit 10 receives from each of the sensor units 14 sensor data representing the force measured by the respective sensor unit. The processing unit may be configured to determine the highest force, the lowest force or a mean force of the forces measured by the sensor units 14.

**[0040]** According to a preferred embodiment, the energy unit 12 is configured to convert energy of a type different from electrical energy to electrical energy. For instance, the electrical energy unit 12 may comprise or be formed by a harvesting unit 22, which is configured to convert mechanical energy or thermal energy into electrical energy. If the insole 2 is inserted to a shoe, the foot of the person wearing the shoe will step on the insole 2 and therefore acting with a force on the harvesting unit 22, such that the harvesting unit 22 will convert this mechanical force into electrical energy. The harvesting unit 22 may be formed by a piezo unit which is configured to convert mechanical pressure or mechanical force into electrical energy according to the piezo electrical effect. But the harvesting unit 22 may alternatively be configured to convert thermal energy into electrical energy. The harvesting unit 22 may therefore comprise a pyro sub-unit that is configured to convert thermal energy into the electrical energy according to the pyro electrical effect. If the foot of the user emits thermal energy, this thermal energy can be converted by the mentioned pyro unit to the electrical energy. Since the mechanical and thermal energy are usually not constably given, the energy unit 12 may comprise a buffer for temporarily storing electrical energy. This buffer may be formed by an electrical capacitor. This capacitor may be a printed electrical capacitor.

**[0041]** It is additionally pointed out that "comprising" does not rule out other elements, and "a" or "an" does not rule out a multiplicity. It is also pointed out that features that have been described with reference to one of the above exemplary embodiments may also be disclosed as in combination with other features of other exemplary embodiments described above. Reference signs in the claims are not to be regarded as restrictive.

## Claims

**1.** Insole (2) for a shoe, the insole (2) comprising:

a top layer (4),
a bottom layer (6),
an intermediate layer (8), which is arranged between the top layer (4) and the bottom layer (6),
a processing unit (10),
an energy unit (12) configured for providing electrical energy,
at least one sensor unit (14) configured for sensing force, acceleration, rotation rate, angular position, temperature and/or humidity, and
a wireless data interface (16),
wherein each of the processing unit (10), the energy unit (12), at least one sensor unit (14) and the wireless data interface (16) is completely embedded in the intermediate layer (8),
wherein the processing unit (10) is connected to the energy unit (12), such that the processing unit (10) is supplied with electrical energy by the energy unit (12),
wherein each sensor unit (14) is connected to the processing unit (10) for transferring sensor data to the processing unit (10),
wherein the processing unit (10) is configured to determine work data based on the sensor data, such that a work data amount of the work data is smaller than a sensor data amount of the sensor data,
wherein the wireless data interface (16) is connected to the processing unit (10) for transmitting the work data or a work signal representing the work data to the wireless data interface (16), and
wherein the wireless data interface (16) is configured to wirelessly transmit a communication signal, which represents the work data.

**2.** Insole (2) according to the preceding claim, wherein the insole (2) comprises a plurality of sensor units (14) configured as force sensors, wherein the force sensors are distributed, preferably evenly distributed, in the intermediate layer (8), and wherein each force sensor is configured to measure a force and/or a pressure.

**3.** Insole (2) according to the preceding claim, wherein the processing unit (10) is configured to determine the work data based on the sensor data of the force sensors, such that the work data represents a distri-

bution of forces and/or pressure acting on the insole (2).

**4.** Insole (2) according to one of the preceding claims 2 to 3, wherein the processing unit (10) is configured to determine the work data based on the sensor data of the force sensors, such that the work data represents the highest force or pressure acting on the insole (2) and/or the smallest force or the smallest pressure acting on the insole and/or a mean value of force or pressure acting on the insole (2).

**5.** Insole (2) according to one of the preceding claims, wherein the insole (2) comprises a plurality of sensor units (14) configured as temperature sensors, wherein the temperature sensors are distributed, preferably evenly distributed, in the intermediate layer (8), and wherein each temperature sensor is configured to measure a temperature, and wherein the processing unit (10) is configured to determine the work data based on the sensor data of the temperature sensors, such that the work data represents the highest temperature of the insole (2), the lowest temperature of the insole and/or a mean temperature of the insole (2).

**6.** Insole (2) according to one of the preceding claims, wherein the energy unit (12) comprises a harvesting unit (22), which is configured to convert mechanical energy and/or thermal energy into electrical energy.

**7.** Insole (2) according to one of the preceding claims, wherein each of the sensor units (14) is a printed sensor.

**8.** Insole (2) according to one of the preceding claims, wherein a thickness of the intermediate layer (8) is of less than 2,5 mm.

**9.** Insole (2) according to one of the preceding claims, wherein the energy unit (12) comprises an energy storage unit, which is configured to store electrical energy.

**10.** Insole (2) according to the preceding claim, wherein the energy storage unit is a printed energy storage unit.

**11.** Insole (2) according to one of the preceding claims, wherein the energy unit (12) comprises a wireless charger unit, which is configured to receive electromagnetic waves and to generate electrical energy from the received electromagnetic waves.

**12.** Insole (2) according to the preceding claim, wherein the energy unit (12) is configured to store electrical energy from the harvesting unit (22) and/or wireless charging unit in the energy storage unit.

**13.** Insole (2) according to one of the preceding claims, wherein the top layer (4) is made of elastomers, thermoplastic elastomers (TPE) thermoplastics and/or natural or artificial materials, like leather, cork or others , and/or where bottom layer (6) is made of elastomers, thermoplastic elastomers (TPE), thermoplastics and/or natural or artificial materials, like leather, cork or others.

**14.** Insole (2) according to one of the preceding claims, wherein a matrix material of the intermediate layer (8) is made of plastic, in particular of polyethylenterephthalat (PET) or of thermoplastic polyurethane (TPU), wherein each of the processing unit (10), the energy unit (12), the at least one sensor unit (14) and the wireless data interface (16) is embedded in the matrix material of intermediate layer (8).

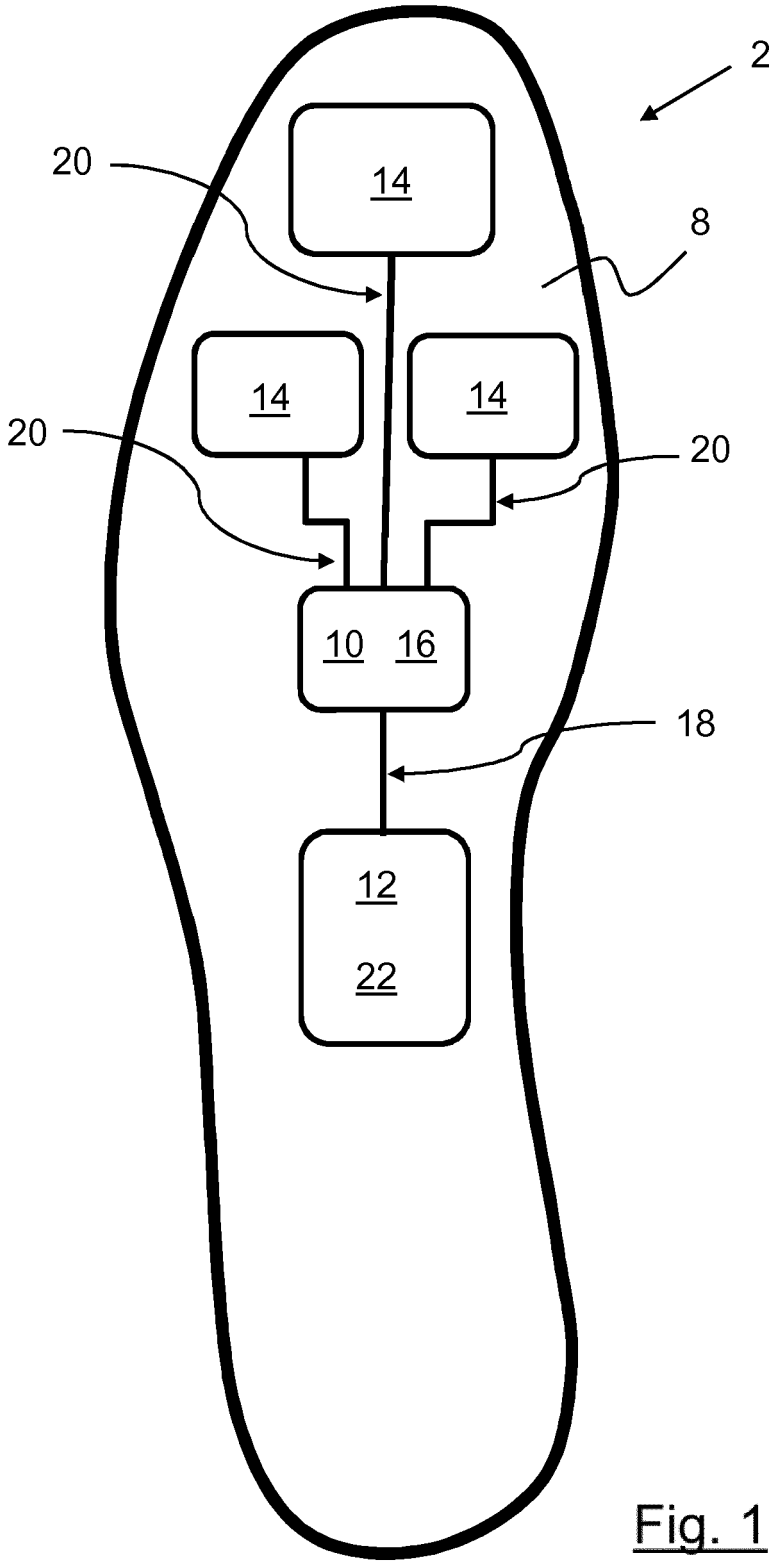


Fig. 1

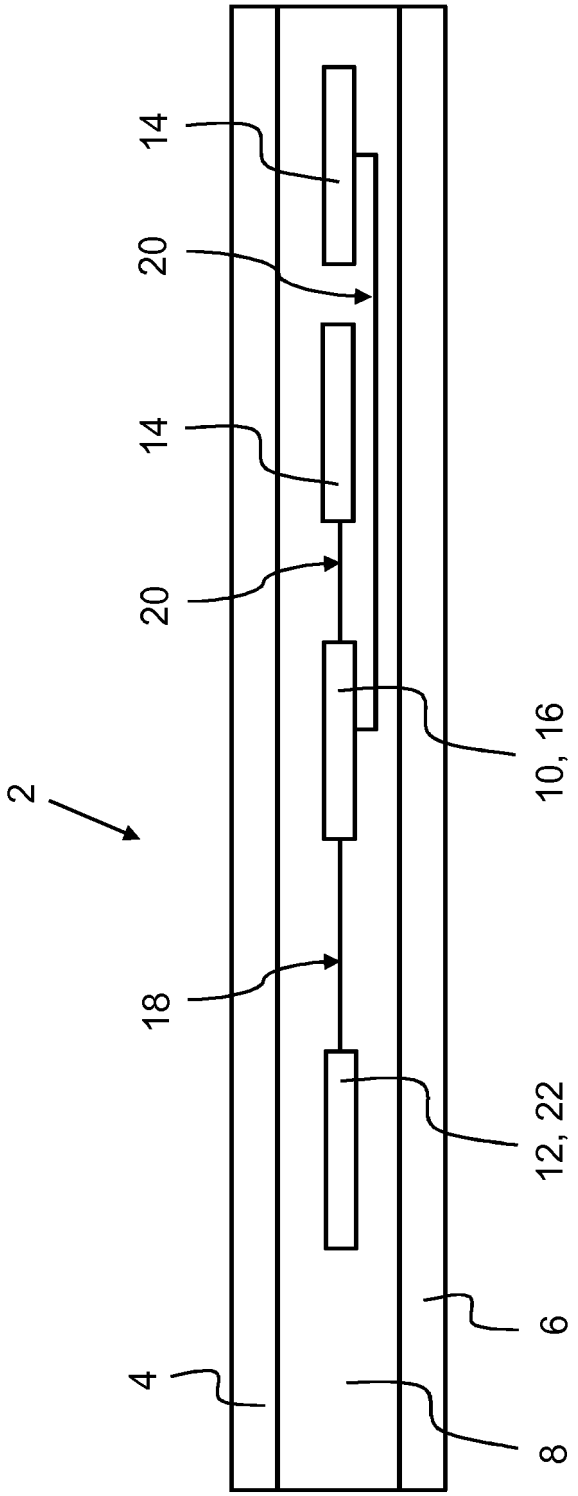


Fig. 2

Europäisches Patentamt
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# EUROPEAN SEARCH REPORT

Application Number
EP 19 18 9296

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
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