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(54) **FOOT MEASUREMENT APPARATUS**

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FOOT MEASUREMENT APPARATUS

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Description

FIELD OF THE INVENTION

[0001] The present invention generally relates to foot measurement and the analysis of foot measurement data.

BACKGROUND

[0002] Many people require footcare products. Footcare products may be placed inside footwear products to provide support, cushioning, to improve fit or comfort, etc. Examples of footcare products include orthotic products (hereinafter referred to as "orthotics"), insoles, foot cushions, heel cups, etc. Examples of footwear products include sneakers, loafers, dress shoes, high heels, etc.

[0003] Footcare products are currently made available in two different ways, namely as a limited range of pre-manufactured footcare products which may be purchased from retail displays in shops, and as custom-made footcare products, which are individually made to match the particular requirements of a customer.

[0004] Both of these ways of purchasing footcare products suffer from a number of problems, however.

[0005] In the case of pre-manufactured footcare products, although packaging may provide some guidance, customers may have to guess which products are appropriate, e.g., the customers' size, foot characteristics, and other attributes. However, even if a customer were given the opportunity to try on a product, the customer may not know the best type of support or size of footcare product for their particular foot characteristics. This practice may result in the customer buying multiple products before the customer finally finds a product that meets the customer's needs. Retailers therefore want to be able to provide a service to help customers select the correct product without having to employ a person that has specialized training and/or knowledge of all possible products, footcare or footwear, and foot types.

[0006] In the case of custom-made footcare products, significant expertise and time is required to measure a customer's feet, determine the required footcare product and manufacture the footcare product to the specification of the customer's feet. As a result, custom-made footcare products are typically more expensive than pre-manufactured footcare products. Furthermore, creating a custom-made footcare product generally requires a trained professional that measures the customer and makes or orders the footcare product.

[0007] There is therefore a requirement for an apparatus and automated technique for making measurements of a person's feet to assist in the selection of a footcare product or to select automatically the footcare product.

[0008] US-A-5,987,982 describes an apparatus and a method to monitor the balance performance of a user. Two separate but similar foot-plates, each slightly larger than the foot of a user, include detectors to detect the load imparted to the foot-plate by a user, about two axes generally at right angles with one axis lying more or less along the length of the user's foot and the other axis transverse thereto. The outputs from the foot-plates are fed to a processing unit which drives a display device, to show graphically to the user on a real-time basis the detected loads and so to allow a user to modify his balance performance.

[0009] US 6 331 893 describes an apparatus and methods for analyzing feet which utilize matrixes of pressures sensors and optical sensors connected to a controller and a monitor. An apparatus includes a housing which houses a controller and a monitor and defines left and right foot wells for receiving left and right feet, respectively. The floor of each foot well includes a pressure pad assembly which includes a matrix of pressure sensor contacts covered by a variably resistive pressure pad to form pressure sensor matrixes. A digital signal processor normalizes and smoothes the pressure data for display on the monitor. Infrared LED's and phototransistors are located around the perimeter of each foot well and are utilized to measure the length, width, and heights of a foot. A microprocessor addresses each LED and phototransistor separately. The controller reads data created by the DSP and IR microprocessor, calculates additional data, and displays the resulting data on the monitor. According to one method, the pressure sensors and optical sensors are utilized to determine, among others, foot length, foot width, shoe size, foot volume, foot shape, force distribution, pronation, arch type, and recommended last type. In other methods, the DSP and IR microprocessors provide data which enable the controller to perform calculations and comparisons to display orthotic prescriptions or insole selection information, as well as medical information related to center of pressure and postural sway analysis which is useful in diagnosing and treating a large variety of medical problems.

[0010] US 2006/0098896 A1 describes a scanner which has a plurality of cameras positioned around an object to be scanned. The object is illuminated by unstructured light and the object is covered by a textured surface. The cameras can be arranged as pairs and each camera pair is supported on a single support. The scanned object can be a foot, and the scanner is positioned at a predetermined incline so that the foot is evenly supported. A positioning system, either visual or automatic, is included on the scanner platform. If automatic, a sensor array is affixed to the platform such that a scan will only initiate when certain sensors or combinations of sensors are ON. Method for attaching the camera pairs on the support, method for calibrating the camera pairs and method of scanning the foot to provide shoe sizes and shoe lasts are also disclosed.

[0011] US 2005/0203712 A1 describes systems and methods for constructing custom orthotics are. Several embodiments of the system use sensor pads to obtain both static and dynamic three dimensional information

concerning the shape or topography of the bottom surface of a patient's foot. The information is analyzed to obtain information useful in constructing a custom orthotic from a selection of basic orthotic shells. Once constructed, the orthotic can modify a patient's gait. One embodiment includes a user terminal including a sensor pad connected to a computer, a server configured to analyze three dimensional information acquired by the sensor pad, a manufacturing terminal configured to display the results of the server's analysis of the three dimensional information and a network that connects the user terminal to the server and the server to the manufacturing terminal.

[0012] Japanese published patent application JP H03-247305 A describes a foot measurement device with pressure sensors on a surface and load cells to detect the center of gravity of the person standing on the surface. The position of the center of gravity is indicated on a display. Japanese published patent application JP 2005-192744 A refers to the same foot measurement device.

[0013] However, the present inventors have found that there are a number of technical problems when implementing such an apparatus/technique. For example, the apparatus must be low-cost, reliable and simple to use. In addition:

(1) Before making measurements of a person's feet, it is important to ensure that the person is standing correctly for the type of measurement sensor being used, otherwise the measurements may be inaccurate and variable.

(2) Even if a person is standing correctly, inaccuracies may occur in the foot measurements, and the apparatus/automated technique should therefore identify and address the cause of these errors.

(3) One measurement which often needs to be taken cf a person's foot is a measure of the arch of the foot. However, a problem arises as to how to measure such a three-dimensional feature using a sensor which makes measurements in a two-dimensional plane, such as a two-dimensional pressure sensor.

(4) For some types of footcare products it is necessary to make dynamic measurements of a person's foot (that is, measurements while the person is walking, for example to analyse the person's gait). Accordingly, an apparatus which can make this type of measurements is necessary. However, the apparatus must not occupy a large volume otherwise it will take up too much floor space in a shop.

(5) The number of different types and sizes of footcare products is very large, and hence the number of foot measurements that need to be made to select a product for a customer is also very large. Accordingly, an apparatus/automated technique which reduces the number of measurements to be made, and therefore the measurements time and opportunity of inaccuracies, is required.

[0014] The present invention has been made with these technical problems in mind.

SUMMARY OF THE INVENTION

[0015] According to a first aspect of the present invention, there is provided an apparatus for determining at least one property of a person's foot, the apparatus comprising: a surface configured to allow a person to stand thereon; a plurality of pressure sensors located under the surface: and computing means arranged to receive signals representing pressure measurements from at least a subset of the plurality of pressure sensors while a person stands upon the surface, the computing means being operable to process the signals to: determine a point of force for the person standing on the surface; compare the person's determined point of force with a target zone for the point of force; provide a display indicating a difference between the person's determined point of force and the target zone to assist the person in changing his point of force to bring it into the target zone; and determine at least one property of the person's foot using signals representing pressure measurements from at least the subset of the plurality of pressure sensors when the person's determined point of force falls in the target zone.

[0016] According to a second aspect of the present invention, there is provided a method of determining at least one property of a person's foot by processing signals representing pressure measurements from at least a subset of a plurality of pressure sensors located beneath a surface while a person stand upon the surface, the method comprising processing the signals to: determine a point of force for the person standing on the surface; compare the person's determined point of force with a target zone for the point of force; generate display data indicating a difference between the person's determined point of force and the target zone to assist the person in changing his point of force to bring it into the target zone; and determine at least one property of the person's foot when the person's determined point of force falls in the target zone.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

FIG. 1 illustrates a functional block diagram of an example kiosk, according to an example embodiment of the present invention.

FIG. 2 illustrates several example foot dimensions.

FIG. 3a illustrates an example of the locations of alignment marks that may be displayed on a pressure mat.

FIG. 3b illustrates measurements that may be derived from pressure measurements on a pressure mat.

FIG. 4 illustrates a flowchart of an example proce-

dure for characterizing a person's feet based on pressure measurements and selecting a recommended footcare product, according to an example embodiment of the present invention.

FIG. 5 illustrates an example pressure map showing foot dimensions that may be used to determine if a foot on a sensor is unshod, according to an example embodiment of the present invention.

FIG. 6 illustrates an example procedure using foot dimensions from FIG. 5 to determine whether an unshod foot is on a pressure mat, according to an example embodiment of the present invention.

FIG. 7 illustrates an example procedure to take pressure measurements to calculate biomechanical data estimates, such as those in FIG. 2, according to an example embodiment of the present invention.

FIG. 8a illustrates an example decision matrix, according to an example embodiment of the present invention.

FIG. 8b illustrates an example procedure for selecting a footcare product from a decision matrix, such as in FIG. 8a, based on pressure measurements, according to an example embodiment of the present invention.

FIG. 9a illustrates an example kiosk selecting premanufactured orthotics, according to an example embodiment of the present invention.

FIG. 9b illustrates an example internal structure of a pressure pad, according to an example embodiment of the present invention.

FIG. 9c illustrates an example layer-by-layer internal structure of a pressure pad, according to an example embodiment of the present invention.

FIG. 10a illustrates an example screen that may display footcare products, according to an example embodiment of the present invention.

FIG. 10b illustrates an example screen that may display a footcare product and its various components, according to an example embodiment of the present invention.

FIG. 11 illustrates any number of example screens that display information, instructions, or that provide a language option, according to an example embodiment of the present invention.

FIG. 12 illustrates an example instruction screen directing a person to take off his or her shoes, according to an example embodiment of the present invention.

FIG. 13a illustrates an example screen that may be displayed to a person to help achieve proper foot alignment and weight distribution, according to an example embodiment of the present invention.

FIG. 13b illustrates an alternative example screen that may be displayed to a person to help achieve proper foot alignment and weight distribution, according to an example embodiment of the present invention.

FIG. 14 illustrates an example screen that may be displayed to a person when the person has his or her weight balanced on both feet, according to an example embodiment of the present invention.

FIG. 15 illustrates an example screen containing instructions that may be displayed to a person regarding taking quasi-dynamic foot measurements, according to an example embodiment of the present invention.

FIG. 16a illustrates an example screen that may be displayed after measurements of a single planting foot are taken, according to an example embodiment of the present invention.

FIG. 16b illustrates an alternative example screen that may be displayed after measurements of a single planting foot are taken, according to an example embodiment of the present invention.

FIG. 17a illustrates an example screen containing instructions that may be displayed to a person regarding taking pressure measurements of the person while the person stands on the right foot, according to an example embodiment of the present invention.

FIG. 17b illustrates an alternative example screen containing instructions that may be displayed to a person regarding taking pressure measurements of the person while the person stands on the right foot, according to an example embodiment of the present invention.

FIG. 18 illustrates an example screen that may be displayed after measurements of a single planting foot are taken, according to an example embodiment of the present invention.

FIG. 19 illustrates an example screen that may display a selected recommended footcare product, in this example, an orthotic.

FIG. 20 illustrates an example screen displaying other information that may be displayed to a person, according to an example embodiment of the present invention.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

[0018] The following describes an apparatus and method in which a plurality of pressure sensors are used to make pressure measurements of a person's foot on a surface. Signals from the pressure sensors are processed to calculate a point of force on the surface for the person (preferably a centre of force point comprising the point on the surface through which the person's weight acts) and to compare this point of force for the person with a previously determined target zone on the surface for correct measurements using the sensors. A display is presented to the user showing the difference in location of the person's current point of force and the target zone in order to assist the user to move (and therefore change the point through which his weight acts) and bring his point of force into the target zone. Measurements of the

person's foot are not taken until the person's point of force is within the target zone.

[0019] The use of pressure sensors, as opposed to optical, gauge, or other previously proposed approaches to measuring feet solves the problem of providing a low-cost, robust measurement system suitable for use in an unattended retail environment. In addition, the apparatus and method ensure that the user is standing in such a way that accurate and reliable measurements can be taken using the pressure sensors.

[0020] With reference to problem (2) above, the present inventors have recognized that many measurement errors occur because a person is not using the measurement apparatus correctly. In particular, the present inventors have recognized that many people wear an item of footwear such as a shoe or sock when measurements are taken, whereas measurements should be taken when the user is not wearing any such item. The following describes an apparatus and method in which signals from the toot measurement sensor (s) are first processed to determine a plurality of different foot dimensions, to calculate one or more ratios of the measured dimensions, and to compare the calculated ratio(s) with one or more reference values to determine if the person is wearing an item of footwear. In this way, further measurements of the person's foot can be delayed until the person has removed any item of footwear, thereby avoiding inaccurate measurement results.

[0021] To address problem (3) above, the present inventors have devised a new technique to characterize the arch of a person's foot using measurements taken on a two-dimensional plane on which the foot is placed. More particularly, the following describes an apparatus and method in which a plurality of pressure sensors are used to generate a pressure map of the sole of the person's foot when it is placed on a two-dimensional surface and the pressure map is processed to determine a measure of the arch of the foot. Preferably, the pressure map is processed to determine the portion thereof relating to the arch of the person's foot, and the ratio of the area of the arch portion to the foot area is determined. This ratio is referred to herein as the "arch index" and the inventors have found that this index is particularly useful for characterizing the arch of a person's foot to enable a suitable footcare product to be selected to match the foot.

[0022] To address problem (4) above, the present inventors have realized that dynamic measurements when a person is walking can be replaced with static measurements taken when the person is standing in a position which simulates movement (such measurements being referred to herein as "quasi-dynamic" measurements). In particular, the present inventors have realised that foot measurements taken while a person stands on only one foot can be used to replace measurements taken while the person is walking. Furthermore, the present inventors have realized that the accuracy and reliability of measurements taken while a person is standing on one foot can be increased by using pressure sensors to make the measurements.

[0023] The following also describes an apparatus and method in which signals from a plurality of sensors associated with a surface are processed to determine if a person is standing on the surface on one foot only. In this way, incorrect measurements taken when the person is standing on two feet can be avoided. Preferably, the determination of whether the person is standing on only one foot is based upon the weight applied to pressure sensors in an area of the surface (the area corresponding to one foot) and/or whether a centre of force for the person on the surface (such as the point through which the person's centre of gravity acts on the surface) falls within a predetermined area on the surface.

[0024] The present inventors have also realised that a person's foot can be better characterized if two sets of foot measurements are used, namely one set of measurements taken while the user stands on two feet and one set of measurements taken while the user stand on only one foot.

[0025] The following therefore describes an apparatus and method in which one or more sensors associated with a surface are used to generate a set of measurement signals while a person stands on two feet on the surface and a set of measurement signals while the person stands on the surface on only one foot. The sets of signals are processed to determine a property of the person's foot, thereby improving accuracy.

[0026] With reference to problem (5) above, the present inventors have devised a technique for accurately and reliably characterizing a person's foot to allow a footcare product to be matched to the foot which requires only a small number of foot measurements, requires only a small amount of data storage and which can be performed quickly.

[0027] The following further describes an apparatus and method in which a foot is characterized and a footcare product is selected based upon foot length, a measure of the foot arch (such as arch index) and body weight. Other features may be used as well, but these add to the complexity of the measurements and product selection, and the inventors have found that just the three features provide extremely accurate and reliable foot characterization and product selection. Data is pre-stored defining a plurality of foot length ranges and a plurality of ranges for the measure of foot arch. For each foot length range, a respective plurality of weight ranges is also stored so that the weight ranges are different for each foot length range. Measurements of a person's foot length and foot arch are taken. The person's weight may be measured or input by the person. The foot length, arch measure and weight are compared against the pre-stored values and a pre-manufactured footcare product is selected in dependence upon the comparison results.

[0028] The following also describes a computer program product, such as a signal carrying a computer program or a storage medium storing a computer program, for implementing the methods.

[0029] FIG. 1 illustrates a functional block diagram of an example kiosk, according to an example embodiment of the present invention. The example kiosk 100 may be used to take a person's foot measurements, and based on the measurements, select a recommended footcare product. The kiosk 100 may include a foot measurement subsystem 114, e.g., a plurality of pressure sensors 101. The pressure sensors 101 may be provided by using a pad having an array of pressure sensors made from pressure sensitive conductive inks, e.g., sensors from Tekscan, Inc. (307 West First Street., South Boston, MA. 02127-1309, USA), and/or sensors described in U.S. Patents 5,989,700 and 6,964,205. Other measurement technologies may also be employed, e.g., force plates, piezoelectric sensors, digital air pressure sensors, optical measurements, gauges, thermal sensors, etc.

[0030] The pressure sensors 101 may be arranged to obtain pressure measurements at different points of a person's foot. For example, the pressure sensors may be arranged as a 2-D grid or a 3-D grid of multiple sensor layers. Sensels (i.e. sensing elements) of up to 7.5 mm by 7.5 mm arranged in an array provide adequate detail to characterize feet up to men's size 15. The sensing elements may provide the measurements needed to provide an accurate pressure map of the foot. For example, in one example embodiment, given the square footage of the pressure pad, a minimum of 1144 number of pressure sensors per foot area with a size of 6.86 mm x 6.65 mm provides an accurate pressure map of a foot. Thus, for two feet there would be 2288 pressure sensors. However, with a varying range of sensor sizes, the number of sensors that may be needed to accurately capture a pressure map of the foot may vary. The foot area, and correspondingly the number sensors, may also vary depending on the target population. For example, an example embodiment of the kiosk may contain pressure pads underlying the feet that are capable of measuring children to adults, and the pads underlying would be large enough to capture the foot area of an adult.

[0031] The pressure measurements taken from the plurality of pressure sensors 101 may, but need not, be the only measurements of the foot collected to select a recommended footcare product. For example, in alternative embodiments, a scale 113 may also be employed in the foot measurement subsystem 101 to provide greater accuracy in estimating a person's weight. It will be appreciated that measurement approaches that produce a relative pressure distribution, without producing absolute pressure values, may also be employed in place of absolute numerical pressure measurements.

[0032] The example kiosk 100 may also contain an output device 102, such as a video screen or LCD screen, and an input device 103, such as a keyboard, mouse, etc. An alternative embodiment may contain a touchscreen as a combination of the input device 103 and the output device 102. The output device 102 may display information received from a processor 104. Such information may include a recommended footcare product in the form of a picture or a model number, instructions on how to use the kiosk, biomechanical data estimates, data containing kiosk transaction information, etc. The output device 102 may display foot pressure in real-time as soon as a user steps onto the pressure sensors. If the output device is a digital display, the pressure may be displayed in pixel format or contoured format, i.e. a real-time smoothed version of the pixilated format for aesthetic display purposes. The display may also show in real-time a pressure map and changes in the pressure map of a person's feet while the person stands on the pressure sensors.

[0033] The output device 102 may also display a final peak pressure map to a person. The peak pressure map is the combination of the peak at each specific point. A dynamic pressure display may use a fixed color legend while a peak pressure generated after data collection may use a floating (variable) legend based on the range of peak pressure. The various pressure maps, such as the peak pressure map, may be used by other embodiments of a kiosk to detect hot spots and recommend therapeutic products or pads. For example, hot spots may be used to detect where the peak pressure is applied in various areas of the foot. Pads or other cushioning foot products may then be recommended to apply to those areas.

[0034] While a person, such as a customer 109, may use the input device 103 to perform a procedure 108 to select a recommended footcare product based on the pressure measurements of a person's foot, another person, such as an administrator 110, may use the input device 103 to configure 111 the processor 104. Configuring 111 may involve adjusting the parameters used to select a recommended footcare product, calibrating the pressure sensors, providing new product listings, etc.

[0035] An administrator 110 may calibrate the processor 104 to ensure the accuracy of the pressure measurements taken from the pressure sensors 101. Two methods may be employed by an administrator 110: a Force Calibration (FC) or a Multi-Level Pressure Calibration (MPC). Using a Force Calibration method, an administrator 110 measures a tester's body weight on a calibrated weight scale and subsequently measures the tester's body standing on the pressure mat 114. The body weight of the tester is entered into the processor and the tester would stand still on the pressure mat for a fixed duration before starting the calibration process. The fixed duration may range from as low as 1 second to 15 seconds. A system that could collect data or frames at higher rates could decrease the time needed.

[0036] Using a Multi-level Pressure Calibration method, an automatic sensitivity adjustment may be executed. In the calibration window, a "sensitivity setting" button may be added. A tester may insert the pressure mat in the calibration mat in the calibration device and load the pressure mat at a fixed known pressure, such as 15 pounds per square inch (psi). The process may involve adjusting sensitivity based on raw digital readings. To

conduct the multi-level pressure calibration, the entire pressure platform may be placed in a pressure calibration device. The pressure mat may then be loaded at various pressure levels, such as 5 psi, 10 psi, 15 psi, 20 psi, 30 psi, etc. A load-output curve is generated for each sensel on the pressure mat, the sensel being an independent sensing cell. Moreover, in order to ensure proper calibration, the processor may perform a test calibration of the pressure sensors in order to offset long-term drifting.

[0037] The example kiosk 100 may also contain a storage device 105, e.g., RAM, a hard drive, flash drive, etc. that may transfer 120 information to be stored or sent, such as the instructions or software upgrades 115 needed to operate the kiosk, a mapping or decision matrix 116 of footcare products to classified subgroups, an inventory list 117, demographic information 118 of people that use the kiosk, parameters 122 of the kiosk that are pre-configured and which may be set by an administrator, records of kiosk transactions 119, demographic information 118 relating types of footcare products selected for foot types, etc. The inventory list 117 may store information of the types of products and also current availability in stock of those products. This information may also be transferred across a communication medium 107, e.g. a modem, DSL, cable, Ethernet, etc., to network servers 106 which may transfer 121 the stored kiosk information from a plurality of kiosks 100.

[0038] The network servers 106 or databases may store the corresponding information from a plurality of kiosks 100, including instructions or software upgrades 123, mappings or decision matrices 124, inventory 125 or product lists, demographic information 126, transactional information 127, and parameters 128. It may appreciated that the operation of the networked kiosks may alternatively be controlled through instructions or software upgrades 123 located only on the network servers 106. Alternatively, networked kiosks may share instructions and operational control with the server 106. An administrator 110, may collect and analyze 112 data from the network servers 106 to adjust parameters used to select a recommended footcare product or to adjust shipment of certain models of footcare products. Moreover, the inventory 125 may be analyzed, as will be explained later, to track the sales statistics of inventory or to register whether certain kiosks need to be restocked or more products need to be manufactured.

[0039] A processor 104 in the example kiosk 100 may be configured to perform a variety of tasks, such as taking pressure measurements from the pressure sensors 101. The processor may be able to calculate biomechanical data estimates of a person's foot based on the pressure measurements. Biomechanical data estimates may include estimated foot dimensions, estimated foot type, and estimated body weight. Foot types may indicate whether the person has flat feet, supination, pronation, etc.

[0040] At the-end of kiosk use, or before it is used during the day, an administrator 110 may initiate a checkup, or alternatively, the kiosk may initiate a self-check-up. A self-check-up may involve a pressure mat condition check-up (sensel misfiring when there is no load), handle-sensor, handle-computer check-up, touch screen check-up, system memory clean-up, calibrating the pressure mat, calibrating a scale, accounting for daylight savings time, etc.

[0041] Prior to the start of the kiosk, or while the kiosk is not in use, an administrator 110 may access the processor 104 using the input device 103 or the output device 102 that can act as an input, such as a touch screen interface. Or, if there is an error while the kiosk is in use, the error may prompt administrator 110 action. An administrator may set parameters for error-checking, such as a weight range limit, equation coefficients to calculate biomechanical data estimates or to select a footcare product. An administrator may also download from a network 107 or upload into the storage device 105 new product lists, inventory 117, video clips, language templates, etc.

[0042] FIG. 2 illustrates several example foot dimensions. The example estimated foot dimensions may be calculated based on pressure measurements taken by the example kiosk described previously. A foot dimension may be a longitudinal line 200 that runs from the lateral center of a heel to the lateral center of a second toe. Foot length 201 may be the distance between the most posterior point, i.e. the point towards the heel, of the foot 204 and the most anterior point 213, i.e. the point farthest toward the toes, on the foot pressure map on the longitudinal line. Foot width 202 may be the projection of distance between the most medial point 206 and most lateral point 207 of the foot pressure map, the projected foot width shown in the figure being perpendicular to the longitudinal line 200. An arch index is an estimate which may be used to characterize the arch. An arch index may be defined as the ratio of the area of the middle third of the toeless footprint to the total toeless footprint area, known as the foot body. The division of the three segments is along a line L 205 that is drawn between the lateral center point of the second toe 211 at the level of the toe line 203 and the lateral center of the heel 212 on the level of the most posterior point of the heel 204. The foot is thus divided into thirds, A 208, B 209, and C 210, with each third being of length L divided by 3. The Arch Index is equal to the areas of B / (A + B + C), which is equal to the area of B divided by the Foot Body Area. It may be appreciated that foot dimensions may be estimated using alternative methods or based on alternative points of measurement.

[0043] FIG. 3a illustrates an example of the locations of alignment marks that are displayed on a pressure mat. When a person stands on a pressure mat his feet should be located at the approximate angle of the two feet-shaped outlines 311. An alignment border 310 marks the furthest posterior boundary capable of receiving measurements. Internally the sensor array grid may detect features of the foot. As long as some part of the region of

measurement can be taken it can be determined whether a person being measured is standing outside the measurement grid. The person would them be instructed in how to move his feet in order to be within the measurement area. For example, one way of determining whether a foot is in a measurement region is to determine whether a part of a foot is on one side of the measurement grid, e.g., whether measurements can be taken on the sensor grid outside the measurement grid. Thus, a measurement grid 312 may be defined within a larger actual sensor grid 313 array boundary. If sensors detected measurements within 312 and also within 313 near that same area, then the system would recognize that a foot was outside the boundary and direct the person to adjust his foot.

[0044] FIG. 3b illustrates measurements that may be derived from pressure measurements on a pressure mat. In this alternative method of determining alignment, a person may stand within a designated area like in FIG. 3a. A longitudinal line 307 may be calculated to provide prospective of the location of a line connecting the center of the heel 305 and the center of the second toe 306. The outline 308 of the foot may be the general measurable boundaries for a person to place his or her foot. The outline may be large enough to fit a majority of people. For example, in one embodiment, a little more than 6 inches may be provided for toes. A grid 309 may be provided in order to provide uniform measurement units and they may, but need not, be provided to the person standing on the pressure mat.

[0045] Three Alignment Marks, X 301, Y 302, and Z 303 are designated across the width of the outline 308. Alignment Mark X 301 may be derived by taking the 100% multiplied by the ratio of the Average First Metatarsal Length over the Average First Toe Length. Average lengths may be derived by studying the mean foot lengths tailored to groups of people based on race, gender, foot type, or an overall population. Alignment Mark Z 303 may be derived by taking 100% multiplied by the ratio of the Average Fifth Metatarsal Length over the Average Fifth Toe Length minus a predefined number of grids. Alignment Mark Y 302 may be derived by taking an average length differential between the second and first metatarsal heads in the longitudinal direction. A generally hyperbolic fitted curve may be drawn over the three points to represent a toe line 304. It may be appreciated that the average lengths may have some variation, and thus, the exact location of the Alignment Marks may deviate slightly.

[0046] In one embodiment, Alignment Mark X 301 may be estimated to be 73% of the pressure mat length (=100% * 19.29/26.32 - 38 grids; 19.29 = average Canadian first metatarsal length; 26.32 = average Canadian first toe length). Alignment Mark Z 303 may be estimated to be 64% of the pressure mat length (= 100% * 16.9/21.69; 16.9 = average Canadian fifth metatarsal length; 21.69 = average Canadian fifth toe length). Each grid may be equal to 6.73 mm. One average length differential between the second and first metatarsal heads in the longitudinal direction is 3.4 mm while another average is 3.2 mm. Taking the average of the two averages would derive an average of 3.35 mm. Assuming an average foot length of 26.32 cm, the location of the second metatarsal head location may be moved up by 4.45 mm (= 3.35 * 35/26.32). If each grid is equal to 6.73 mm, the location of Alignment Mark Y 302 may be moved approximately 2/3 of the distance of a single grid. The location of center of the heel 305 and the center of the second toe 306 may be derived from averages, but in this example embodiment, it is defined to be between the ninth and tenth grid in the lateral direction.

[0047] FIG. 4 illustrates a flowchart of an example procedure for characterizing a person's feet based on pressure measurements and selecting a recommended footcare product, according to an example embodiment of the present invention. The example procedure may be implemented by a kiosk, such as the example kiosk described in FIG. 1. In 400, the example procedure may be initiated by an administrator. In 401, an output device may display an attract screen, e.g., pictures of products that may be sold in a merchandise display area of an example kiosk, and awaits a person's input 402. While there is no input, the attract screen may continue to display footcare products 401 or other images to attract a person. In an alternative embodiment, a dispensing mechanism may replace a merchandise display area, and the dispensing mechanism may automatically, or at the request of the person, begin the procedure to dispense the recommended footcare product. Intermittent audio and video clips may accompany the display of the footcare products.

[0048] When a person responds to the attract screen, e.g. by touching a touch screen or pressing a start button, the procedure may indicate that various language options 403 may be available, e.g., English or Spanish. The person may indicate a language preference and an error-check may be performed 404. While pressure measurements are taken, while a person's feet is grouped into a classified subgroup, or while a recommended footcare product is being selected, various screens may be displayed. At each of these screens, errors may occur or the user may voluntarily abort the procedure. These errors or aborts and the corresponding screen that it occurred may be tracked, e.g. by storing in the kiosk storage device or sending over a network to be tracked at a server 106. If an error or abort occurs, the procedure may restart 405 and return to its waiting mode by displaying footcare products 401.

[0049] If an error did not occur in 403, at 406, the procedure may re-display the instructions or display more detailed instructions. The person may place his feet on the pressure mat, if the person had not done so already. In 407, the display may provide a person with feedback, e.g., showing a real-time display of a pressure map of the person's feet. In 408, a person may be instructed to align the person's feet, for example using with alignment

marks such as those in FIG. 3b. Alignment marks may be displayed that match the exact pressure map locations. Alignment marks may include toelines and longitudinal lines for the left and right foot and may be illustrated by different zones of color. The center of the heel and the center of the second toe may automatically be detected. If it is not, a longitudinal line may be displayed and a person may be asked to adjust the foot until the feet are aligned with the longitudinal line. Alternatively, as in Fig. 3a, the user may be prompted to move his feet within the boundaries as detected by pressure sensors. The kiosk may determine if the feet are out of bounds of the pressure mat, whether the person's body weight is out of a pre-determined range, or whether a person's feet are unshod. In 409, whether a person has unshod feet while standing on the pressure mat may be verified.

[0050] In 410, multiple error checks may be performed. Based on prior determinations, errors are flagged if the issues may not be resolved. These errors may include: (1) if it cannot be recognized that a person is standing on the pressure with unshod feet (even if the person is); (2) if the person is standing out of the bounds of the pressure mat; (3) if the person has their feet misaligned; or (4) if the person's weight is not placed evenly on the pressure mat. Moreover, other error checks may be determined. For example, a minimum and maximum limit for a person's weight may be determined. It may be required that a person weigh between 70 and 400 pounds. It may be appreciated that a weight range may vary and also be represented in other metrics. As a result of the errors, the procedure may attempt to re-display the instructions 406 in order to help the person resolve any issues. The procedure may reach a threshold where the issues may not be easily resolved and thus restart the entire procedure 405.

[0051] If there are no errors, the procedure continues to 411. In 411, measurements of the feet may be obtained, e.g. pressure measurements from an array of pressure sensors. Throughout the measuring process, the person being measured may abort the procedure, e.g., by stepping off the pressure mat. The procedure may be also be aborted if there are problems in the measurement process, such as by the user shifting his weight unevenly. In 412, any measuring errors or aborts may be detected. If the issue cannot be resolved, the procedure may be re-started 405. In 413, based on the pressure measurements and biomechanical data estimates, a person may be grouped into a classified subgroup. In 414, a recommended footcare product is selected for the person based on a decision matrix or a mapping. For example, a product may be selected for a person based on physical characteristics such as arch index, weight, or foot length.

[0052] In one embodiment, the footcare product may be a pre-manufactured orthotic. In alternative embodiments, the processor or pressure sensors may be configured to collect pressure measurements to select another footcare product, e.g. a heel cup, a pressure pad, etc. The same pressure measurements may be implemented in the selection and recommendation procedures for different types of footcare products. However, alternative points may be taken from a pressure mat to recommend different types of footcare products. For example, while the same pressure measurements may be used to recommend an orthotic and a heel cup, alternative points of measurements concentrated in the heel may be more accurate to determine a heel cup fit. Both methods may be used and the processor and pressure sensors need only be configured to accommodate both footcare products.

[0053] Alternatively, in 414, multiple footcare products may be selected for a person to choose from. The person may also be prompted to answer questions providing additional information, for example, in order to provide the procedure with accuracy factors that can adjust parameters to search for a more accurate match. Such accuracy factors may use preferences, types of activities that the person frequently engages in, the type of shoes that the footcare product may be used with, gender of the person, etc. in order to further narrow the list of selected orthotics. Alternative questions may be asked earlier in the procedure, such as before the pressure measurements are taken. Alternative factors may change the recommended footcare product from one type of footcare product to another, e.g. an orthotic versus a heel cup.

[0054] In 415, several types of information may be displayed, e.g. to the person using the kiosk described above. Indicia identifying the model of the recommended footcare product may be displayed. These indicia may help the person locate a corresponding footcare product that is located in a merchandise display area. Moreover, along with the real-time pressure measurements that a person may already view, a peak pressure map may be displayed to show the pressure measurements taken by the kiosk. Information regarding any of the biomechanical data estimates, such as estimated weight, foot type, or others may also be displayed. Examples of biomechanical data estimates that may be displayed include foot length, foot width, body weight, arch index, outline of the foot and toeline, a longitudinal line (drawn on the peak pressure map), or the intersection of the longitudinal line and foot body, i.e. the area of the foot excluding the toes.

[0055] In 416, after the person has completed the measurements and received information about the recommended footcare product, the person can choose to restart the process or the person can step off the measuring device, which would automatically restart the procedure to display foot care products, in 401, while waiting for a new person to initiate the procedure.

[0056] If a person were to use the procedure with the example kiosk of FIG. 1, values may be stored or sent over a network regarding kiosk transactions that were performed. Examples of kiosk transaction information that may be stored are the number of times the kiosk has been used, the number of times the system was used to completion of selecting a footcare product to a person,

if a person aborted use of the kiosk and at which screen the person was viewing at the time of aborting, a count of which products have been recommended, and a total count of persons that used the kiosk and the time of day that the kiosk was used as well as the length of time spent using the kiosk per person. If the kiosk is not activated for a significant period or if the kiosk is scheduled to operate during only certain times of the day, the last person may be measured and the kiosk may automatically shutdown or go to sleep in 417.

[0057] Measurements of a person's foot vary significantly if the foot is not unshod. Accordingly procedures may be provided to automatically detect whether a footwear is worn by a person whose foot is being measured. FIG. 5 illustrates an example pressure map showing foot dimensions that may be used to determine if a foot on a sensor is unshod, according to an example embodiment of the present invention. The pressure map may be generated after collecting a static pressure for a prescribed period of time, for example, 2 seconds. On the pressure map, a longitudinal line 500 connects the lateral center of the heel 502 and the lateral center of the second toe 501. The center of the heel and the center of the second toe (and any other point of interest) may be determined by comparing the measured foot profile with general foot templates. Generalized foot templates may be created by taking samples of actual feet measurements or averaging many foot types. Based on the pressure map, a geometric center of the feet may be determined. The general foot templates may expand or shrink depending on the size or length of the foot and the general foot template may be compared to that of the pressure map outline using the geometric center as a reference point. A matching method, such as best fit, may then be used to determine the most comparable general foot template. Using the most comparable general foot template, all other points of the foot may be estimated, including the center of the heel and center of the second toe.

[0058] For the purpose of clarity and explanation, in FIG. 5, the most anterior point and the most posterior point along the longitudinal line are projected out as the most posterior point line 503 and the most anterior point line 504, which are perpendicular to the longitudinal line. The projection of the line between the most posterior point and most anterior point is the Foot Length (FL) line 505, which is equal to the distance between the most posterior point and the most anterior point. Three points are identified along the longitudinal line measured in relation to the foot length. These are point A 506, measured at 16% of the FL line 505 from the posterior end, point B 507, measured at 50% of the FL line 505 from the posterior end, and point C 508, measured at 75% of the FL line from the posterior end. It may be appreciated that these points may vary, and these points may derived from trial runs on the feet of approximately 30 test subjects.

[0059] Line A 509, is perpendicular to the longitudinal line and is drawn through point A 506. Line A 509 intersects with the boundaries of the pressure map, and the length of Line A 509 may be truncated within the outline of the pressure map. The outline of the pressure map indicates the outermost pressure points that are reflected in a real-time pressure measurement. The length of Line A 509 represents the Heel Width (HW). Line B 510, is perpendicular to the longitudinal line and is drawn through point B 507. Line B 510 intersects with the boundaries of the pressure map in the midfoot area and the length is truncated within the outline of the pressure map. The length of Line B 510 represents an estimate of the Arch Width (AW). Line C 511, is perpendicular to the longitudinal line and is drawn through point C 508. The widest points between Line B 510 and Line C 511 are projected out as lines, parallel to the foot, on the medial side 512 and the lateral side 513. The longest width of the pressure map between Line B 510 and Line C 511, i.e. the distance between lines 512 and 513, represents an estimate of the Forefoot Width (FW).

[0060] FIG. 6 illustrates an example procedure using foot dimensions from FIG. 5 to determine whether an unshod foot is on a pressure mat, according to an example embodiment of the present invention. In 600, a pressure map may be generated at the start of the unshod foot detection. As explained previously, the pressure map may be generated from collecting a static pressure for a prescribed period of time. In 601, the longitudinal line 500 is identified. In 602, key points are identified, in particular point A 506, point B 507, and point C 508. In 603, the estimated Heel Width may be determined, as explained in FIG. 5 relating to deriving Line A 509. In 604, the estimated Arch Width may be determined, as explained in FIG. 5 relating to deriving Line B 510. In 605, if there is no intersection with the pressure map, then in 607, the Arch Width is assigned a pre-determined number, e.g. some constant that is not zero to avoid the situation where a number could be divided by zero. If the Arch Width does have a value, then in 606, the Arch Width is assigned that value. In 608, the Forefoot Width may be determined, as explained in FIG. 5 relating to deriving Line C 511. In 609, the values previously recorded are compared with pre-determined values. The pre-determined values can be derived by recording and comparing values of actual test subjects wearing shoes and comparing them to measurements while standing unshod. For both feet, an example condition is:

$(FL/HW \geq FL\_low)$ & $(FL/HW \leq FL\_high)$ & $(FW/HW > FW\_limit)$ & $(AW/HW \geq AW\_limit)$ In this example, FL_low = 3.5; FL_high = 6.0; FW_limit = 1.2; AW_limit = 0.1.

[0061] In 610, after the condition is determined, if the condition is "true" then, in 611, the person is recognized as being unshod. If the condition is false, then in 612, the user is recognized as wearing shoes. It may be appreciated that values can be added to the condition range to have the option to determine if a person is wearing socks. The procedure to determine if an unshod foot is on a pressure sensor ends in 613.

[0062] The target ratios and constant values may be

derived by comparing the ratios to actual test subjects and calculating whether the ratios and constants match, on average, the ratios for those test subjects. However, it the ratios may also be altered by adjusting the point of Line A 509, Line B 510, or Line C 511 on varying degrees along the foot length line. The locations of these varying lines are derived from testing multiple subjects and calculating ranges with the least errors. Alternative measurements may allow the lines to vary or in fact to add further lines. For example, a Line D may be added between Line A 509 and Line B. Ratios of Line D compared to the other widths and lengths may also create a new constant with which to compare the ratio. This new constant may be a floor or minimum or a ceiling or maximum constant when compared to the ratio of Line D to a measurement of the length, width, arch width, some other newly derived line, etc.

[0063] FIG. 7 illustrates an example procedure to take pressure measurements to calculate biomechanical data estimates, such as those in FIG. 2, according to an example embodiment of the present invention. In 700, the procedure may begin after a person's feet are on pressure measurement sensors. At the start, various other checks may also be performed to interact with a person that is being measured. For example, an output may display a real-time pressure map as soon as a person steps on a pressure mat; a person may be prompted to remove their shoes and step on the pressure mat at designated areas on the pressure mat with their weight balanced between the left and right, front and back; the person may be prompted to indicate whether or not the person is ready for measurement, such as by clicking on a "Start" button. Several error checks may have been performed at the pressure measurement collection time, such as to determine whether an unshod foot is actually on the sensor as in FIG. 6, or whether there are other errors with foot alignment, weight, etc. as in 408 or 410 in FIG. 4.

[0064] In 701, a target zone may be defined. The target zone may be the geometric center of the pressure print of both feet, but may also be another geometric pressure point of reference. In determining the target zone, the target zone may be shifted 10% distally to force the user to lean forward slight, and consequentially, allow the person's toes to have direct contact with the pressure mat. In 702, a person may be prompted to match the person's center of force (COF) into the target zone. The center of force may be determined by calculating the moment of torque for each sensor point and taking the centroid weighted by the force at each point to create an overall representation of the force of both magnitude and location of the various forces. The center of force may be used to indicate the body's center of gravity.

[0065] In 703, if the length of the foot pressure map changes by more than 15 mm, approximately a 2 sensel element difference, 701 is repeated and the target zone may be re-calculated and displayed to the person on an output device. The length of pressure map change that would trigger a re-calculation of defining a target zone may depend on the use of the measurement. A 15 mm threshold is approximately 2 shoe sizes and may justify a re-calculation. The person may be prompted to continue to match the person's COF into the new target zone. If in 703, there is no significant increase of foot pressure length, the initial target zone may not be re-calculated. In 704, the final target zone may be located at a fixed location unless the person moves or lifts his feet. In alternative embodiments, the target zone may also be determined dynamically, wherein the COF matches a dynamic target zone, which may be defined as the center of area.

[0066] In 705, a static pressure measurement may be initiated. Frames may be collected at different rates. Pressure data may be collected at a rate of 10 frames per second. While frames are taken, the target zone may be displayed on an output device. In 706, frames of pressure data may be collected. Depending on the desired accuracy of pressure measurements, a minimum number of frames may be needed, such as 20 frames of pressure data. Twenty frames of pressure data at 10 frames per second may require a person to hold a target zone for 2 seconds.

[0067] Among the frames collected, some of the frames may have be poor. Some frames may be eliminated for use through a qualifying process. The qualifying process may use any number of different methods. For example, the method described in FIG. 6 for determining whether a foot is unshod may also be used to determine whether a frame is a qualifying frame. If a foot is determined to be unshod, the frame would be qualified. If the frame would not be qualified as unshod, it is likely that the collected frame was poor or that there was an error and would thus be eliminated. Another example method may be to determine whether the balance of weight between the front and back and the sides are properly distributed based on the COF.

[0068] In 707, based on the pressure measurements taken, a static foot outline (SFO) may be derived from the pressure measurements. In 708, after static pressure measurements have been taken, the person may be informed that the static pressure measurement has been completed.

[0069] In 709, the quasi-dynamic pressure measurement process may commence. Generally, dynamic measurements are taken during ambulation in order to determine pressure on various parts of the person based on his or her gait. However, a quasi-dynamic process estimates the types of pressures created without a need for ambulation. Rather, a quasi-dynamic process may allow for pressure measurements to be taken while a person is standing on one foot in order to simulate pressure that may be generated during ambulation.

[0070] In 710, the person may be prompted to hold a balance, such as by holding a balance bar or to keep their balance on their own, and then to gently and slowly lift one foot while balancing and standing on a first planting foot. In 711, a target zone may be defined for the first

planting foot based in part on the static foot outline previously determined in 707. The location of the target zone may be slightly modified according to the one-foot pressure map. The user may be prompted to match the target zone for the first planting foot.

[0071] In 712, the biomechanical status of the person may be monitored and different triggers for pressure frame collection may be implemented. For example, one trigger to start collecting pressure frames may be when the COF enters the target zone and is stable for a short pre-defined period, such as one second. Again varying number of frames may be collected; for example, 20 frames at 10 frames per second may be collected. An alternative trigger may be to collect frames when the load on the planting foot reaches 90% bodyweight. It may be appreciated that variations and combinations of biomechanical status may trigger the collection of frames. For example, frame collection may be triggered when a person's COF matches the target zone and at least 95% of static weight is achieved. In 713, once the measurement collection is completed, a person may be instructed place replace the raised foot back onto the pressure mat.

[0072] In 714, if both feet have been measured individually, parameters may be calculated in 715. If not, 710 to 713 may be repeated to collect frames for the second planting foot. The order of the frame collection of the individually feet may be altered. During the second round of 710, when measuring the second planting foot, the SFO may need to be rotated to match the pressure print of the second planting foot. In 711, a new target zone may also be defined based on the SFO. The location may also be slightly modified according to the one-foot pressure map.

[0073] In 715, based on the static or quasi-dynamic pressure measurements from the collected frames, biomechanical data estimates of the foot may be calculated. Only the qualifying frames are used to calculate biomechanical data estimates. Determining qualifying frames may involve methods previously mentioned, such as using the method of determining whether a foot is unshod. The qualifying process is generally performed before the biomechanical data estimate calculations are performed because otherwise the processing would be wasted if a frame were discarded in the qualifying process. Nevertheless, the order of qualifying and calculating biomechanical data estimates may be altered. For example, qualifying may be done for all frames and then calculations of biomechanical data estimates may be done for remaining frames, or vice versa. Alternatively, the combination of the qualifying process and calculation of biomechanical data estimate may be done for each frame at a time.

[0074] Using FIG. 2 as a reference for the calculation of biomechanical data estimates, a foot length 201 may be determined by searching along the longitudinal axis and determining the lowest and highest points. The distance between the most posterior point of the heel 204 and the most anterior point 213 may be calculated as the foot length 201. A general foot profile may be used to match the pressure map, similar to the methods described in FIG. 5. A lateral center point of the second toe 211 and a lateral center of the heel 212 may be derived from the foot template and a longitudinal line may be derived which is a line between the two points. The longitudinal line becomes the axis of the searching direction. Using the pressure maps, the toe line 203 may be determined by searching for the peaks and valleys of pressure. For example, the big toe is known to have a large peak in pressure and valleys in pressure exist between the toes. The distance between the toe line 203 and the most posterior point of the heel 204 is the distance of line L 205. The total area of the foot within line L of the foot is the foot body, consisting of the sums of the areas of sections A 208, B 209, and C 210. Based on the location of pressure, the area of A 208, B 209, and C 210 may be calculated. The Arch Index is equal to B divided by the area of the foot body. The arch index of a person's foot may then be the average arch index of all the qualified frames for each foot.

[0075] The biomechanical data estimates may include foot dimensions, estimated foot type, and estimated body weight. For example, biomechanical data estimates that may be calculated may include peak pressure maps of both static and quasi-dynamic pressure, an artificial double-footed peak pressure map derived from the combined left and right foot quasi-dynamic foot pressure measurements, foot length, foot width, body weight, a longitudinal line, an arch index, etc. The biomechanical data estimates may be stored in the kiosk storage area or sent over a network to be stored. Demographic information, for example, information relating a user id number associated with corresponding biomechanical data estimates and a recommended footcare product, may be stored in a storage device or relayed over a network for storage in a central database or server.

[0076] FIG. 8a illustrates an example decision matrix, according to an example embodiment of the present invention. A decision matrix module is used to correlate classified subgroups with a footcare product model. The decision may, in part, be derived from the various footcare products available, and may thus vary based on the product specification list that is stored in the storage area. The classified subgroups may be based on biomechanical data estimates or directly on the pressure measurements themselves. Another example of selecting a footcare product is a mapping between a classified subgroup and footcare products.

[0077] A set of 14 pre-manufactured orthotics may be provided as described in concurrently filed application titled, "Cushioned Orthotic", filed U.S. Application No. 11/524,979 filed September 21, 2006, assigned to Schering-Plough Healthcare Products, Inc. the assignee of the present application. These orthotics include 4 lengths/size, 2 different levels of arch support and 2 different levels of cushioning. However, only one level of cushioning is provided for the largest size. This may be

because people of the largest size feet require the maximal cushioning.

[0078] The particular matrix in FIG. 8a is divided into bands and indexed by weight of the person and arch index. The bands represent the foot length of the person. For example, in the example matrix there are four bands: Band A 850 for foot lengths below 244 mm, Band B for foot lengths greater than and including 244 and less than 255 mm, Band C for foot lengths greater than 255 mm and less than 270 mm, and Band D for foot lengths greater than and equal to 270 mm. Each band contains a cross-reference between a weight and an arch index.

[0079] In the example matrix the weights are divided between low weight and high weight, although with more product models and weights tested the weight categories within a band may increase. The dividing weight between low and high weight is the median weight. The determination of the median weight is the median weight that is expected for people of a particular foot length. The type of support may require more cushioning for people of a certain foot length but heavier than the median weight for that foot length. The median weight would thus vary between the different bands. As foot length increased, a median weight would also be expected to increase.

[0080] In the example matrix the arch index is divided between low, medium or normal, and high, although with more product models the arch index may increase in categories. The low arch index range 853 may be defined as greater than 0.257. The medium arch index range 859 may be greater than 0.173 and less than or equal to 0.257. The high arch index range 860 may be less than or equal to 0.173. In these examples, there is an inverse relationship between the arch index and the arch, e.g., the higher the arch index the lower the arch. It is possible for the foot care products to be sold individually for the left and the right foot because it is possible that the right and the left foot will have differing arch indexes. Presumably, the foot length and body weight will not differ. If the footcare product were only sold in pairs, then the low or high arch index would dominate over the medium/normal arch index. For example, if the right foot was a high arch index and the left foot was a normal arch index, the selected model would be for the high arch index. Between the high arch index and the low arch index the more conservative product may be selected, e.g. the medium arch index may be selected.

[0081] Using the foot length, arch index, and weight of a person a product model may be selected and then recommended to that person. For example, if a person had a foot length of 220 mm, weighed 120 pounds, and an arch index of 0.261. A length of 220 mm would mean the person would fall within Band A 850. Band A 850 has a median weight 855 of 135 pounds, thus a person weighing 120 pounds would be classified in the low weight 851. An arch index of 0.261 would place the person in the low arch 854 of Band A. A low arch 854 within Band A 850 of low weight 851 would recommend "Product 1" 856. As another example, suppose a person had a foot length of 220 mm, weighed 150 pounds, and had an arch index of 0.205. The foot length as before would fall into Band A 850. Band A 850 has a median weight 855 of 135 pounds, thus a person of 150 pounds would be classified in the high weight 852. An arch index of 0.205 would place the person in the medium or normal arch 858 of Band A. A medium arch 858 within Band A 850 of high weight 852 would recommend "Product 4" 857.

[0082] It may be appreciated that while this decision matrix is displayed in this example as a spreadsheet, the organization of the products and biomechanical data estimates may be organized, searched, and accessed in the kiosk storage using other methods, such as an array, linked list, database table, etc.

[0083] FIG. 8b illustrates an example procedure for selecting a footcare product from a decision matrix, such as in FIG. 8a, based on pressure measurements, according to an example embodiment of the present invention. The procedure may be used in selecting a recommended footcare product 414 as in FIG. 4. In 800, when the procedure has started, the person's weight, arch index, and foot length will have already been determined, from the pressure measurements, the scale, or the person's input. In 801, the person is classified into a Band. In 802, if the person's foot length is less than 244 mm the person is classified into Band A in 806. If not, in 803, if the person's foot length is greater than or equal to 244 mm or less than 255 mm the person is classified into Band B in 807. If not, in 804, if the person's foot length is greater than or equal to 255 mm or less than 270 mm the person is classified into Band C in 808. If not, in 805, if the person's foot length is greater than or equal to 270 mm the person is classified into Band D in 809.

[0084] After the Band is determined, in 810 the person's arch index may be cross-referenced with an arch index range. In 811, if the person's arch index is greater than 0.257, the person is classified as having a low arch in 814. If not, in 812, if the arch index is greater than 0.173 or less than or equal to 0.257, the person is classified as having a medium arch in 815. If not, in 813, if the arch index is less than or equal to 0.173, the person is classified as having a high arch in 816.

[0085] After the person is classified into a Band and Arch Index, in 817 the person is classified into a weight range. In 818, if the person's weight is less than the median weight, the person is into a low weight for the particular band 820. If not, in 819, and by default, if the person's weight is greater than or equal to the median weight, the person is classified into a high weight for the particular band 821. As in Figure 8a, the median weight may vary depending on the particular band. The order of the designation of the arch index range, weight range, and Band may also vary. For example, depending on how the data is stored or how the software is written, the weight range may be determined before arch index range. After a person is classified based on selection criteria, the selection criteria may be cross-referenced in 822 to determine the recommended product model. This

product model is returned in 823 to be recommended to the person.

[0086] FIG. 9a illustrates an example kiosk selecting pre-manufactured orthotics, according to an example embodiment of the present invention. A pressure mat 900 which may be removably attached to the kiosk is located on the bottom of the kiosk. On the surface 904 of the pressure mat 900, alignment marks may be displayed that match the exact pressure map locations. The foam template mat may overlay the pressure sensors in order to guide a person using the kiosk in the placement of the person's feet, and the entire pressure sensor and foam template mat combination may form a pressure mat 900. A set of candidate footcare products, in this example orthotics, may be displayed on or near the kiosk in a merchandise display area 901 located on the sides of the kiosk, e.g. stored in clear plastic shelves that allow removal. Other forms of removable attachments may be used to display products. It may be appreciated that the merchandise display area may be located on the kiosk or near the kiosk. Alternatively, footcare products may be dispensed like that of a vending machine. Handlebars 903 which a person may use to balance while standing on one foot during a pressure measurement procedure may be vertical bars, but in alternative kiosks, handlebars 903 may be located on the sides. An output device 902, such as a touch screen device, may be located at eye-level or where a person standing on the pressure mat 900 may easily access and view the touch screen.

[0087] FIG. 9b illustrates an example internal structure of a pressure pad, such as the pressure pad 900 in FIG. 9a, according to an example embodiment of the present invention. A sensor grid array for the left foot 906 and right foot 907 is separated 908 by 10 cm at the lower-right corner of the left foot sensor grid 906 and the lower-left corner of the right foot sensor grid 907. The angle of separation 905 between the two sensor grids is 17.5 degrees. The layout of the grid is developed for the comfort of the user and is not necessary for measurement. The pressure pad also contains a handle 909. The pressure pad itself is sloped upward at an angle where the point at 915 is at a vertical height lower than the point at 916. While the system in theory could be calibrated to work with any angle of the pressure pad, or a flat pressure pad, having angled pressure pad reduced the likelihood of the device being overridden by shopping carts in an unattended retail environment. The reason for this is because people naturally tend to stand without as much pressure on their toes, and the angle forces the person to create a pressure image. The actual degree of the slope may vary, but a lean of approximately 10% is recommended. The importance of the sensors receiving proper contact from the toes is to ensure a proper reading of the foot length. The width 916 of the pressure mat may be 24 inches and the length 917 is 21.5 inches.

[0088] FIG. 9c illustrates an example layer-by-layer internal structure of a pressure pad, such as the pressure pad 900 in FIG. 9a and 9b, according to an example embodiment of the present invention. The first layer 909 is the top of the pressure mat and contains an image of the foot outline and boundaries of the foot measurement area, as viewable by a person using the pressure mat. This is also the layer that is in direct contact with the person's feet. The second layer 910 may be a foam sheet that may provide padding for the feet. A third layer 911 may be a Teflon sheet, or other non-conductive material. A fourth layer 912 may be the sensor mat containing pressure sensors. Extending from the sensor mat may be a set of leads 915 attached to a handle 914. The bottom layer 913 hard layer supporting the pressure mat and may be made of acrylonitrile-butadiene-styrene (abs). The various layers of the pressure mat may be altered, either in order or in material, depending on various factors, such as the sensitivity of the pressure, comfort level, or height of the pressure mat.

[0089] Figs. 10 through 20 illustrate example screens that may be displayed on an output device while performing the example procedures of Figs. 4, 7, and 8b, according to an example embodiment of the present invention. FIG. 10a illustrates an example screen that may display footcare products, according to example 401 in FIG. 4, while the system is not in use, according to an example embodiment of the present invention. An example image 1000 of a footcare product, e.g. a cushion orthotic, in the set of available footcare products may be displayed. Alternatively, a video clip or a rotating image of the product may be displayed. Audio may also be provided along with the image or video. Descriptions 1002 of the displayed footcare product may also accompany the video or image 1000. An instruction 1001 to initiate the kiosk may be displayed as well, e.g. a button reading "Touch Screen to Begin." FIG. 10b illustrates an example screen that may display a footcare product and its various components, according to an example embodiment of the present invention. For example, a cover layer 1003, cushioning layers 1004 and 1005, and a bottom shell layer 1006 of a footcare product, like that shown in FIG. 10a, may be displayed on a page with an instruction 1001 to initiate the kiosk.

[0090] FIG. 11 illustrates any number of example screens that display information, instructions, or that provide a language option, according to examples 403 and 406 in FIG. 4, according to an example embodiment of the present invention. For example, a title 1100, which may contain the name of the system or the name or trademark of the company employing the kiosk, may be listed on the screen. Instructions 1102 on how to generally use the kiosk may also be displayed. A language option may be presented, e.g. the user may choose English language 1101 or Spanish language 1103 instructions. Alternatively, a "switch to Spanish" option may be displayed where the default may be English language instructions, or vice versa. It may be appreciated that other languages may be accommodated by adding language files to the kiosk.

[0091] FIG. 12 illustrates an example instruction

screen directing a person to take off his or her shoes, according to an example embodiment of the present invention. The screen may show a real-time pressure map 1200 of the person's feet. Instructions 1201 may be displayed on another side of the screen. At the direction of the instruction screen, a person may take off his shoes and step back onto the pressure mat. An error check may be performed using a procedure to determine whether an unshod foot is on the pressure mat, such as the example procedure of FIG. 7. Moreover, error checks may be performed, such as those described in 410 of FIG. 4. Subsequent error checks may be performed on any subsequent screens as well. If an error is detected, the person may be prompted to restart the procedure, or further instructions or more detailed instructions may be displayed to help the person rectify any errors.

[0092] FIG. 13a illustrates an example screen that may be displayed to a person to help achieve proper foot alignment and weight distribution, according to an example embodiment of the present invention. Foot alignment may be determined according to analysis of foot measurements, e.g. analysis of foot pressure measurements as described above in example 408 in FIG. 4. A person may be asked to position his or her toes at a line 1300, and a corresponding line may also appear on the pressure mat to guide the person to stand in the appropriate position. A target Center of Force 1303 and a current Center of Force 1304 oval may be displayed on the screen. Further instruction may request that the person balance his or her weight evenly on both feet by aligning two displayed ovals 1301 (in alternative embodiments circles or other shapes may be displayed). As the person shifts his or her weight, the COF is recalculated and the COF oval moves on the screen. While the weight is unbalanced, the person may be unable to proceed to the next step because a "proceed" button 1302 may not be active.

[0093] FIG. 13b illustrates an alternative example screen that may be displayed to a person to help achieve proper foot alignment and weight distribution, according to an example embodiment of the present invention. Alignment marks in the anterior of the feet may be replicated on the screen as the anterior limit 1308 of the measurement boundary. A foot pressure gauge 1307 may be displayed to allow the user to interpret the pressure results. The person may be instructed 1309 to move a yellow circle 1306 into a red target circle 1305, similar to the example in FIG. 13a where a person may be asked to move a current COF to a target COF.

[0094] FIG. 14 illustrates an example screen that may be displayed to a person when the person has his or her weight balanced on both feet, according to an example embodiment of the present invention. An active "proceed" button 1400 may be highlighted as active after the weight is balanced. This may be indicated if the Current COF and Target COF oval become an overlapping balanced COF 1401. Measurements may be obtained, for example, in a procedure described in 411 of FIG. 4, or illustrated in more detail in 705 to 708 of FIG. 7.

[0095] FIG. 15 illustrates an example screen containing instructions that may be displayed to a person regarding taking quasi-dynamic foot measurements, e.g. pressure measurements of the person while the person stands on the left foot, according to an example embodiment of the present invention. Instructions 1500 may be displayed in one section and various steps may be highlighted as they are performed. A first instruction 1502 may request that the person place his or her hands on a bar for balance and safety purposes. The person may hold onto bars, such as those of 903 of the example kiosk illustrated in FIG. 9. The bars may contain sensors that may register contact in order for a kiosk to determine when this step has been performed. A second instruction 1503 may instruct the person to slowly raise the right foot completely off the pressure mat. A third instruction 1504 may instruct the person to balance his or her weight on the remaining left foot, in this case the first planting foot. These three instructions may be implemented according to example 707 to 709 of FIG. 7. Pressure measurements may be taken while the person is standing on the left foot. While pressure measurements are collected, a pressure map of the first planting foot 1501, in this case the left foot, may be displayed on the screen.

[0096] FIG. 16a illustrates an example screen that may be displayed after measurements of a single planting foot are taken, according to an example embodiment of the present invention. An instruction 1600 may be highlighted after measurements have been taken to indicate that the person's foot may be placed back onto the pressure mat. When the person's foot is detected on the pressure mat, the real-time pressure map 1602 may display the foot that was previously lifted off the mat, in this example the right foot. This may be done according to example 710 in FIG. 7. When measurements are completed and the foot is replaced, a "proceed" button 1601 may be activated to indicate to a person that the measurements of the left foot were taken.

[0097] FIG. 16b illustrates an alternative example screen that may be displayed after measurements of a single planting foot are taken. In the example screen, after the foot is placed back on the mat the person may be prompted for a weight input 1603 asking whether the person weighs less than a pre-defined weight. The predefined weight may be derived from a median weight of a particular band, for example, of a band as shown in FIG. 8a. The screen at which the user is asked to input weight may be displayed at any point of the measurement process. For example, the prompt for a weight input may be shown after both feet have been measured individually, before any feet have been measured, etc. Alternatively, the prompt may not be displayed at all if the pressure measurements are deemed accurate enough to calculate the weight, or if an optional scale is used to verify the pressure measurement's weight calculation.

[0098] FIG. 17a illustrates an example screen containing instructions that may be displayed to a person re-

garding taking pressure measurements of the person while the person stands on the right foot. Instructions 1700 may be displayed in one section and various steps may be highlighted as they are performed. A first instruction 1702 may request that the person place his or her hands on a bar for balance and safety purposes. The person may hold onto bars, such as those of 903 of the example kiosk illustrated in FIG. 9. The bars may contain sensors that may register contact in order for a kiosk to determine when this step has been performed. A second instruction 1703 may instruct the person to slowly raise the right foot completely off the pressure mat. A third instruction 1704 may instruct the person to balance his or her weight on the remaining right foot, in this case the planting foot, by aligning the ovals, for example, a current COF oval 1706 with that of a target COF oval 1705. These three instructions may be implemented through the repeated 707 to 709 of FIG. 7. Foot measurements, e.g. pressure measurements, may be taken while the person is standing on the right foot, in this example the second planting foot. While measurements are collected, a pressure map of the second planting foot 1701, in this case the right foot, may be displayed on the screen. It will be appreciated that foot order may be reversed, or only one foot might be measured.

[0099] FIG. 17b illustrates an alternative example screen containing instructions that may be displayed to a person regarding taking pressure measurements of the person while the person stands on the right foot. Instructions for measuring on one foot 1712 may be displayed and highlighted. The person may be instructed to move a yellow circle 1710 into a red circle 1711 in order to balance the COF.

[0100] FIG. 18 illustrates an example screen that may be displayed after measurements of a single planting foot are taken. This screen is similar to FIG. 16, although the instruction to replace the foot onto the pressure map may be integrated with an activated button 1800 instructing the person that he or she may proceed. This may be done according to example 710 in FIG. 7. A real-time pressure map 1801 of the feet may be displayed on the screen as the raised foot is placed back onto the pressure mat. When measurements have been completed and the person is ready to proceed, as indicated in pressing 1800, biomechanical data estimates may be calculated behind-the-scenes according to example 712 in FIG. 7.

[0101] FIG. 19 illustrates an example screen that may display a selected recommended footcare product, in this example, an orthotic. An image 1900 of the footcare product may be displayed that a person may use to recognize the footcare product displayed in the merchandise display area, like that of 901 of FIG. 9. It may be appreciated that other indicia identifying a recommended footcare product may also be displayed, such as a rotating image, or an image that a person may manipulate through a touch screen, or a video clip containing an audio description, etc. It may be advantageous to color code various products so that a customer can more easily locate a recommended product.

[0102] FIG. 20 illustrates an example screen displaying other information that may be displayed to a person, according to an example embodiment of the present invention. For example, the screen may display further indicia of the recommended footcare product that was selected, such as a model number 2000. The packaging 2002 of the footcare product as it would appear on a merchandise display area 901, such as that of FIG. 9a, may also be displayed. A restart button 2001, in order to restart the selection process according to example 414 in FIG. 4, may be displayed to allow a person to restart the selection process, or so that another person waiting to use the kiosk may immediately start the process. Other information may also be displayed on the final screen, for example, any of the prior calculated biomechanical data estimates or pressure maps may be displayed. The person may be able to maneuver through various pages to view the person's own biomechanical data estimates.

[0103] In alternative embodiments, when the selection process is complete, the kiosk may display several recommended footcare products. The person may then, from these few selected footcare products, narrow the range of products down, either by eliminating the choices directly, or by answering a set of questions, such as comfort preferences, activities typically engaged in by the person, the particular activity that the footcare product may be used with, the type of shoe that the person may wear, or the type of socks that are worn. The footcare products may also be different types of products from which the user can choose. For example, the kiosk may display an assortment of orthotics and heel cups. In alternative embodiments, these preference choices may be asked prior to the last page and the kiosk may automatically eliminate choices for the person.

[0104] It will be understood form the description above that the inventors of the present application have recognized an unmet need to provide an economic and efficient method and apparatus, which provides recommendations from a wide, but not unlimited range of pre-manufactured orthotics including different amounts of support, different sizes, and different cushioning. Using a limited number of measurements, the inventors have found that a large proportion of the population can then be guided to one of these pre-manufactured orthotics, achieving at least part of the benefit of a custom approach without the associated cost. Moreover, the inventors of the present application have recognized a need for and developed a solution which allows the measurement and mapping to be conducted using an unattended kiosk located in a retail environment.

[0105] Some prior devices have been proposed which use measurement approaches including optical measurements using two-dimensional or three-dimensions optical or laser scanners, thermal imaging, ink-blot measurement of the foot, and physical measurement with gauges. However, none of these types of devices has been found to be cost-effective or reliable enough to use

in a device widely deployed in a mass-market retail environment. Moreover, many of these measurements require careful supervision by an operator and may not be suitable for use in an unattended measurement kiosk application. In contrast, the inventors of the present application have recognized the unmet need for a device which can reliably and accurately characterize a customer's foot for the purpose of choosing a footcare product, e.g., an orthotic, where the measurement device is inexpensive and relatively robust, making it suitable for use in a mass-market retail environment. As disclosed in the present application, the inventors of the present application have identified pressure measurement devices, e.g., using a piezoelectric mat, as particularly suited to use in this environment.

[0106] When a podiatrist or other trained person fits a custom orthotic to a patient, the podiatrist may make a large number of different types of observations and measurements. In particular, the podiatrist, in addition to static measurements of the foot, may observe and/or measure the patient's dynamic gait. While instruments for gait analysis exist, they are not suitable for use in an unattended retail device. Accordingly, the inventors of the present application have recognized the unmet need for methods and apparatus that can characterize a person's foot and identify an appropriate footcare product, e.g., an orthotic. The inventors have developed methods and system that incorporate elements of dynamic gait analysis in a manner which is suitable for use in a relatively simple and inexpensive, unattended measurement kiosk. These methods and systems include quasi-dynamic measurement of the foot, to provide some of the advantages of dynamic gate analysis using a simple, automated tool. In particular, the inventors of the present application have developed methods and systems for characterizing the foot based on pressure measurements of a person standing on only one foot, which can be used to add a dynamic element to a static two-footed measurement. This solution may allow a more accurate characterization of the foot and a better recommendation of a footcare product, e.g., an orthotic, without the need for additional more complicated and expensive measurements and/or measurement devices.

[0107] To provide a device that can accurately characterize a user's foot and recommend a foot care product that is suitable for use in an unattended retail environment, several other problems had to be solved. First, the inventors of the present application have observed that, without proper supervision, users may use a measurement device improperly. For example, users may wear shoes when they should be unshod, and users may lean on the device rather than standing. Accordingly, the inventors have recognized an unmet need for systems and methods which automatically determine if a user is making proper user of the measurement device, e.g., by detecting if the user is shod, wearing socks, or unshod, by determining if the user is leaning on the device or placing their full weight on the measurement system, for determining if the user's weight is properly centered on the measurement device, for determining if the user's feet are properly positioned on the measurement device. Moreover, there is a further unmet need, once pressure sensors are adopted, for solving these problems using only pressure measurements, or with pressure measurements plus a limited range of easy to obtain information that does not add greatly to the cost of the measurement device (e.g., a simple weight measurement or query of the user) .

[0108] In some example embodiments, a kiosk measures a person's feet and determines a recommended footcare product, e.g., a pre-manufactured orthotic, for the person and the recommended product may be dispensed or may be selected by the person from a display. The measurements may be taken with a surface containing pressure sensors to measure a person's feet. A processor may correlate footcare products to the person's foot measurements. In one example embodiment, the kiosk may contain a video screen that provides instructions to the person. The system selects a recommended footcare product from among a set of candidate footcare products based at least in part upon a plurality of pressure measurements received from the pressure sensors. The set of candidate footcare products may be displayed on or near the kiosk in a merchandise display area, and the person would be provided with an indicia of the recommended footcare product, such as a picture of the footcare product, the model number of the footcare product, a color or symbol, etc. The person may then easily locate the footcare product that will provide the best calculated fit and support for the person's needs. Alternatively, products may be dispensed from a kiosk, for example, the kiosk may be configured as a vending machine. The footcare product sold may be a pre-manufactured orthotic, and the set of candidate footcare products may be a set of different models of pre-manufactured orthotics of varying attributes, such as size, arch support levels, arch index, cushioning levels (i.e. foam density, cushioning material used, etc.), etc. The range of models provided are chosen to address the most common conditions needing a footcare product, while coming in a range of sizes and models needed to fit and provide an appropriate support level for the vast majority of the potential user population.

[0109] One example embodiment may be a system including a surface, wherein the surface is configured to allow a person to stand upon the surface; a plurality of pressure sensors located under the surface forming a 2-D array of sensors; a measurement system configured to obtain measurements from a customer's feet; a processor in communication with the plurality of pressure sensors, the processor configured to receive a plurality of pressure measurements from at least a subset of the plurality of pressure sensors while the person stands upon the surface, the processor further configured to select a recommended footcare product from among a set of candidate footcare products based at least in part upon

the plurality of pressure measurements, wherein the processor is configured to receive at least a first subset of the plurality of pressure measurements while the person stands on one foot; an output device to display information received from the processor, the information identifying the recommended footcare product to the person; an input device configured to receive a person's input in selection of a recommended product; and a merchandise display area, the merchandise display area configured to display the set of candidate footcare products.

[0110] The use of pressure sensors, as opposed to optical, gauge, or other previously proposed approaches to characterizing the foot solves the problem providing a low-cost, robust measurement system suitable for use in an unattended retail environment. Moreover, the use of pressure measurements allows measurement approximating the results that would be obtained from a dynamic gait analysis to be obtained, without the need for more complicated measurements unsuitable for use in a retail kiosk. Providing a range of products of different levels of support, cushioning, and size, e.g., the 14 products provided in a preferred embodiment disclosed below, solves the problem of providing improved comfort and fit for consumers at a product cost similar to conventional pre-manufactured inserts, without the attendant cost and inconvenience of obtaining a custom made product. By measuring the customer and accurately recommending a suitable product, the consumer obtains may obtain a better fit than and superior comfort than simply purchasing a product "off-the-shelf" and may be more willing to pay a higher price for a pre-manufactured product. The customer also may avoid having to purchase incorrect products, which may frustration and dissatisfaction.

[0111] An alternative example embodiment may be a method of selecting a recommended orthotic, including determining if a foot on a sensor is unshod; collecting a first set of pressure measurements of a foot of a person while the person stands stationary on one foot, wherein a plurality of pressure measurements are taken from different points of the foot of a person; calculating a biomechanical data estimate of the foot using the pressure measurements, wherein biomechanical data comprises foot length, foot width, body weight, arch index, outline of the foot and toeline, a peak pressure map, a longitudinal line drawn on a peak pressure map, or an intersection of a longitudinal line and a foot body; comparing the biomechanical data with values from a decision matrix of orthotics and classified subgroups; and selecting an orthotic based on the comparison.

[0112] The use of pressure sensors may provide superior results to optical measurements. Moreover, the use of pressure sensors solves the problem of providing a robust solution suitable for use in an unattended retail kiosk. However, because the pressure data is much more limited than full range of data used by a podiatrist in a foot analysis, the systems and methods presented herein solve the problem of providing a broad range of biomechanical characteristics of the user's foot, using only pressure data, or pressure data plus a limited amount of other data, e.g., the customer's weight on a scale or in response to a query. This may solve the problem of how to accurately characterize the user's foot with only a limited amount of data.

[0113] The use of a decision matrix mapping orthotics and classified subgroups of measurements solves the problem of how to map a customer's feet to recommended products using only limited data. These mappings have been developed based on testing and mapping of actual users.

[0114] Because the example embodiments described herein are intended for use in an unattended retail environment, customers will use them without supervision. If a customer uses the system while wearing shoes, this will alter the measurements and may produce an unsatisfactory product recommendation. The system and method for determining whether a customer is shod or unshod solves the problem, which will always potentially be present in an unattended system, of automatically identifying a customer who is using the system improperly, so that proper use of the kiosk can be encouraged.

[0115] An alternative example embodiment may be an apparatus with a surface, multiple pressure sensors located under the surface, and a processor in communication with the plurality of pressure sensors, the processor configured to receive multiple pressure measurements from a subset of the multiple pressure sensors while the person stands upon the surface. The process may also be configured to select a recommended footcare product from among a set of candidate footcare products based at least in part upon the multiple pressure measurements. The surface may be configured to allow a person to stand upon the surface. Footcare products may include orthotics. The set of candidate footcare products includes a set of orthotics, the set including pre-manufactured orthotics with a plurality of different sizes and a plurality of different support levels. The pressure sensors may be a grid of pressure sensors, possibly formed of a 2-D array. There may be 1144 sensors in an array for a single foot. The sensors may be 7.5 mm x 7.5 mm or smaller. The pressure sensors may include a pressure-sensitive conductive ink, a piezoelectric sensor, etc. The apparatus may select a recommended footcare product and the selection may be made without other foot measurements being taken other than the pressure measurements. In alternative embodiments, a scale may be used to provide a weight measurement of the person.

[0116] The example embodiment of the apparatus may also contain input and output features. The apparatus may contain an output device to display information received from the processor, the information identifying the recommended footcare product to the person. The output device may be a video screen configured to display an image of the recommended footcare product, a biomechanical data estimate, or display instructions, the instructions directing the person to stand on one foot. Biomechanical data may include at least one of the foot

length, foot width, body weight, arch index, outline of the foot and toeline, a peak pressure map, a longitudinal line drawn on a peak pressure map, or an intersection of a longitudinal line and a foot body. The video screen may also be a touch screen, configurable to receive both input and output. A separate input device may also receive input to configure the processor.

[0117] Displaying measured data to the system may help solve the problem of getting the user of an unattended kiosk to properly use the system, and be engaged with its use. For example, systems and methods are presented for encouraging the user to properly center their weight on the machine, particularly when one-footed measurements are taken, so that proper characterization of the user's foot can be achieved.

[0118] The apparatus may also be configured to receive and calculate pressure measurements with a processor. The processor may be configured to take pressure measurements while the person stands on only one foot or may be configured to receive at least a first subset of the plurality of pressure measurements while the person stands on only one foot. The processor may be configured to receive at least a second subset of the plurality pressure measurements while the person stands on both feet. The processor may be configured receive demographic information.

[0119] Taking one-footed or "quasi-dynamic" measurements may provide more accurate characterization of the user's foot, as compared to a single two-footed static measurement. This enables a more accurate recommendation of an appropriate footcare product using a relatively simple and robust measurement system, without the cost of a full custom examination.

[0120] To select a recommended footcare product, a storage device may store a mapping of footcare products to classified subgroups. The storage device may also store a storage record containing an apparatus transaction. The processor may be configured to calculate biomechanical data estimates based on the plurality of pressure measurements. The categories of biomechanical data estimates include estimated foot dimensions, estimated foot type, and estimated body weight. Foot dimensions may be a longitudinal line that runs from the center of a heel to the center of a second toe, a toe line that is a fitted curve through three alignment marks, a foot length that is the projection of the distance between the most anterior point and most posterior point of foot pressure map on the longitudinal line, a foot width that is the projection of distance between the most medial point and most lateral point of foot pressure map on the perpendicular line of the longitudinal line, the arch index that is the ratio of the area of the middle third of the toeless footprint to the toeless footprint area, etc. The processor may be configured to select a recommended footcare product based on the biomechanical data estimates. The processor of the apparatus may also be configured to determine whether an unshod foot, a shoe, or a sock is on the pressure sensors. The processor may use some of the biomechanical data estimates or pressure measurements to make this determination.

[0121] As stated above, the apparatus may select a recommended footcare product from a set of candidate footcare products. The set of candidate footcare products may include a set of different pre-manufactured orthotics. The set of different pre-manufactured orthotics may include orthotics that differ in size, arch support levels, and cushioning levels. The set of different pre-manufactured orthotics variations may be calculated to fit the majority of the population. The processor may be configured to receive accuracy factors from a person. The accuracy factors may be received before making the recommendation or after making a recommendation. The accuracy factors may be integrated with the calculations and procedures performed for selection of the recommended footcare product but may also be a complete separate procedure. The apparatus may also include a merchandise display area configured to display the set of candidate footcare products.

[0122] The collection of accuracy factors, for example queries about the customer's body type, weight, height, etc., solves the problem of how to make accurate characterizations and recommendations using only relatively simple and robust measurement systems, such as the pressure sensors described herein. Moreover, because some of the example embodiments described herein are intended for unattended use in a retail environment, they are provided with bars for a customer to support themselves, e.g., while standing on one foot. Accordingly, there is a problem that customers may lean or overly support themselves while measurements are being taken, possibly resulting inaccurate characterizations of the foot or product recommendations. The use of additional confirmation information from the customer helps validate that the measurements have been taken accurately. They also allow demographic data to be collected for improving the system over time.

[0123] An example embodiment may be a point-of-sale system for selling orthotics including a set of pre-manufactured orthotics different types, a measurement system configured to obtain measurements from a customer's feet, and a processor configured to receive the measurements and to recommend an orthotic to the customer from the set of pre-manufactured orthotics based at least in part on the measurements. The measurement system may contain a plurality of pressure sensors. The processor may be configured to derive biomechanical data from measurements collected by the measurement system. The biomechanical data may be selected from the foot length, foot width, body weight, arch index, outline of the foot and toeline, a peak pressure map, a longitudinal line drawn on a peak pressure map, and an intersection of a longitudinal line and a foot body, among others. A dispensing mechanism may provide an orthotic from the set of pre-manufactured orthotics to the person.

[0124] An example embodiment may also perform a method of characterizing a foot. The method may collect

a first set of pressure measurements of a foot of a person while the person stands stationary on one foot and characterize the foot based on the first set of pressure measurements. Selection of a footcare product may then be based on the characterization of at least the one foot. The method may collect a second set of pressure measurements from both feet of a person while the person stands on both feet and characterize the foot based on the first set and second set of pressure measurements. Alternatively, the method may only collect pressure measurements from both feet as the first set of pressure measurement of a person and characterize the foot based on the first set, in this example, the pressure measurements of both feet. The method may also calculate a biomechanical data estimate of the foot using the pressure measurements. The method may compare the biomechanical data with values from a decision matrix of orthotics and classified subgroups, wherein a classified subgroup may include the weight of the person, the band of the person (i.e. a band based on a person's foot length), a person's arch index, etc. The method may involve calibrating a plurality of pressure sensors and a processor using a Force Calibration method or a Multi-level Pressure Calibration method. The method may involve adjusting coefficients in a processor change the accuracy factors to recommend an orthotic. The decision matrix may be created based on a product specification list.

[0125] An example embodiment may also perform a method of selecting an orthotic. The method may include collecting a plurality of pressure measurements at different points of the foot of a person and selecting an orthotic based on the pressure measurements. The method may perform a combination of grouping a person into one of a plurality of classified subgroups based on the pressure measurements; recommending a footcare product based on a person's classified subgroup; deriving biomechanical data estimates from the pressure measurements of at least one of the both feet of a person, the left foot of a person, or the right foot of a person; estimating the biomechanical data of the person's feet using the first set of pressure measurements and the second set of pressure measurements; confirming the person is balanced based on the received pressure measurements; confirming the person is not wearing a footwear based on the pressure measurements; confirming the person is not wearing a footwear based on the biomechanical data estimates; receiving the second set of pressure measurements when the load on the individual planting foot reaches a predetermined bodyweight percentage; receiving the second set of pressure measurements when the person's Center of Force enters a target zone, wherein a target zone is a pressure reference point; receiving the second set of pressure measurements when the Center of Force matches a target zone and at least 95% of static weight, weight calculated by the sum of forces created by the feet when relatively still, is achieved; or generating a static foot outline based on pressure measurements. Biomechanical data may include foot length, foot width, body weight, arch index, outline of the foot and toeline, a peak pressure map, a longitudinal line drawn on a peak pressure map, or an intersection of a longitudinal line and a foot body. A specified bodyweight percentage may be between the range of 90 to 95 percent of bodyweight.

[0126] Calculating the various biomechanical data based on pressure measurements, solves the problem of obtaining an adequate characterization of the user's foot to make a product recommendation using only a relatively simple, inexpensive measurement system in an unattended system. Mapping the data into subgroups based on empirical analysis solves the problem of automatically recommending a good solution for the vast majority of customers using only a limited range of pre-manufactured products and a limited amount of measurement data.

[0127] Getting the customer to match a center of force, solves of the problem of having a customer correctly use an unattended kiosk. The target center of force can be shown on the screen, which helps the customer to properly balance and position their weight on the measurement apparatus so that accurate measurements can be made. Similarly, tracking the bodyweight percentage helps verify the user is properly balanced on the system when a one-footed measurement is taken, solving the problem of how to take an accurate measurement in an unattended system, particularly given that user's are inclined to lean or improperly balance when standing on one foot.

[0128] Generating the various foot characterization measures described, solves the problem of providing a sufficient characterization of the user's foot to make accurate product recommendations using only a pressure measurement map, or a pressure measurement map with small amounts of supplemental information.

[0129] An example embodiment may also perform a method of determining if a foot on a sensor is unshod. The method may include determining plurality of foot dimensions, calculating a plurality of foot dimension ratios, and comparing the foot dimension ratios to pre-determined values (e.g. 3.5, 6.0, 1.2, and 0.1). The foot dimensions may be selected from the group consisting of foot length, heel width, arch width, and forefoot width, although it will be appreciated that other dimensions may also be used. Foot dimension ratios may include foot length (e.g. the length of the line between the most posterior and most anterior points of each foot pressure print) over the heel width (e.g. the length of a first line that is perpendicular to a second line, wherein the second line is a line between the center of the heel and the center of the second toe, and the first line is located at 16%, though it may range between 5 to 20%), forefoot width/heel width, and arch width/heel width.

[0130] Several example embodiments of the present invention are specifically illustrated and described herein. However, it will be appreciated that modifications and variations of the present invention are covered by the above teachings and within the purview of the appended

claims without departing from the intended scope of the invention, as defined by the claims.

Claims

1. Apparatus for determining at least one property of a person's foot, the apparatus comprising:

   a surface (114) configured to allow a person to stand thereon;
   a plurality of pressure sensors (101) located under the surface; and
   computing means (104) arranged to receive signals representing pressure measurements from at least a subset of the plurality of pressure sensors while a person stands upon the surface, the computing means (104) being operable to process the signals to:

   determine a point of force for the person standing on the surface;
   compare (702) the person's determined point of force (1304) with a target zone (1303) for the point of force;
   provide a display (102) indicating a difference between the person's determined point of force (1304) and the target zone (1303) to assist the person in changing his point of force to bring it into the target zone; and
   determine at least one property of the person's foot using signals representing pressure measurements from at least the subset of the plurality of pressure sensors when the person's determined point of force falls in the target zone.

2. Apparatus according to Claim 1, wherein the computing means is operable to:

   provide the display indicating the difference between the person's determined point of force (1304) and the target zone (1303) by displaying a symbol representing the position of the person's determined point of force and a symbol representing the target zone; and
   change the position on the display of the symbol representing the position of the person's determined point of force as the person moves.

3. Apparatus according to Claim 1 or Claim 2, wherein the computing means (104) is operable to determine the point of force (1304) for the person standing on the surface by processing the signals to determine a centre of force for the person indicative of the point on the surface through which the person's centre of gravity acts.

4. Apparatus according to any preceding claim, wherein the computing means (104) is operable to compare the person's determined point of force with a target zone (1303) at the geometric centre of a pressure print of both feet of the person.

5. Apparatus according to any of Claims 1 to 3, wherein the computing means (104) is operable to compare the person's determined point of force (1304) with a target zone (1303) at a position comprising the geometric centre of a pressure print of both feet of the person shifted distally.

6. Apparatus according to any preceding claim, wherein the surface is arranged at an acute angle to a horizontal plane.

7. Apparatus according to any preceding claim, wherein the plurality of pressure sensors are arranged in a two-dimensional array.

8. Apparatus according to any preceding claim, wherein the computing means (104) is operable to determine at least one property of the person's foot from the group of properties comprising foot length, foot width, arch index, outline of the foot and toeline, a peak pressure map, a longitudinal line drawn on a peak pressure map, or an intersection of a longitudinal line and a foot body.

9. A method of determining at least one property of a person's foot by processing signals representing pressure measurements from at least a subset of a plurality of pressure sensors (101) located beneath a surface (114) while a person stands upon the surface, the method comprising processing the signals to:

   determine a point of force (1304) for the person standing on the surface (114);
   compare the person's determined point of force (1304) with a target zone (1303) for the point of force;
   generate display data indicating a difference between the person's determined point of force and the target zone to assist the person in changing his point of force to bring it into the target zone; and
   determine at least one property of the person's foot when the person's determined point of force falls in the target zone.

10. A method according to Claim 9, wherein:

    the step of generating display data comprises generating display data comprising a symbol representing the position of the person's determined point of force and a symbol representing

the target zone; and
changing the position in the display data of the symbol representing the position of the person's determined point of force as the person moves.

11. A method according to Claim 9 or Claim 10, wherein the point of force for the person standing on the surface (114) is determined by processing the signals to determine a centre of force for the person indicative of the point on the surface through which the person's centre of gravity acts.

12. A method according to any of Claims 9 to 11, wherein the person's determined point of force (1304) is compared with a target zone (1303) at the geometric centre of a pressure print of both feet of the person.

13. A method according to any of Claims 9 to 11, wherein the person's determined point of force (1304) is compared with a target zone (1303) at a position comprising the geometric centre of a pressure print of both feet of the person shifted distally.

14. A method according to any of Claims 9 to 13, wherein the signals processed comprise signals from pressure sensors (101) beneath a surface arranged at an acute angle to a horizontal plane.

15. A method according to any of Claims 9 to 14, wherein the signals processed comprise signals from pressure sensors (101) arranged in a two-dimensional array.

16. A method according to any of Claims 9 to 15, wherein at least one property of the person's foot is determined from the group of properties comprising foot length, foot width, arch index, outline of the foot and toeline, a peak pressure map, a longitudinal line drawn on a peak pressure map, or an intersection of a longitudinal line and a foot body.

17. A storage medium storing computer program instructions to program a programmable processing apparatus to become operable to perform a method as set out in at least one of Claims 9 to 16.

18. A computer program comprising instructions to program a programmable processing apparatus to become operable to perform a method as set out in at least one of Claims 9 to 16.

Patentansprüche

1. Vorrichtung zum Bestimmen mindestens einer Eigenschaft eines Fußes einer Person, wobei die Vorrichtung Folgendes umfasst:

eine Oberfläche (114), die dafür ausgelegt ist, einer Person zu ermöglichen darauf zu stehen;
eine Vielzahl von unter der Oberfläche befindlichen Drucksensoren (101); und
ein Berechnungsmittel (104), das dafür eingerichtet ist, Signale, die Druckmessungen darstellen, von mindestens einer Untermenge der Vielzahl von Drucksensoren zu empfangen, während eine Person auf der Oberfläche steht, wobei das Berechnungsmittel (104) betreibbar ist zum Verarbeiten der Signale, um:

einen Punkt einer Kraft für die auf der Oberfläche stehende Person zu bestimmen;
den bestimmten Punkt der Kraft (1304) der Person mit einer Zielzone (1303) für den Punkt der Kraft zu vergleichen (702);
eine Anzeige (102) bereitzustellen, die einen Unterschied zwischen dem bestimmten Punkt der Kraft (1304) der Person und der Zielzone (1303) angibt, um der Person dabei zu helfen, ihren Punkt der Kraft zu ändern, um ihn in die Zielzone zu bringen; und
mindestens eine Eigenschaft des Fußes der Person unter Verwendung von Signalen zu bestimmen, die Druckmessungen von mindestens der Untermenge der Vielzahl von Drucksensoren repräsentieren, wenn der bestimmte Punkt der Kraft der Person in die Zielzone fällt.

2. Vorrichtung nach Anspruch 1, wobei das Berechnungsmittel betreibbar ist zum:

Bereitstellen der Anzeige, die den Unterschied zwischen dem bestimmten Punkt der Kraft (1304) der Person und
der Zielzone (1303) angibt, durch Anzeigen eines Symbols, das die Position des bestimmten Punkts der Kraft der Person darstellt, und eines Symbols, das die Zielzone darstellt; und
Ändern der Position auf der Anzeige des Symbols, das die Position des bestimmten Punkts der Kraft der Person darstellt, wenn sich die Person bewegt.

3. Vorrichtung nach Anspruch 1 oder Anspruch 2, wobei das Berechnungsmittel (104) betreibbar ist zum bestimmen des Punkts der Kraft (1304) für die Person, die auf der Oberfläche steht, indem die Signale verarbeitet werden, um ein Zentrum der Kraft für die Person zu bestimmen, das indikativ für den Punkt auf der Oberfläche ist, durch den der Schwerpunkt der Person wirkt.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei das Berechnungsmittel (104) be-

treibbar ist zum Vergleichen des bestimmten Punkts der Kraft der Person mit einer Zielzone (1303) bei dem geometrischen Zentrum eines Druckabdrucks beider Füße der Person.

5. Vorrichtung nach einem der Ansprüche 1 bis 3, wobei das Berechnungsmittel (104) betreibbar ist zum Vergleichen des bestimmten Punkts der Kraft (1304) der Person mit einer Zielzone (1303) bei einer Position, die das geometrische Zentrum eines Druckabdrucks beider Füße der Person distal verschoben umfasst.

6. Vorrichtung nach einem vorhergehenden Anspruch, wobei die Oberfläche in einem spitzen Winkel zu einer horizontalen Ebene angeordnet ist.

7. Vorrichtung nach einem vorhergehenden Anspruch, wobei die Vielzahl von Drucksensoren in einem zweidimensionalen Array angeordnet ist.

8. Vorrichtung nach einem vorhergehenden Anspruch, wobei das Berechnungsmittel (104) betreibbar ist zum Bestimmen mindestens einer Eigenschaft des Fußes der Person aus der eine Fußlänge, eine Fußweite, einen Fußgewölbeindex, einen Umriss des Fußes und der Zehenlinie, eine Spitzendruckkarte, eine auf einer Spitzendruckkarte gezeichnete Längslinie oder eine Überschneidung einer Längslinie und eines Fußkörpers umfassenden Gruppe von Eigenschaften.

9. Verfahren zum Bestimmen mindestens einer Eigenschaft eines Fußes einer Person durch Verarbeiten von Signalen, die Druckmessungen von zumindest einer Untermenge von einer Vielzahl von unterhalb einer Oberfläche (114) befindlichen Drucksensoren (101) darstellen, während eine Person auf der Oberfläche steht, wobei das Verfahren Verarbeiten der Signale zu Folgendem umfasst:

Bestimmen eines Punkts einer Kraft (1304) für die Person, die auf der Oberfläche (114) steht;
Vergleichen des bestimmten Punkts der Kraft (1304) der Person mit einer Zielzone (1303) für den Punkt der Kraft;
Erzeugen von Anzeigedaten, die einen Unterschied zwischen dem bestimmten Punkt der Kraft der Person und der Zielzone angeben, um der Person dabei zu helfen, ihren Punkt der Kraft zu ändern, um ihn in die Zielzone zu bringen; und
Bestimmen mindestens einer Eigenschaft des Fußes der Person, wenn der bestimmte Punkt der Kraft der Person in die Zielzone fällt.

10. Verfahren nach Anspruch 9, wobei:

der Schritt des Erzeugens von Anzeigedaten Erzeugen von Anzeigedaten umfasst, die ein Symbol, das die Position des bestimmten Punkts der Kraft der Person darstellt und ein Symbol, das die Zielzone darstellt, umfassen; und
Ändern der Position des Symbols in den Anzeigedaten, das die Position des bestimmten Punkts der Kraft der Person darstellt, wenn sich die Person bewegt.

11. Verfahren nach Anspruch 9 oder Anspruch 10, wobei der Punkt der Kraft für die Person, die auf der Oberfläche (114) steht, bestimmt wird, indem die Signale verarbeitet werden, um ein Zentrum einer Kraft für die Person zu bestimmen, das indikativ für den Punkt auf der Oberfläche ist, durch den der Schwerpunkt der Person wirkt.

12. Verfahren nach einem der Ansprüche 9 bis 11, wobei der bestimmte Punkt der Kraft (1304) der Person mit einer Zielzone (1303) bei dem geometrischen Zentrum eines Druckabdrucks beider Füße der Person verglichen wird.

13. Verfahren nach einem der Ansprüche 9 bis 11, wobei der bestimmte Punkt der Kraft (1304) der Person mit einer Zielzone (1303) bei einer Position verglichen wird, die das geometrische Zentrum eines Druckabdrucks beider Füße der Person distal verschoben umfasst.

14. Verfahren nach einem der Ansprüche 9 bis 13, wobei die verarbeiteten Signale Signale von Drucksensoren (101) unterhalb einer Oberfläche umfassen, die in einem spitzen Winkel zu einer horizontalen Ebene angeordnet ist.

15. Verfahren nach einem der Ansprüche 9 bis 14, wobei die verarbeiteten Signale Signale von in einem zweidimensionalen Array angeordneten Drucksensoren (101) umfassen.

16. Verfahren nach einem der Ansprüche 9 bis 15, wobei mindestens eine Eigenschaft des Fußes der Person aus der eine Fußlänge, eine Fußweite, einen Fußgewölbeindex, einen Umriss des Fußes und der Zehenlinie, eine Spitzendruckkarte, eine auf einer Spitzendruckkarte gezeichnete Längslinie oder eine Überschneidung einer Längslinie und eines Fußkörpers umfassenden Gruppe von Eigenschaften bestimmt wird.

17. Speicherungsmedium, das Computerprogrammanweisungen zum Programmieren einer programmierbaren Verarbeitungsvorrichtung dazu umfasst, dass sie betreibbar wird zum Durchführen eines Verfahrens nach mindestens einem der Ansprüche 9 bis 16.

18. Computerprogramm, das Anweisungen zum Pro-

grammieren einer programmieren Verarbeitungsvorrichtung dazu umfasst, dass sie betreibbar wird zum Durchführen eines Verfahrens nach mindestens einem der Ansprüche 9 bis 16.

Revendications

1. Appareil pour déterminer au moins une propriété d'un pied d'une personne, l'appareil comprenant :

une surface (114) configurée pour permettre à une personne de s'y tenir debout ;
une pluralité de capteurs de pression (101) situés sous la surface ; et
un moyen informatique (104) conçu pour recevoir des signaux représentant des mesures de pression en provenance d'au moins un sous-ensemble de la pluralité de capteurs de pression pendant qu'une personne se tient debout sur la surface, le moyen informatique (104) permettant de traiter les signaux :

pour déterminer un point de force pour la personne se tenant debout sur la surface ;
pour comparer (702) le point de force déterminé de la personne (1304) avec une zone cible (1303) pour le point de force ;
pour fournir un dispositif d'affichage (102) indiquant une différence entre le point de force déterminé de la personne (1304) et la zone cible (1303) pour aider la personne à changer son point de force pour l'amener dans la zone cible ; et
pour déterminer au moins une propriété d'un pied de la personne à l'aide de signaux représentant des mesures de pression à partir d'au moins le sous-ensemble de la pluralité de capteurs de pression lorsque le point de force déterminé de la personne tombe dans la zone cible.

2. Appareil selon la revendication 1, dans lequel le moyen informatique permet :

de fournir le dispositif d'affichage indiquant la différence entre le point de force déterminé de la personne (1304) et la zone cible (1303) en affichant un symbole représentant la position du point de force déterminé de la personne et un symbole représentant la zone cible ; et
de changer la position sur le dispositif d'affichage du symbole représentant la position du point de force déterminé de la personne au fur et à mesure que la personne se déplace.

3. Appareil selon la revendication 1 ou la revendication 2, dans lequel le moyen informatique (104) permet de déterminer le point de force (1304) pour la personne se tenant debout sur la surface en traitant les signaux pour déterminer un centre de force pour la personne indiquant le point sur la surface sur laquelle le centre de gravité de la personne agit.

4. Appareil selon l'une quelconque des revendications précédentes, dans lequel le moyen informatique (104) permet de comparer le point de force déterminé de la personne avec une zone cible (1303) au centre géométrique d'une empreinte de pression des deux pieds de la personne.

5. Appareil selon l'une quelconque des revendications 1 à 3, dans lequel le moyen informatique (104) permet de comparer le point de force déterminé de la personne (1304) avec une zone cible (1303) à une position comprenant le centre géométrique d'une empreinte de pression des deux pieds de la personne décalés de façon distale.

6. Appareil selon l'une quelconque des revendications précédentes, dans lequel la surface est disposée selon un angle aigu par rapport à un plan horizontal.

7. Appareil selon l'une quelconque des revendications précédentes, dans lequel la pluralité de capteurs de pression sont disposés dans un réseau en deux bidimensionnel.

8. Appareil selon l'une quelconque des revendications précédentes, dans lequel le moyen informatique (104) permet de déterminer au moins une propriété du pied de la personne parmi le groupe de propriétés comprenant la longueur du pied, la largeur du pied, l'indice de cambrure, le contour du pied et la ligne des orteils, une carte de pressions maximales, une ligne longitudinale tracée sur une carte de pressions maximales, ou une intersection d'une ligne longitudinale et d'un corps de pied.

9. Procédé de détermination d'au moins une propriété d'un pied d'une personne en traitant des signaux représentant des mesures de pression en provenance d'au moins un sous-ensemble d'une pluralité de capteurs de pression (101) situés en dessous d'une surface (114) pendant qu'une personne se tient debout sur la surface, le procédé consistant à traiter les signaux :

pour déterminer un point de force (1304) pour la personne se tenant debout sur la surface (114) ;
pour comparer le point de force déterminé de la personne (1304) avec une zone cible (1303) pour le point de force ;
pour générer des données d'affichage indiquant une différence entre le point de force déterminé

de la personne et la zone cible pour aider la personne à changer son point de force pour l'amener dans la zone cible ; et
pour déterminer au moins une propriété d'un pied de la personne lorsque le point de force déterminé de la personne tombe dans la zone cible.

10. Procédé selon la revendication 9, dans lequel :

l'étape de génération de données d'affichage consiste à générer des données d'affichage comprenant un symbole représentant la position du point de force déterminé de la personne et un symbole représentant la zone cible ; et
à changer la position dans les données d'affichage du symbole représentant la position du point de force déterminé de la personne au fur et à mesure que la personne se déplace.

11. Procédé selon la revendication 9 ou la revendication 10, dans lequel le point de force pour la personne se trouvant sur la surface (114) est déterminé en traitant les signaux pour déterminer un centre de force pour la personne indiquant le point sur la surface sur laquelle le centre de gravité de la personne agit.

12. Procédé selon l'une quelconque des revendications 9 à 11, dans lequel le point de force déterminé de la personne (1304) est comparé avec une zone cible (1303) au centre géométrique d'une empreinte de pression des deux pieds de la personne.

13. Procédé selon l'une quelconque des revendications 9 à 11, dans lequel le point de force déterminé de la personne (1304) est comparé avec une zone cible (1303) à une position comprenant le centre géométrique d'une empreinte de pression des deux pieds de la personne décalés de façon distale.

14. Procédé selon l'une quelconque des revendications 9 à 13, dans lequel les signaux traités comprennent des signaux provenant de capteurs de pression (101) en dessous d'une surface disposée selon un angle aigu par rapport à un plan horizontal.

15. Procédé selon l'une quelconque des revendications 9 à 14, dans lequel les signaux traités comprennent des signaux provenant de capteurs de pression (101) disposés dans un réseau bidimensionnel.

16. Procédé selon l'une quelconque des revendications 9 à 15, dans lequel au moins une propriété du pied de la personne est déterminée parmi le groupe de propriétés comprenant la longueur du pied, la largeur du pied, l'indice de cambrure, le contour du pied et la ligne des orteils, une carte de pressions maximales, une ligne longitudinale tracée sur une carte de pressions maximales, ou une intersection d'une ligne longitudinale et d'un corps de pied.

17. Support de stockage stockant des instructions de programme d'ordinateur pour programmer qu'un appareil de traitement programmable soit exploitable pour réaliser un procédé tel que présenté dans au moins l'une des revendications 9 à 16.

18. Programme d'ordinateur comprenant des instructions pour programmer qu'un appareil de traitement programmable soit exploitable pour réaliser un procédé tel que présenté dans au moins l'une des revendications 9 à 16.

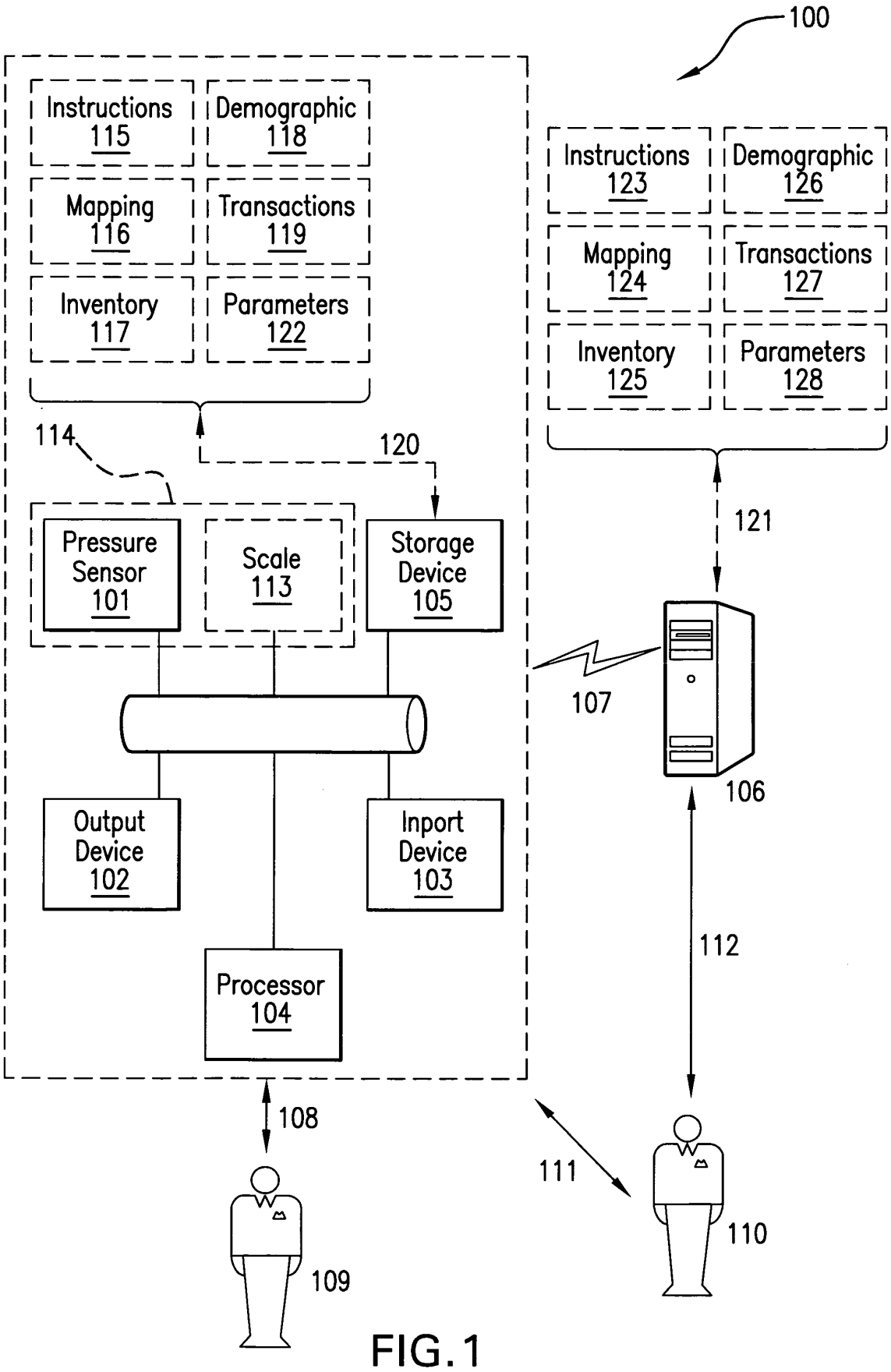
100
Instructions 115
Demographic 118
Mapping 116
Transactions 119
Inventory 117
Parameters 122
114
120
Pressure Sensor 101
Scale 113
Storage Device 105
Output Device 102
Inport Device 103
Processor 104
108
109
Instructions 123
Demographic 126
Mapping 124
Transactions 127
Inventory 125
Parameters 128
121
107
106
112
111
110

FIG. 1

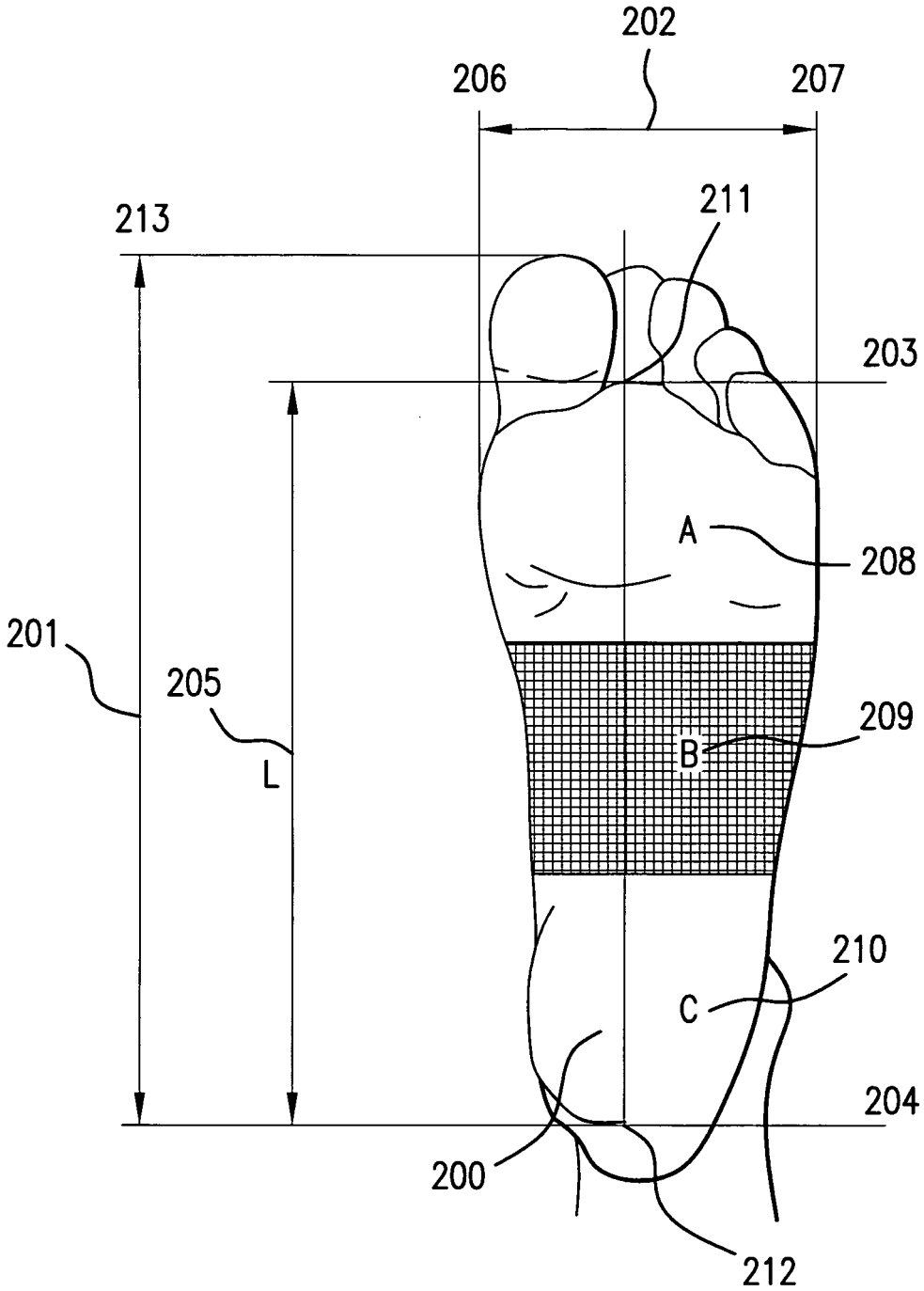

FIG.2

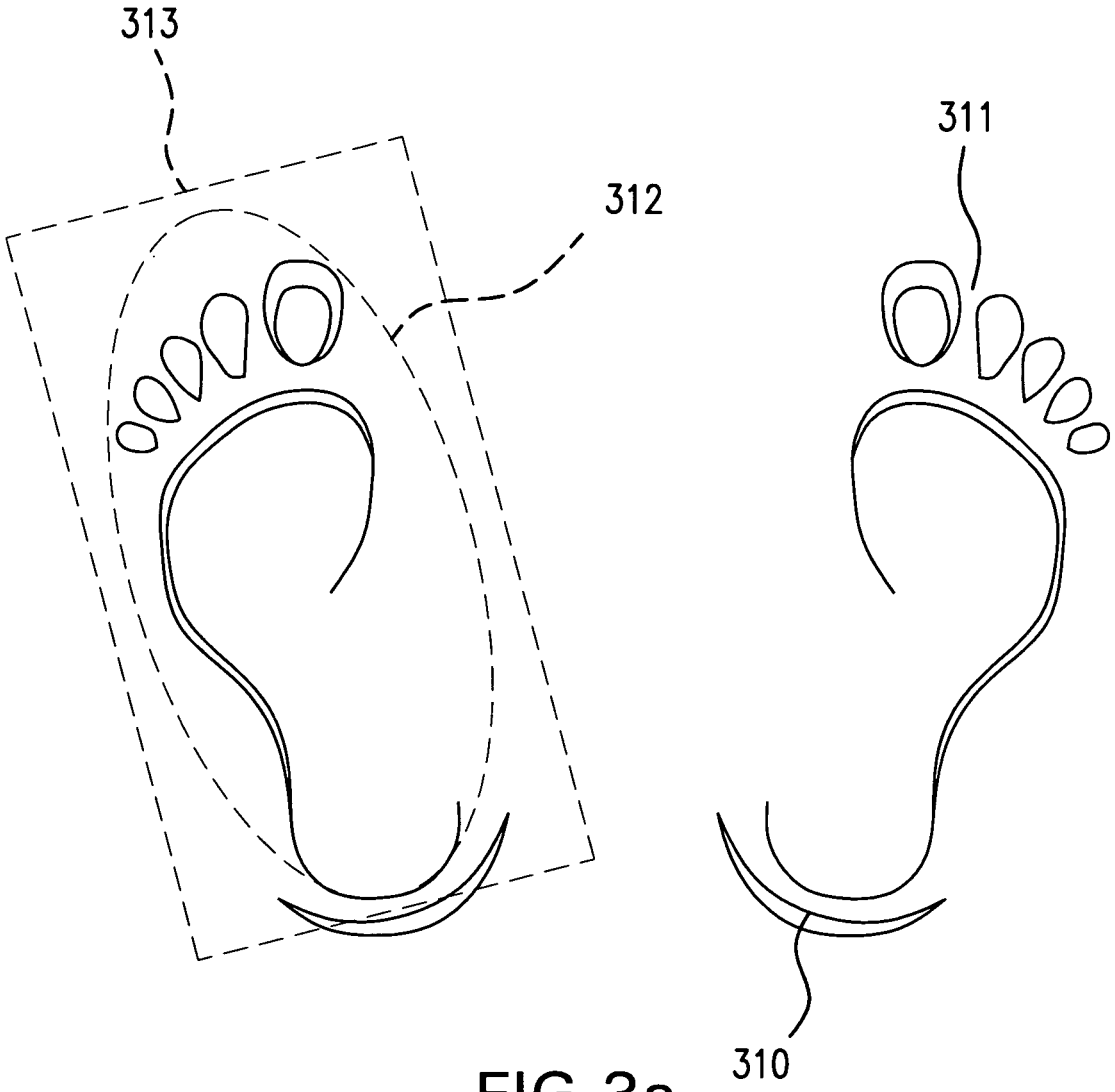

FIG.3a

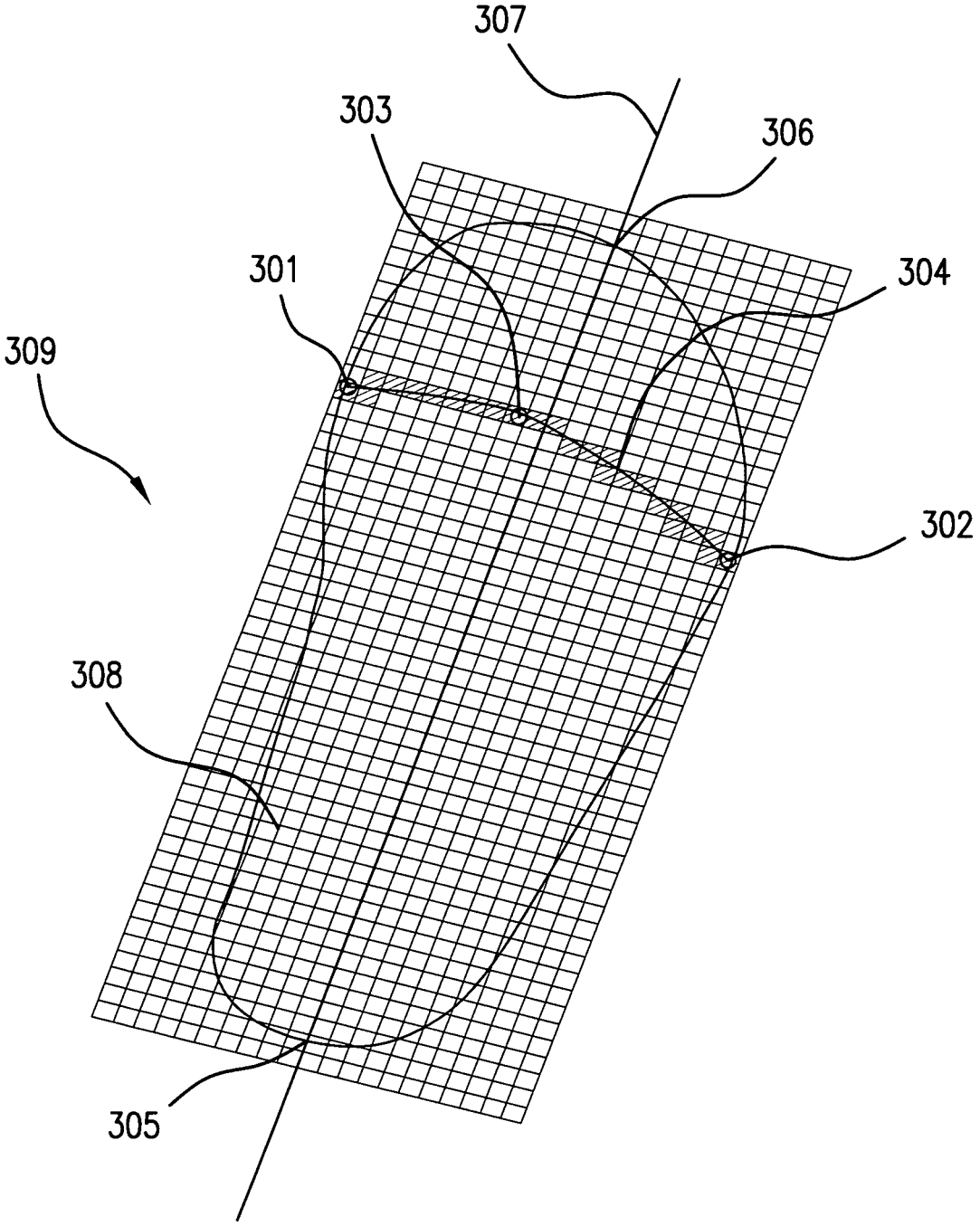

FIG.3b

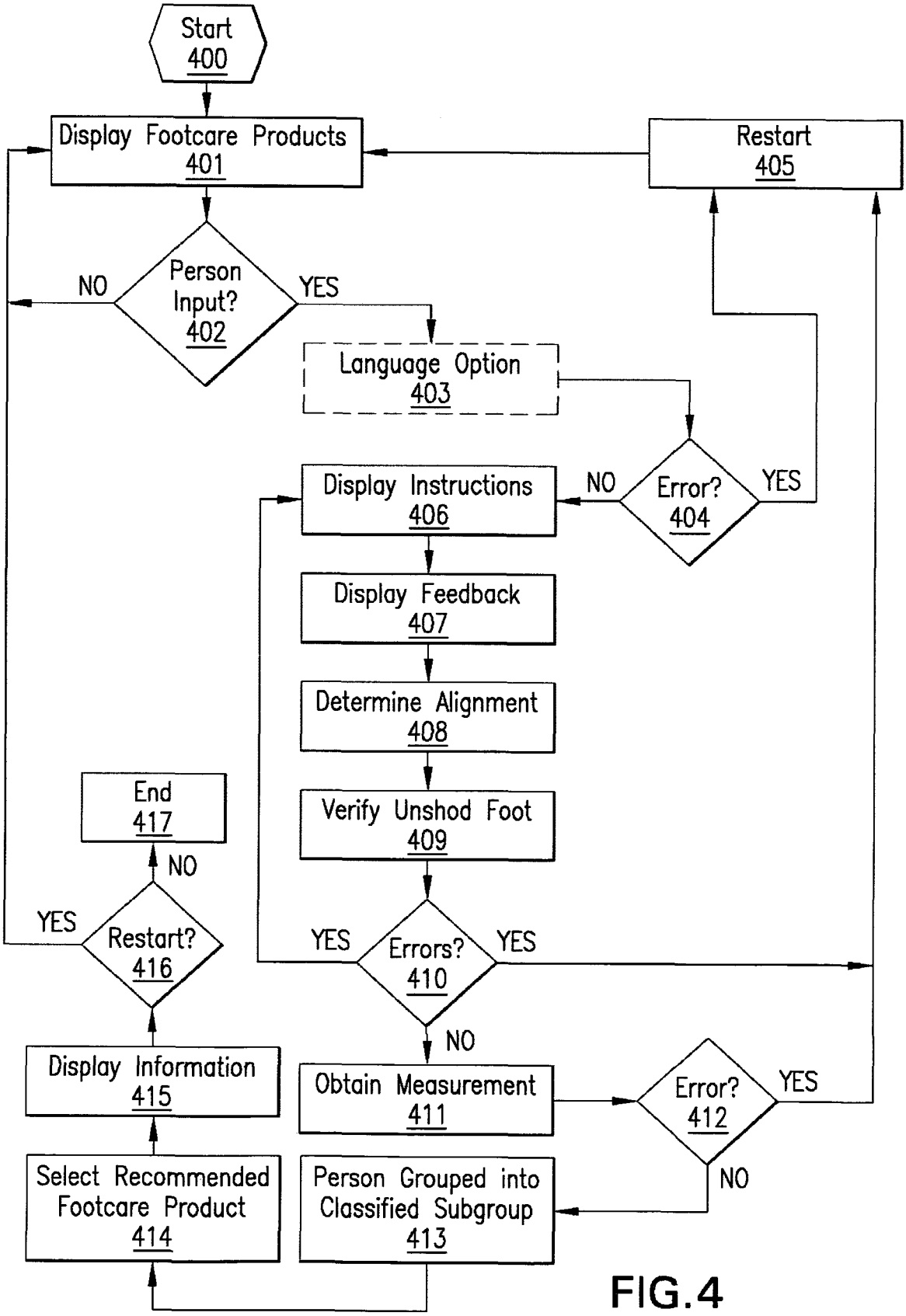
Start
400
Display Footcare Products
401
Restart
405
Person Input?
402
NO
YES
Language Option
403
Error?
404
NO
YES
Display Instructions
406
Display Feedback
407
Determine Alignment
408
Verify Unshod Foot
409
Errors?
410
YES
YES
NO
Obtain Measurement
411
Error?
412
YES
NO
Person Grouped into Classified Subgroup
413
Select Recommended Footcare Product
414
Display Information
415
Restart?
416
YES
NO
End
417

FIG.4

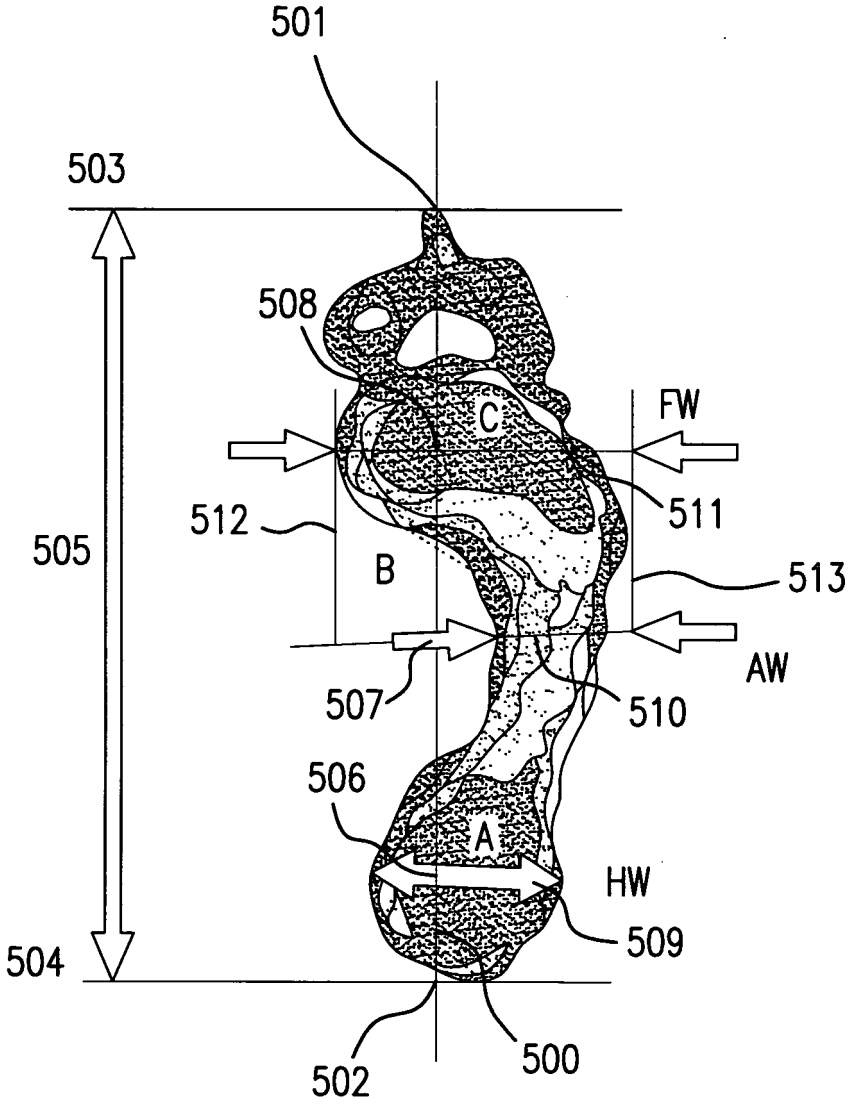
501
503
508
C
FW
511
512
505
B
513
AW
507
510
506
A
HW
509
504
502
500

FIG.5

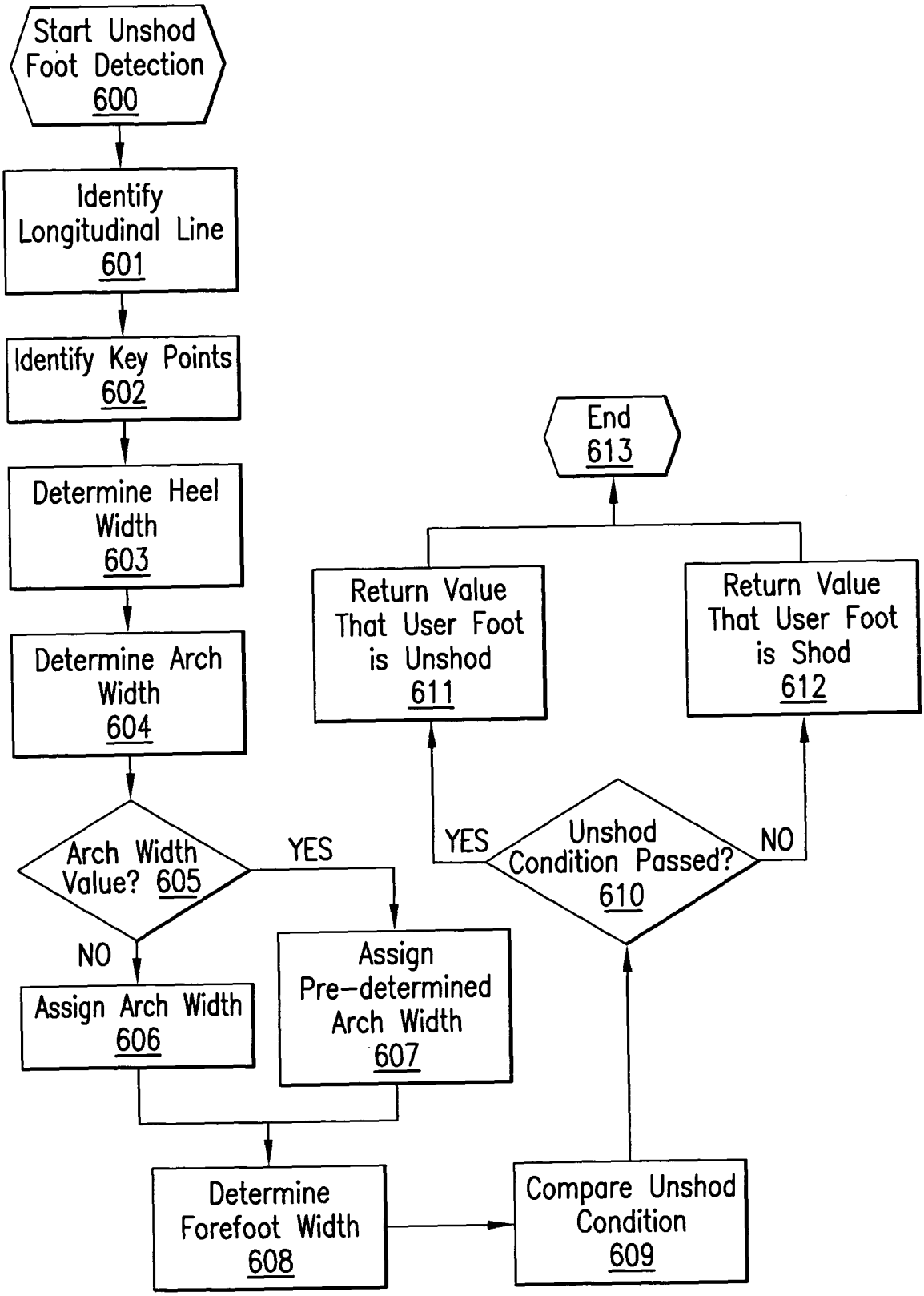
Start Unshod Foot Detection 600
Identify Longitudinal Line 601
Identify Key Points 602
Determine Heel Width 603
Determine Arch Width 604
Arch Width Value? 605
YES
NO
Assign Arch Width 606
Assign Pre-determined Arch Width 607
Determine Forefoot Width 608
Compare Unshod Condition 609
Unshod Condition Passed? 610
YES
NO
Return Value That User Foot is Unshod 611
Return Value That User Foot is Shod 612
End 613

FIG.6

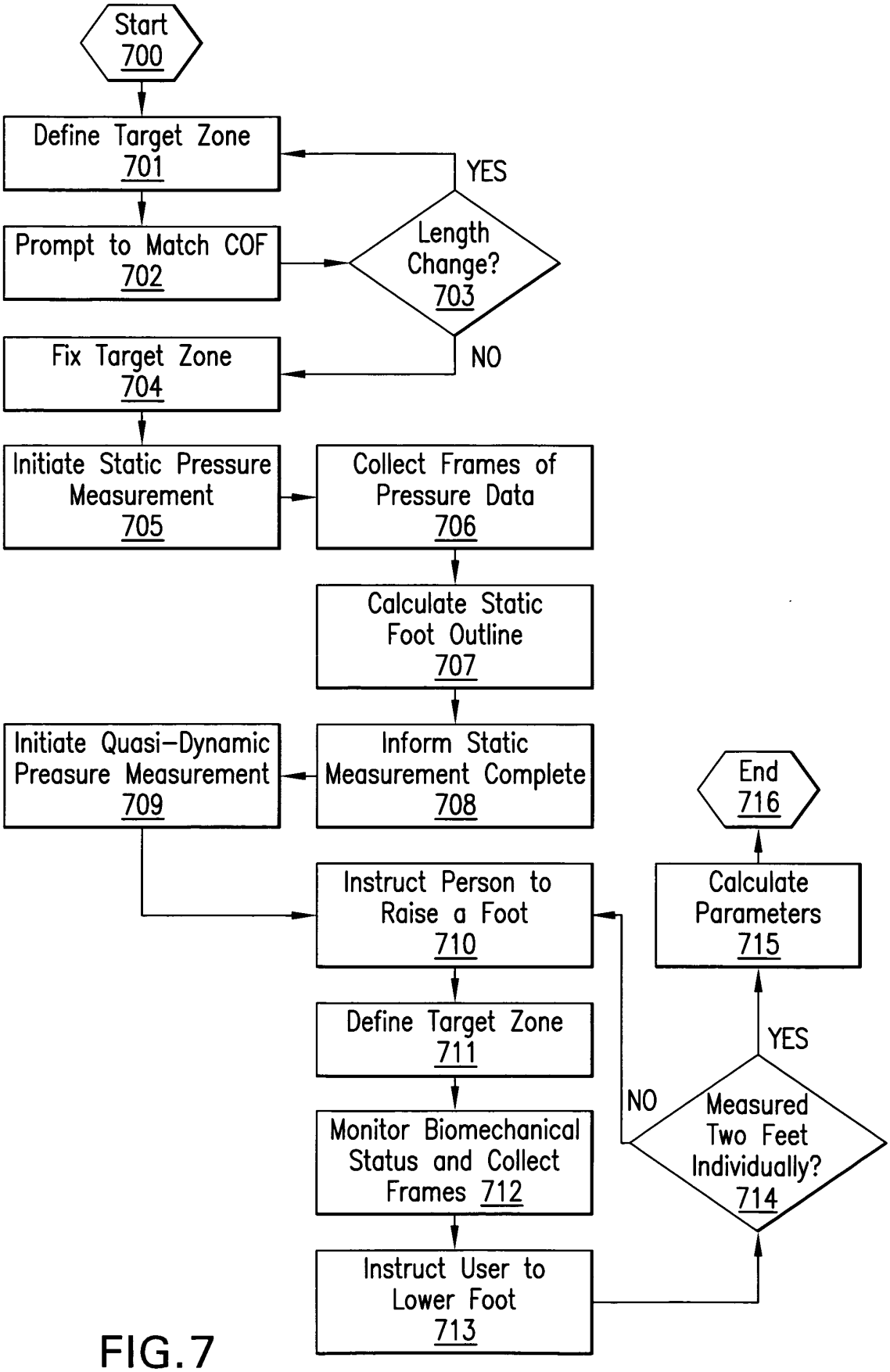
Start
700
Define Target Zone
701
Prompt to Match COF
702
Length Change?
703
YES
NO
Fix Target Zone
704
Initiate Static Pressure Measurement
705
Collect Frames of Pressure Data
706
Calculate Static Foot Outline
707
Inform Static Measurement Complete
708
Initiate Quasi-Dynamic Preasure Measurement
709
Instruct Person to Raise a Foot
710
Define Target Zone
711
Monitor Biomechanical Status and Collect Frames 712
Instruct User to Lower Foot
713
Measured Two Feet Individually?
714
NO
YES
Calculate Parameters
715
End
716

FIG.7

850 851 852 853 854 855 856 857 858 859 860

	Band A (Foot Length < 244mm)	
	Low Weight	High Weight
Low Arch	Product 1	Product 2
Medium Arch	Product 3	Product 4
High Arch	Product 3	Product 3
	Medium Weight	135 lbs

	Band B (244mm ≤ Foot Length < 255mm)	
	Low Weight	High Weight
Low Arch	Product 5	Product 6
Medium Arch	Product 7	Product 8
High Arch	Product 7	Product 7
	Medium Weight	160 lbs

	Band C (255mm ≤ Foot Length < 270mm)	
	Low Weight	High Weight
Low Arch	Product 9	Product 10
Medium Arch	Product 11	Product 12
High Arch	Product 11	Product 11
	Medium Weight	180 lbs

	Band D (Foot Length ≥ 270mm)	
	Low Weight	High Weight
Low Arch	N/A	Product 13
Medium Arch	N/A	Product 14
High Arch	N/A	Product 14
	Medium Weight	190 lbs

	Low Arch	0.257 < Arch Index
	Medium Arch	0.173 < Arch Index ≤ 0.257
	High Arch	Arch Index ≤ 0.173

FIG.8a

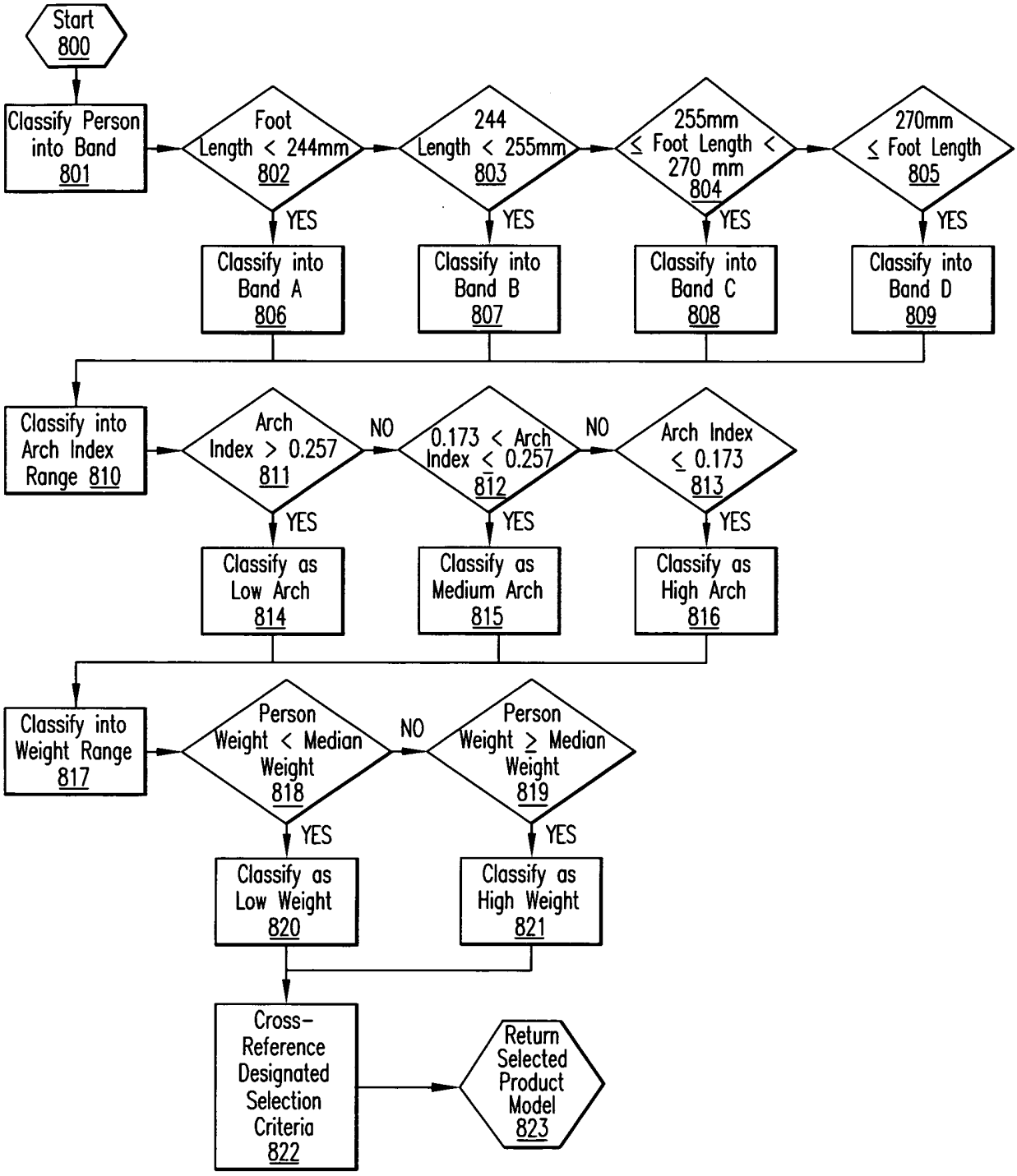
Start
800
Classify Person into Band
801
Foot Length < 244mm
802
244 Length < 255mm
803
255mm ≤ Foot Length < 270 mm
804
270mm ≤ Foot Length
805
YES
YES
YES
YES
Classify into Band A
806
Classify into Band B
807
Classify into Band C
808
Classify into Band D
809
Classify into Arch Index Range 810
Arch Index > 0.257
811
NO
0.173 < Arch Index ≤ 0.257
812
NO
Arch Index ≤ 0.173
813
YES
YES
YES
Classify as Low Arch
814
Classify as Medium Arch
815
Classify as High Arch
816
Classify into Weight Range
817
Person Weight < Median Weight
818
NO
Person Weight ≥ Median Weight
819
YES
YES
Classify as Low Weight
820
Classify as High Weight
821
Cross-Reference Designated Selection Criteria
822
Return Selected Product Model
823

FIG.8b

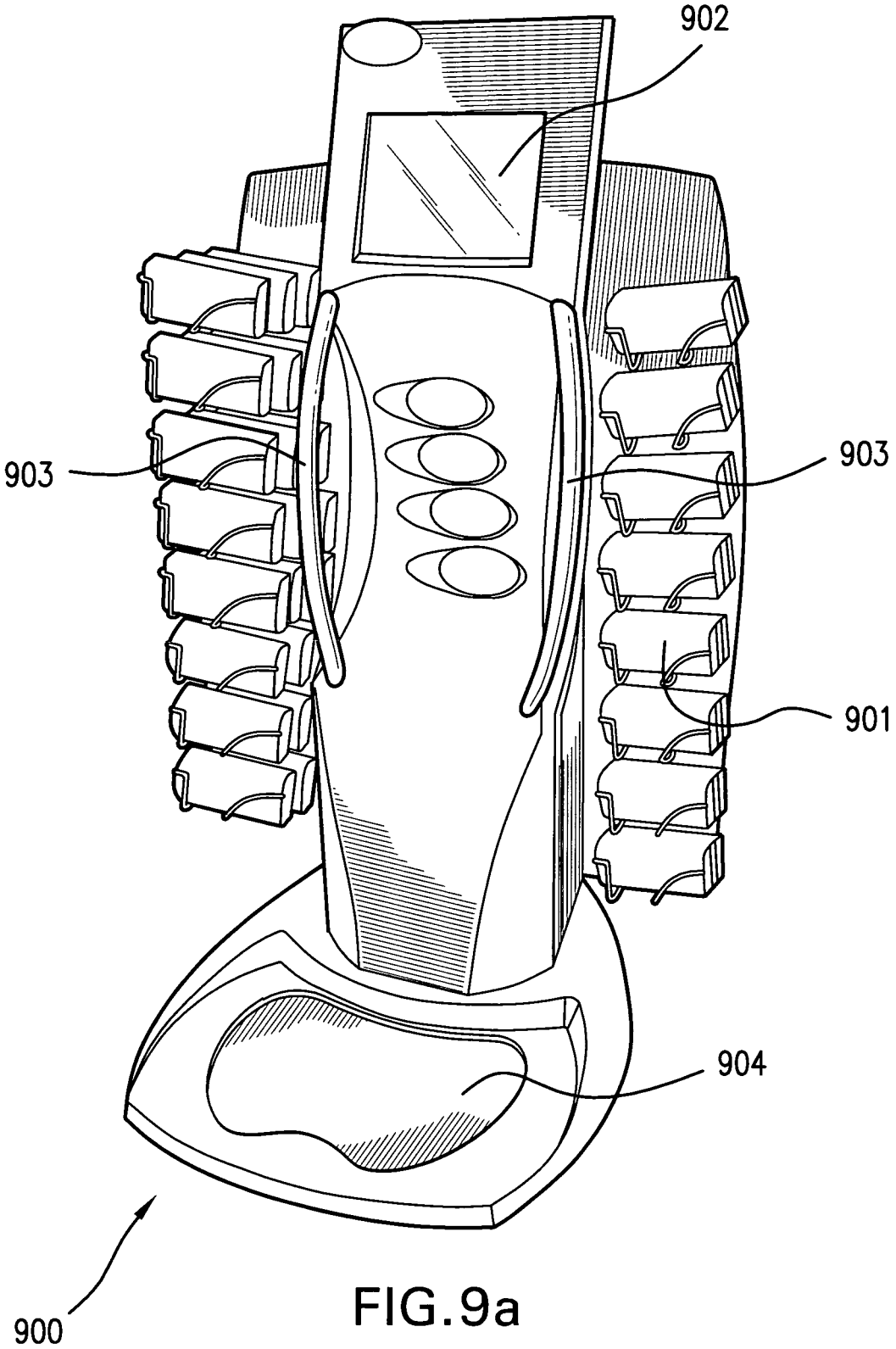

FIG.9a

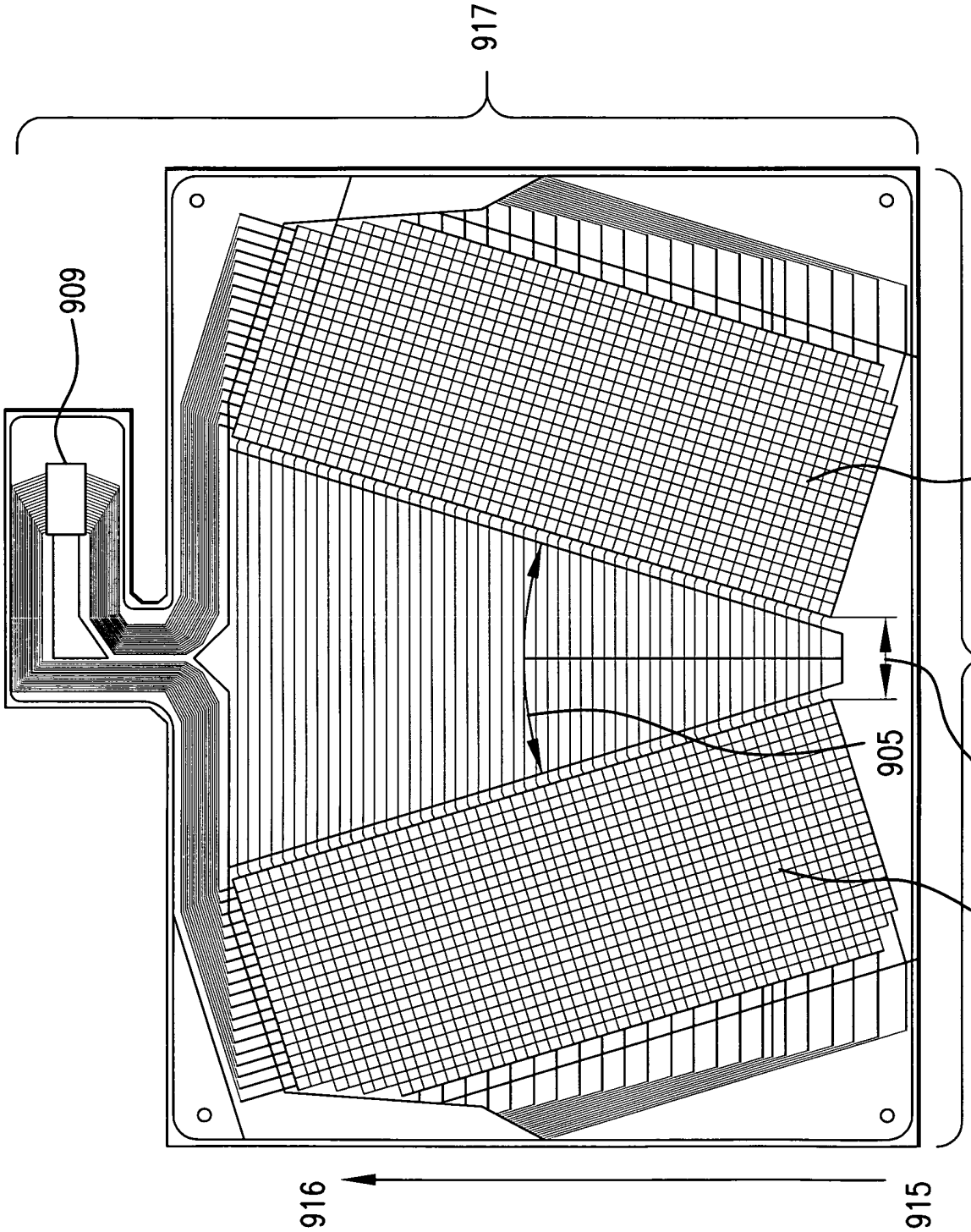

FIG.9b

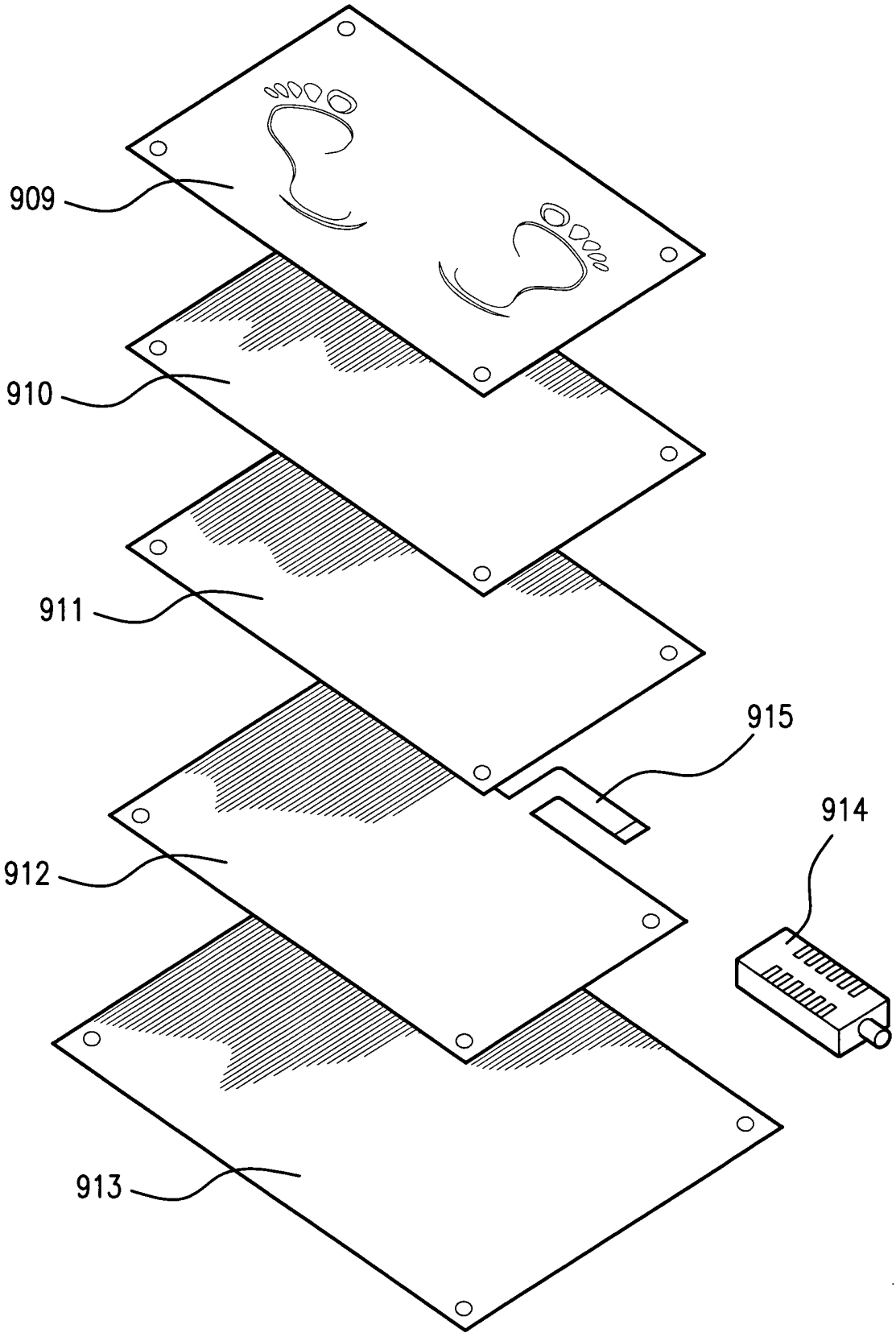

FIG.9c

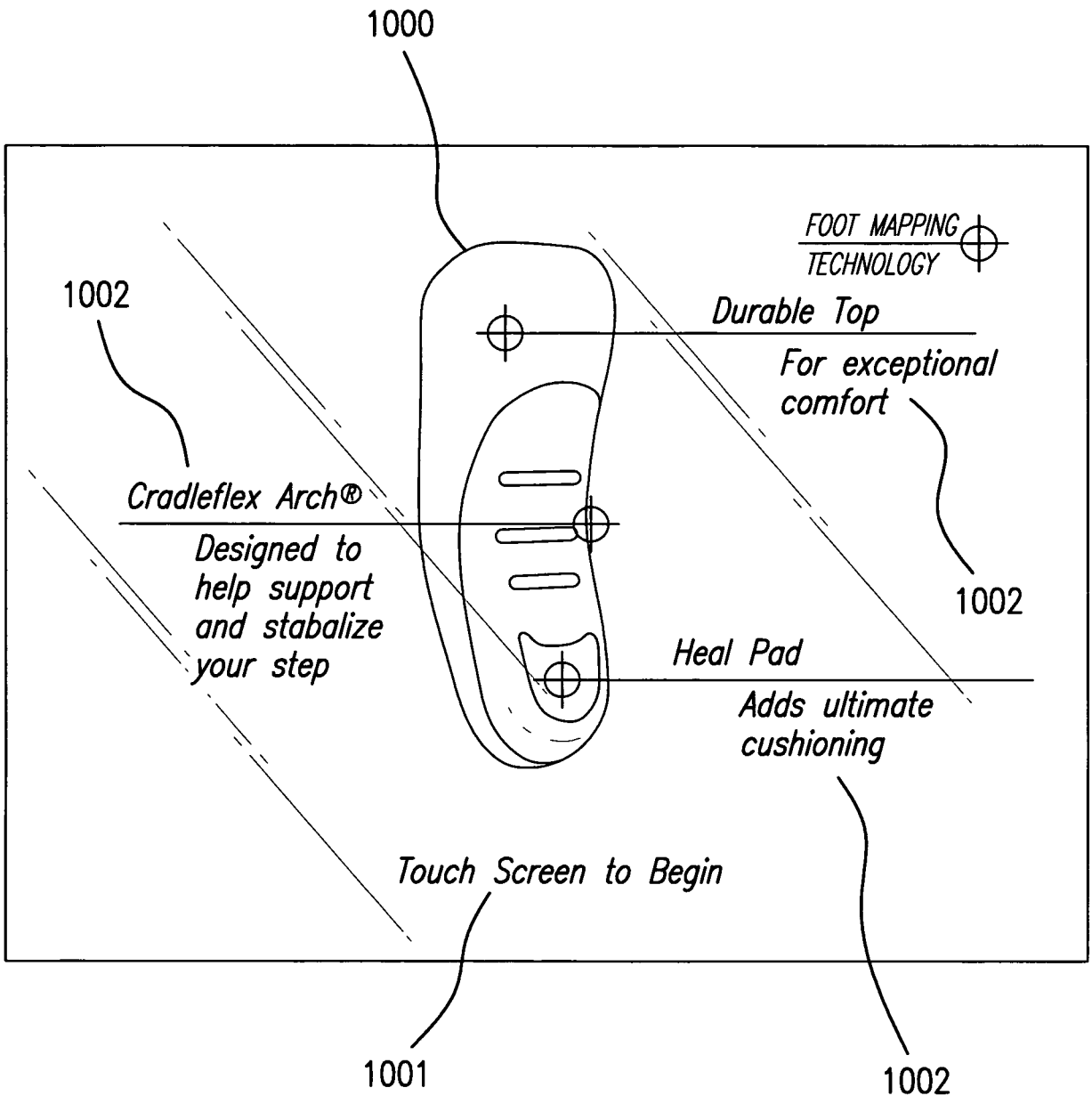
1000
FOOT MAPPING
TECHNOLOGY
1002
Durable Top
For exceptional
comfort
Cradleflex Arch®
Designed to
help support
and stabalize
your step
1002
Heal Pad
Adds ultimate
cushioning
Touch Screen to Begin
1001
1002

FIG.10a

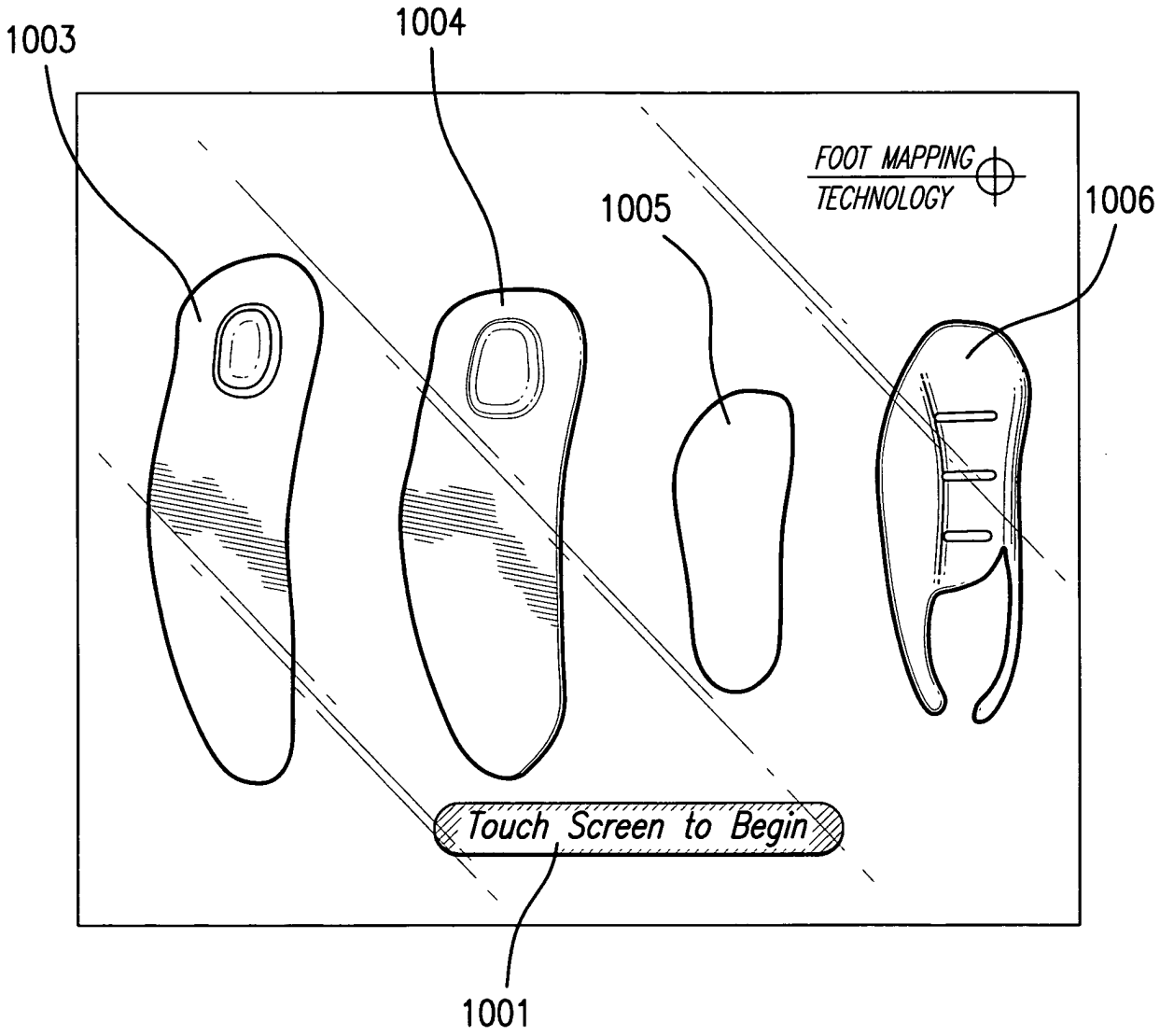
1003
1004
1005
1006
FOOT MAPPING
TECHNOLOGY
Touch Screen to Begin
1001

FIG.10b

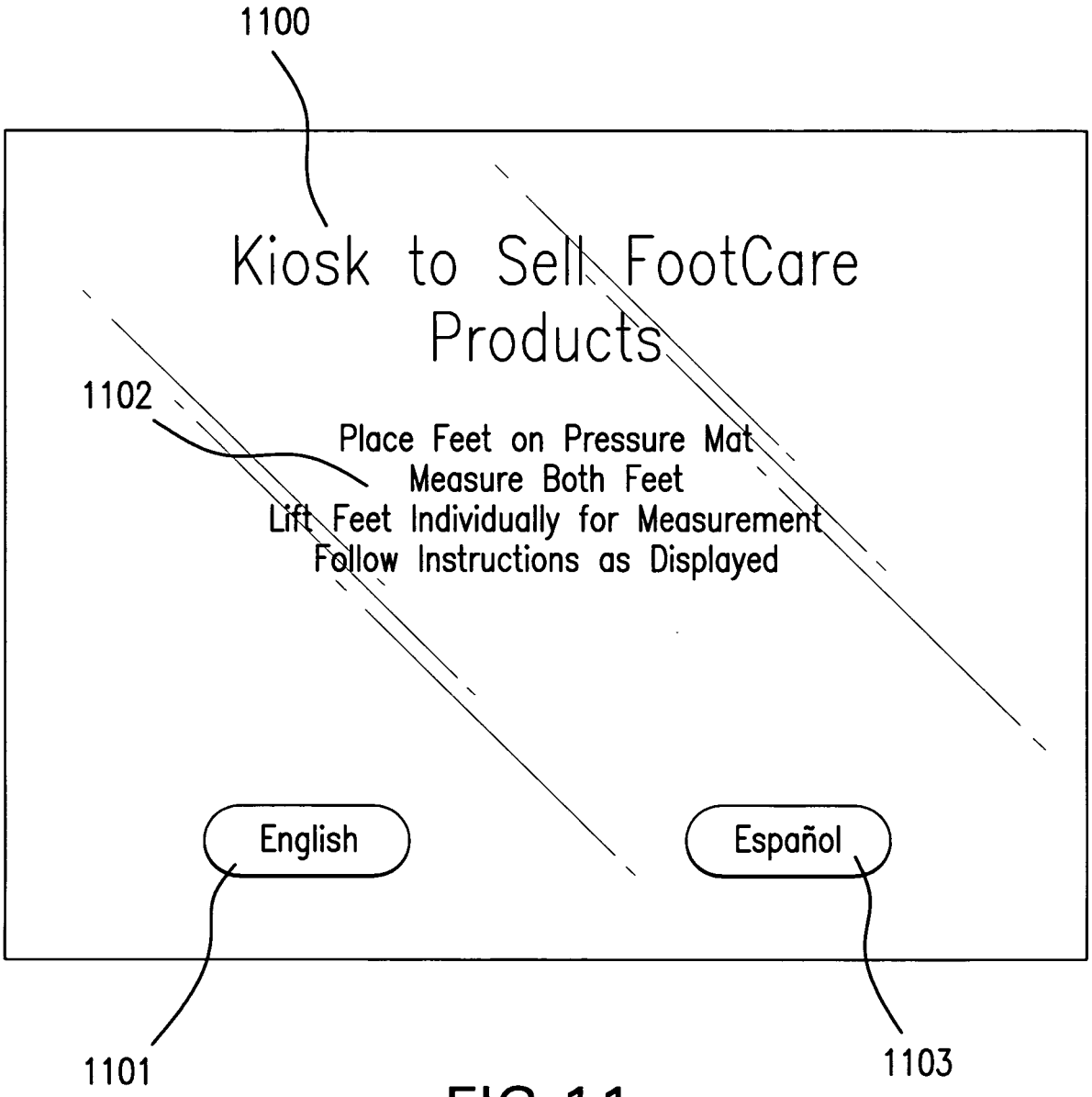
1100
Kiosk to Sell FootCare Products
1102
Place Feet on Pressure Mat
Measure Both Feet
Lift Feet Individually for Measurement
Follow Instructions as Displayed
English
Español
1101
1103

FIG.11

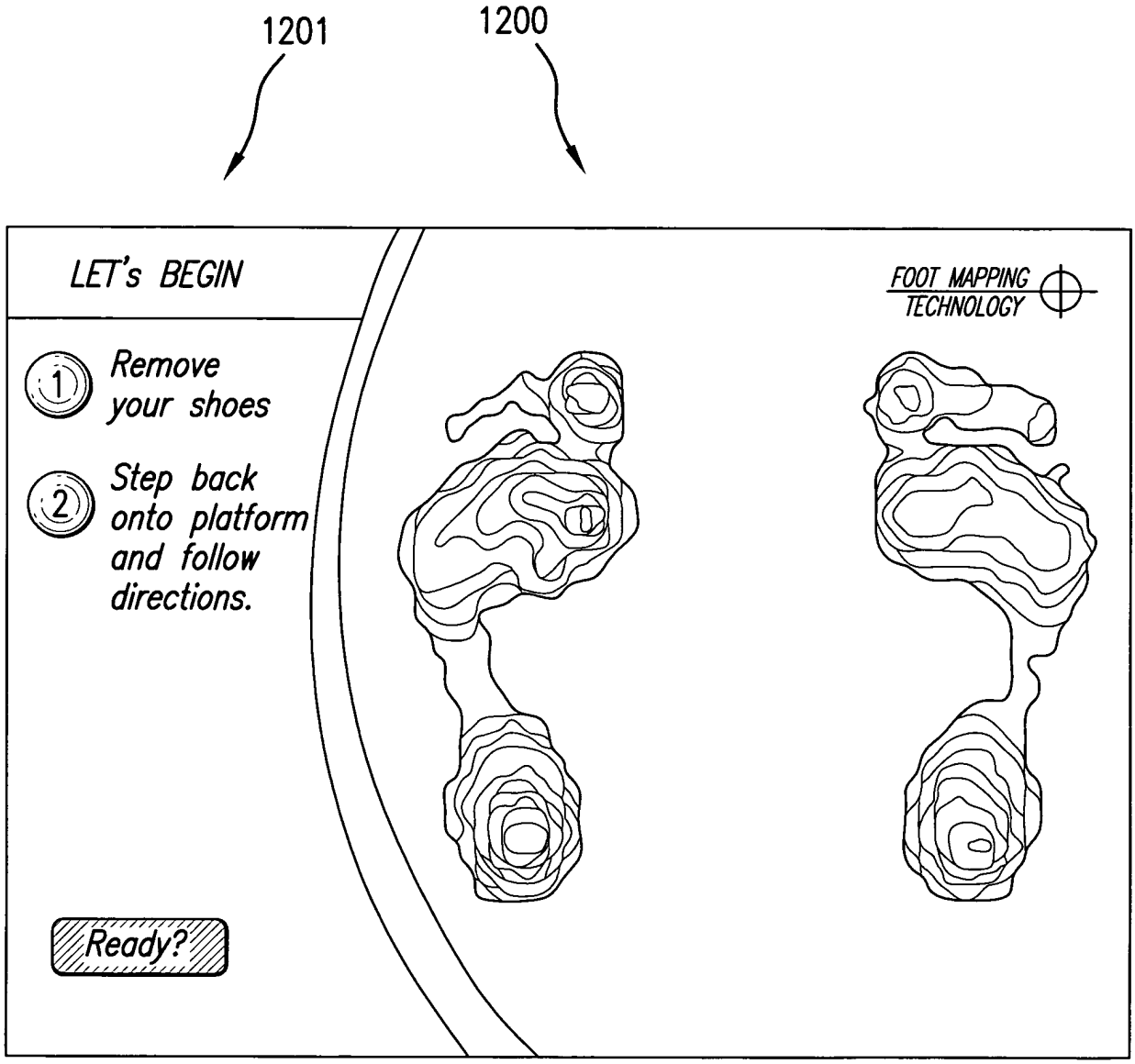
1201
1200
LET's BEGIN
FOOT MAPPING TECHNOLOGY
1
Remove your shoes
2
Step back onto platform and follow directions.
Ready?

FIG.12

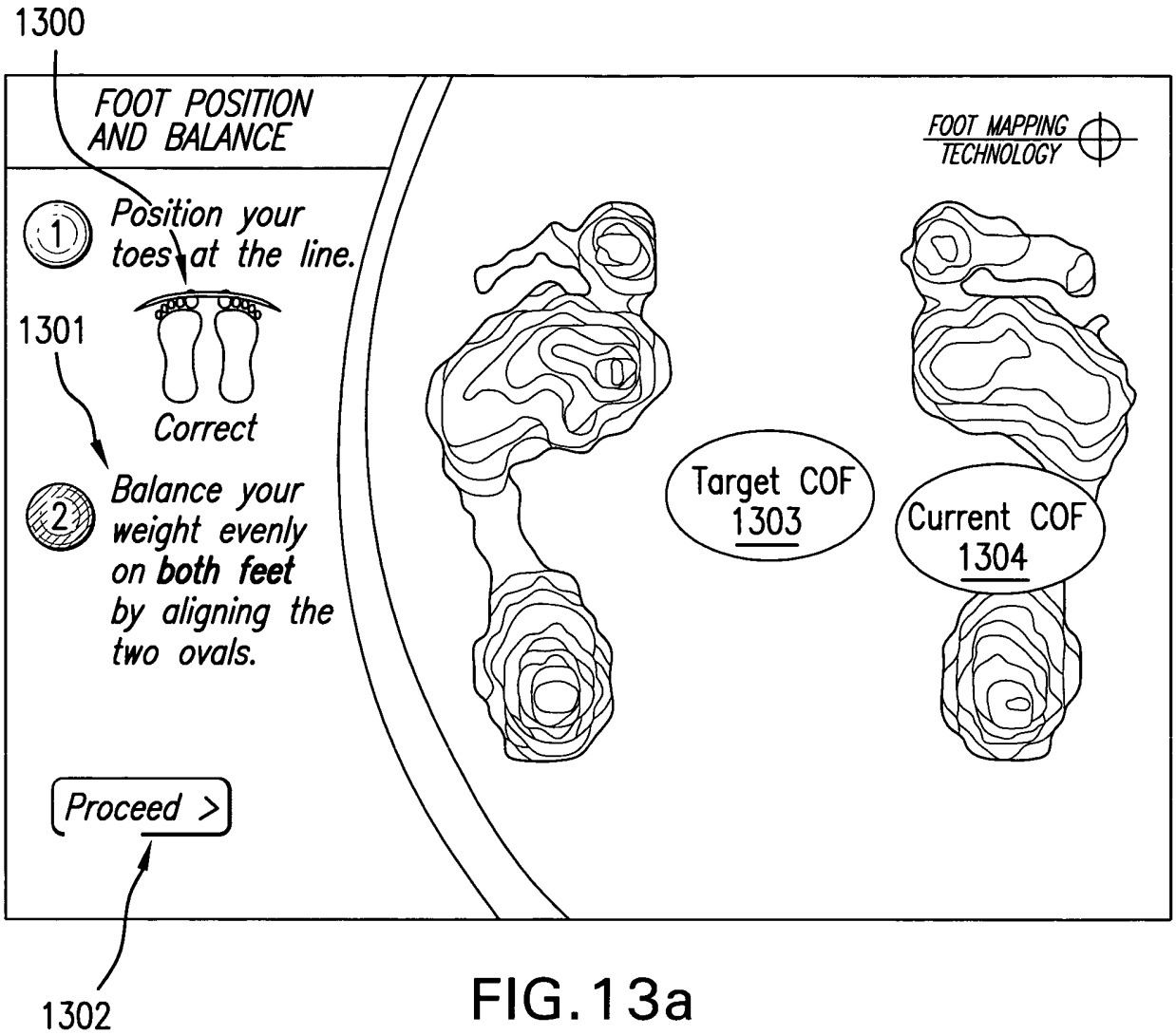
1300
FOOT POSITION AND BALANCE
FOOT MAPPING TECHNOLOGY
1
Position your toes at the line.
1301
Correct
2
Balance your weight evenly on both feet by aligning the two ovals.
Target COF 1303
Current COF 1304
Proceed >
1302

FIG.13a

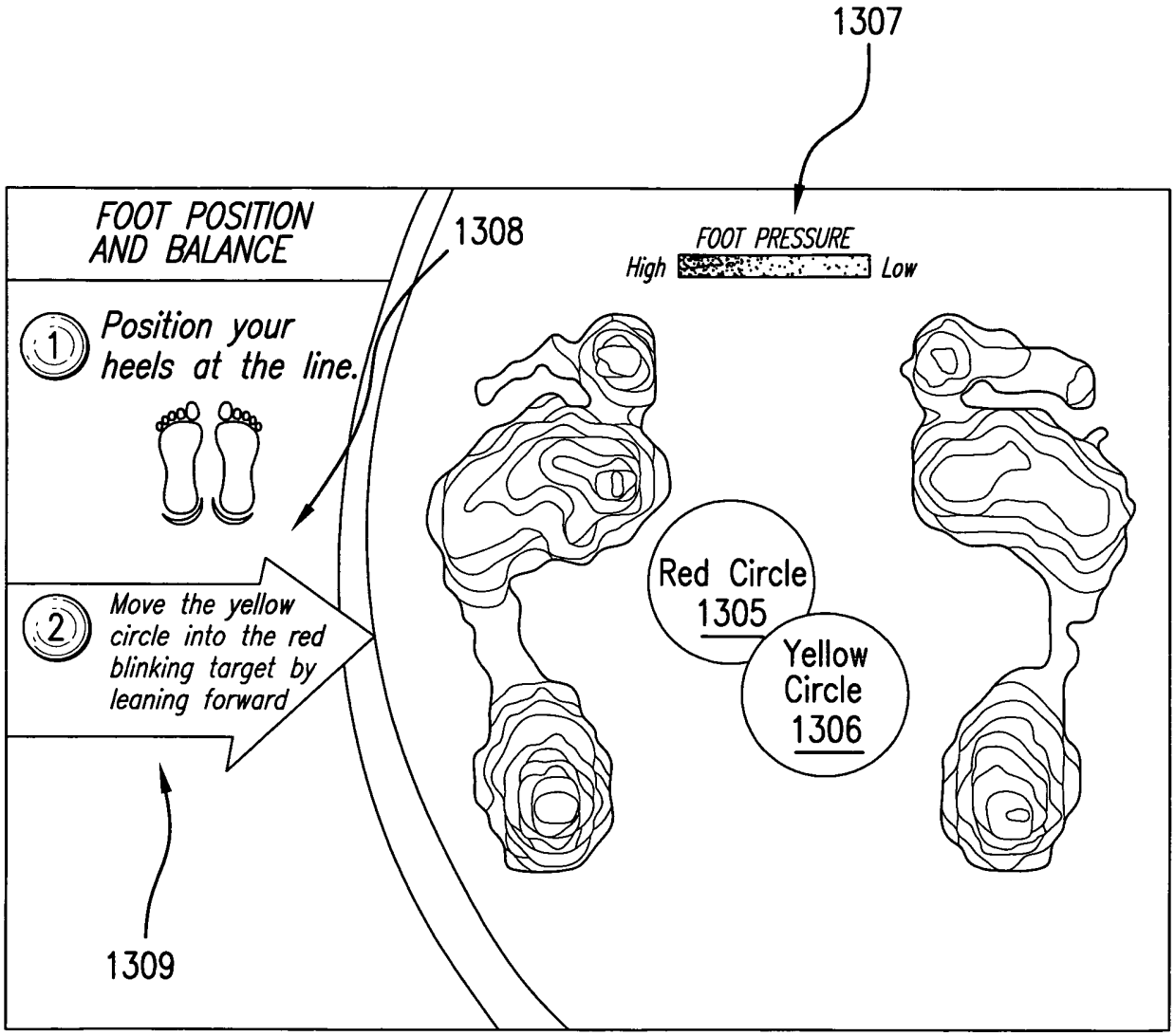
1307
FOOT POSITION AND BALANCE
1308
FOOT PRESSURE
High
Low
1
Position your heels at the line.
2
Move the yellow circle into the red blinking target by leaning forward
Red Circle 1305
Yellow Circle 1306
1309

FIG.13b

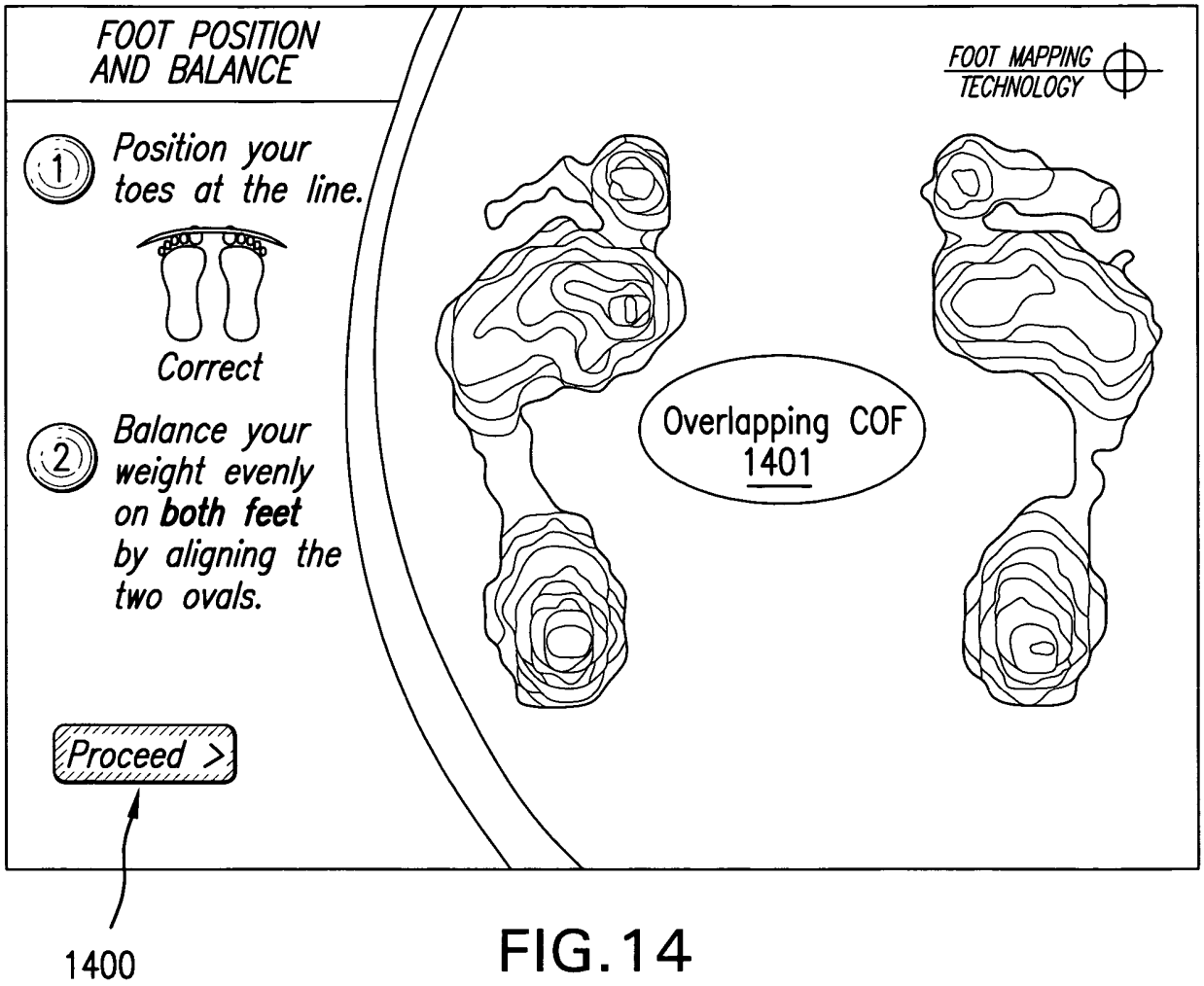
FOOT POSITION AND BALANCE
1
Position your toes at the line.
Correct
2
Balance your weight evenly on both feet by aligning the two ovals.
Proceed >
1400
FOOT MAPPING TECHNOLOGY
Overlapping COF
1401

FIG.14

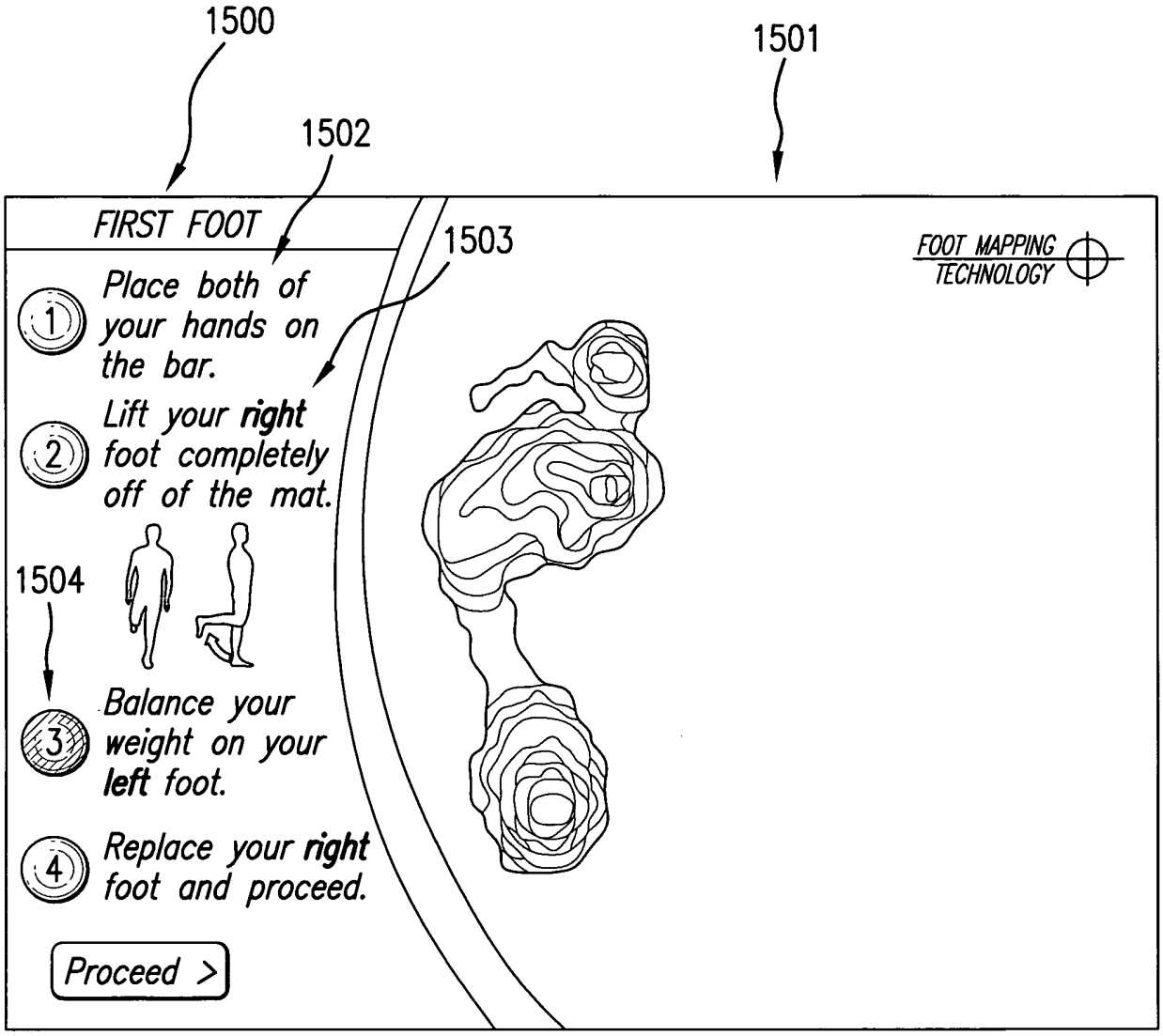
1500
1501
1502
1503
1504
FIRST FOOT
Place both of your hands on the bar.
Lift your right foot completely off of the mat.
Balance your weight on your left foot.
Replace your right foot and proceed.
Proceed >
FOOT MAPPING TECHNOLOGY

FIG.15

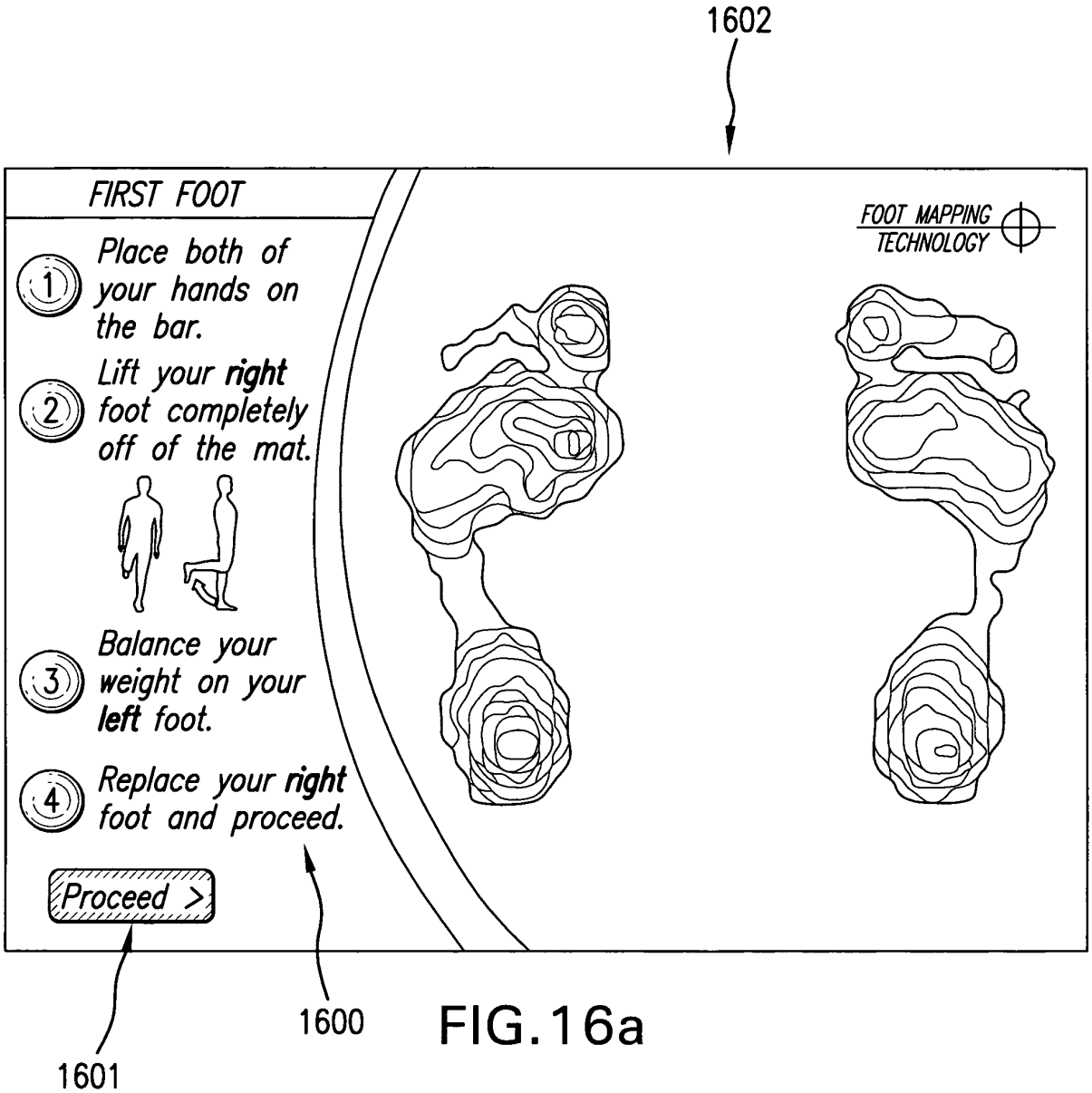
1602
FIRST FOOT
1
Place both of your hands on the bar.
2
Lift your right foot completely off of the mat.
3
Balance your weight on your left foot.
4
Replace your right foot and proceed.
Proceed >
FOOT MAPPING TECHNOLOGY
1600
1601

FIG.16a

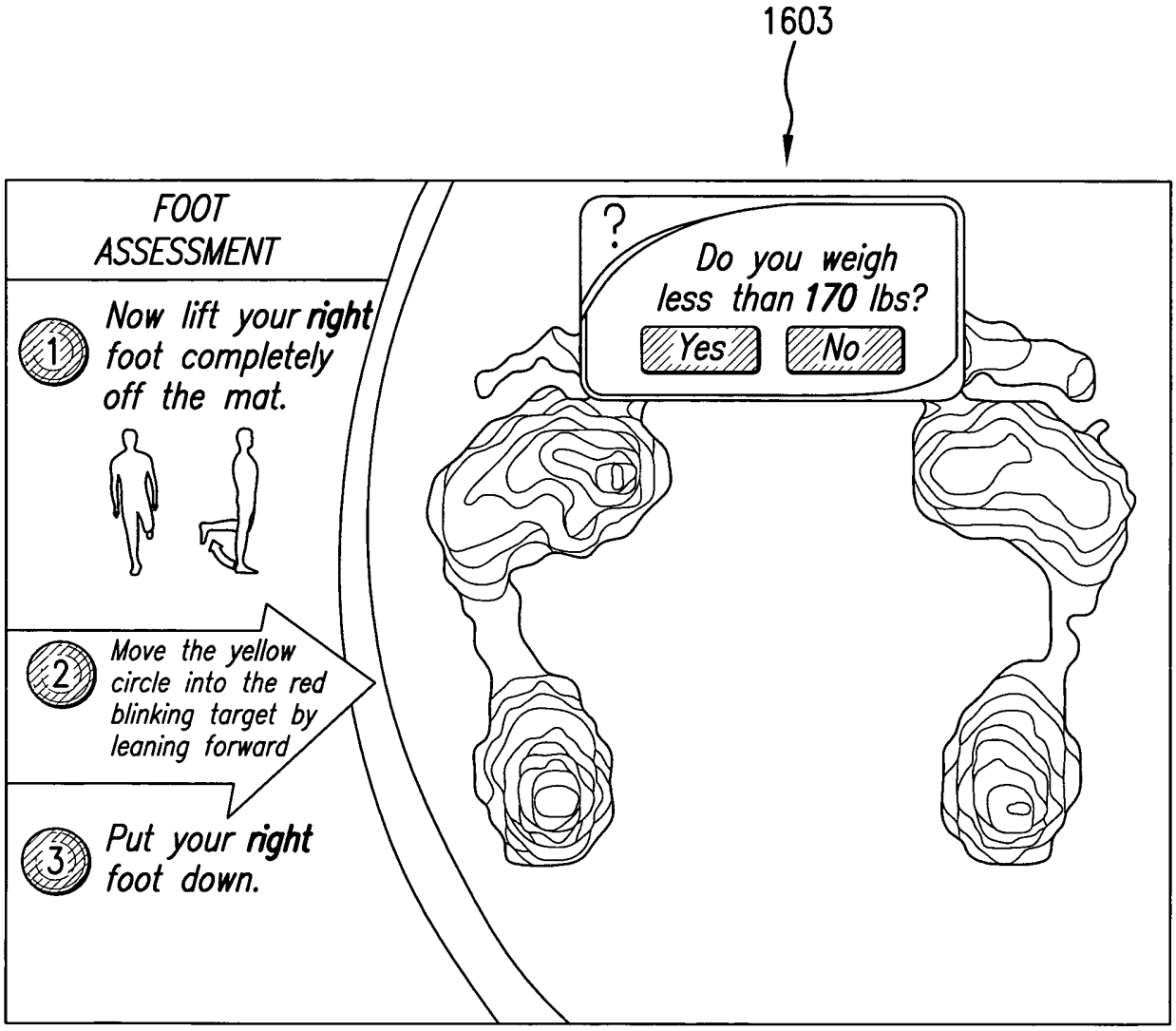
1603
FOOT ASSESSMENT
1
Now lift your right foot completely off the mat.
2
Move the yellow circle into the red blinking target by leaning forward
3
Put your right foot down.
?
Do you weigh less than 170 lbs?
Yes
No

FIG.16b

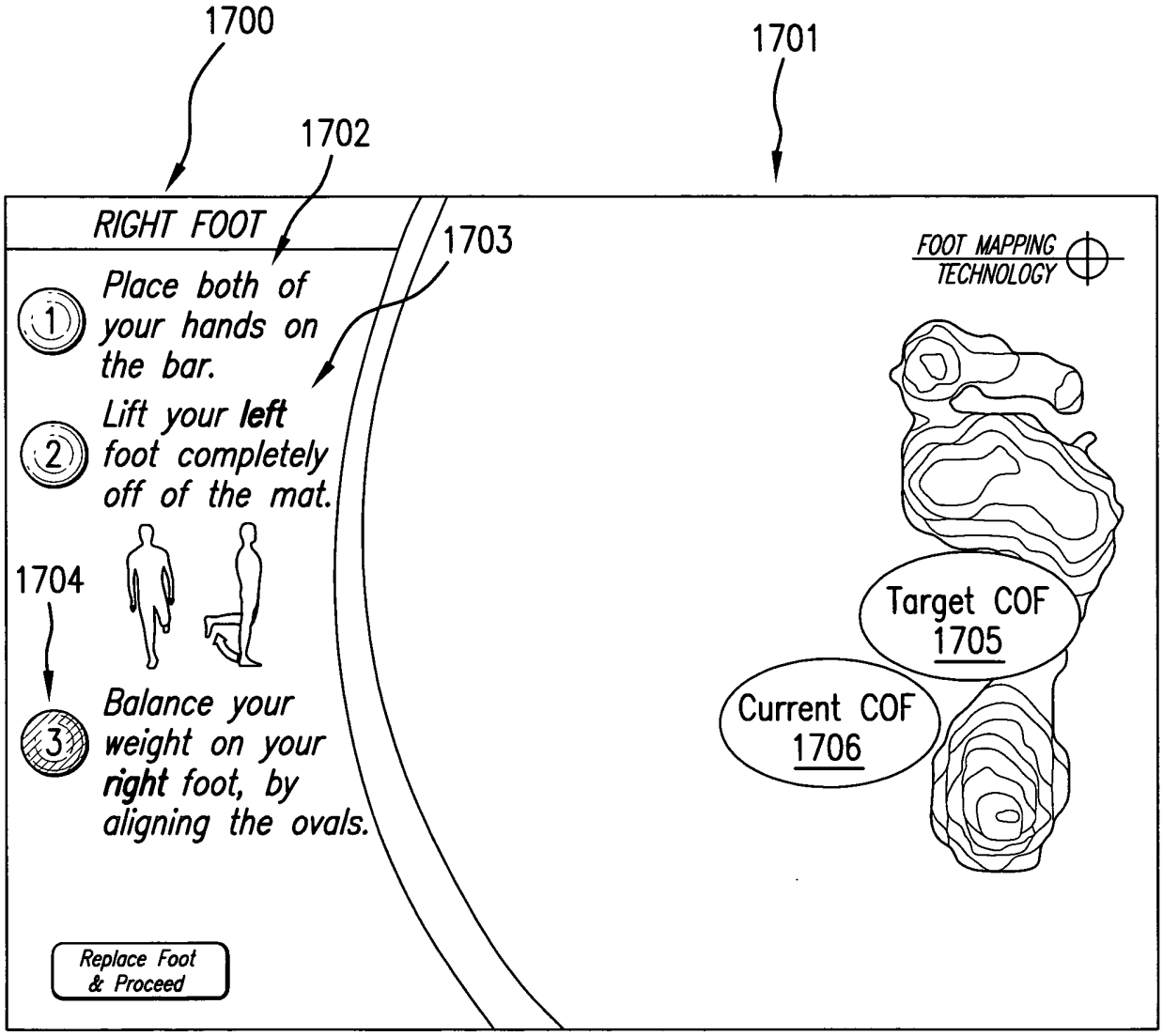
1700
1701
1702
1703
RIGHT FOOT
Place both of your hands on the bar.
Lift your left foot completely off of the mat.
1704
Balance your weight on your right foot, by aligning the ovals.
Replace Foot & Proceed
FOOT MAPPING TECHNOLOGY
Target COF
1705
Current COF
1706

FIG.17a

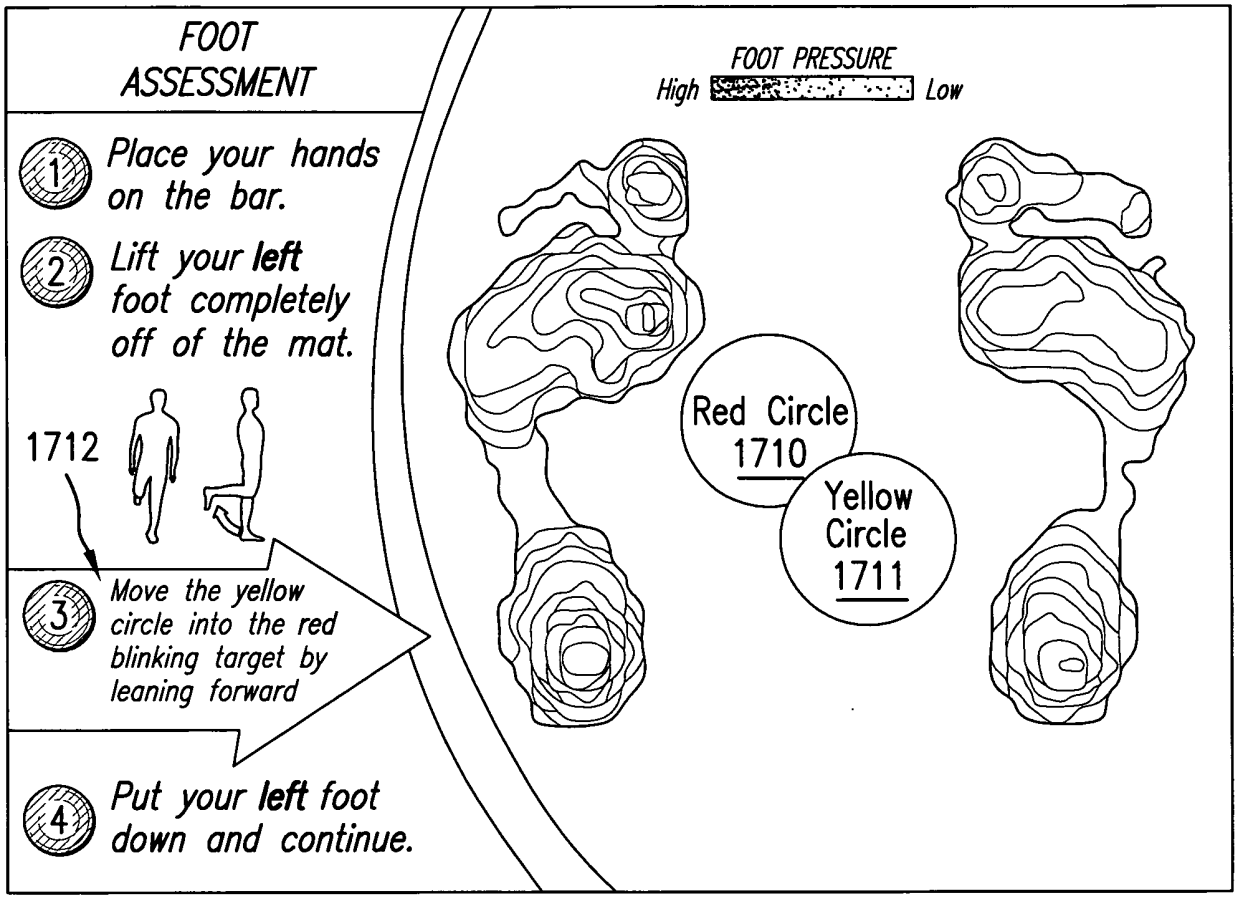
FOOT ASSESSMENT
1 Place your hands on the bar.
2 Lift your left foot completely off of the mat.
1712
3 Move the yellow circle into the red blinking target by leaning forward
4 Put your left foot down and continue.
FOOT PRESSURE
High
Low
Red Circle 1710
Yellow Circle 1711

FIG.17b

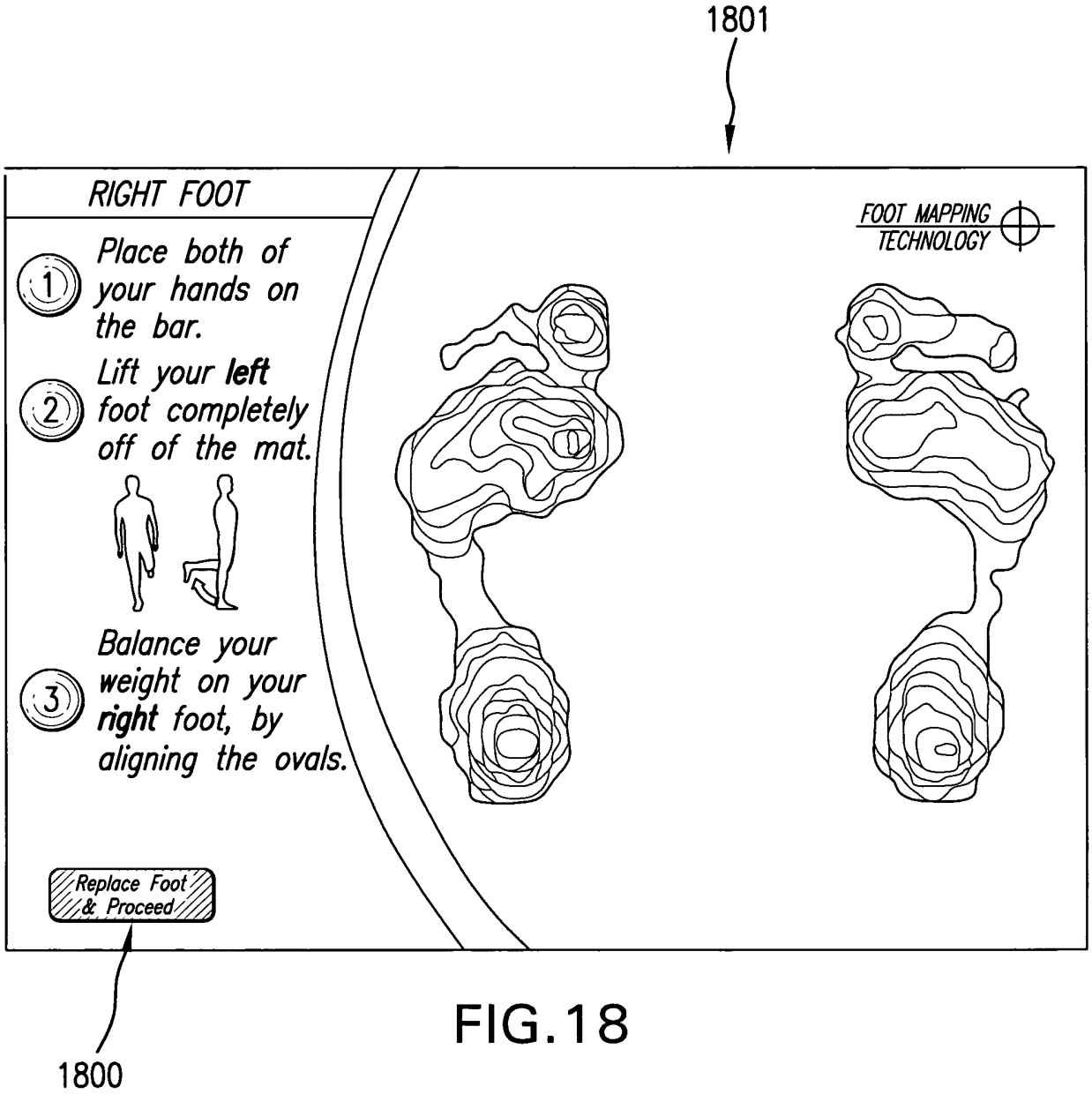
1801
RIGHT FOOT
1
Place both of your hands on the bar.
2
Lift your left foot completely off of the mat.
3
Balance your weight on your right foot, by aligning the ovals.
Replace Foot & Proceed
FOOT MAPPING TECHNOLOGY
1800

FIG.18

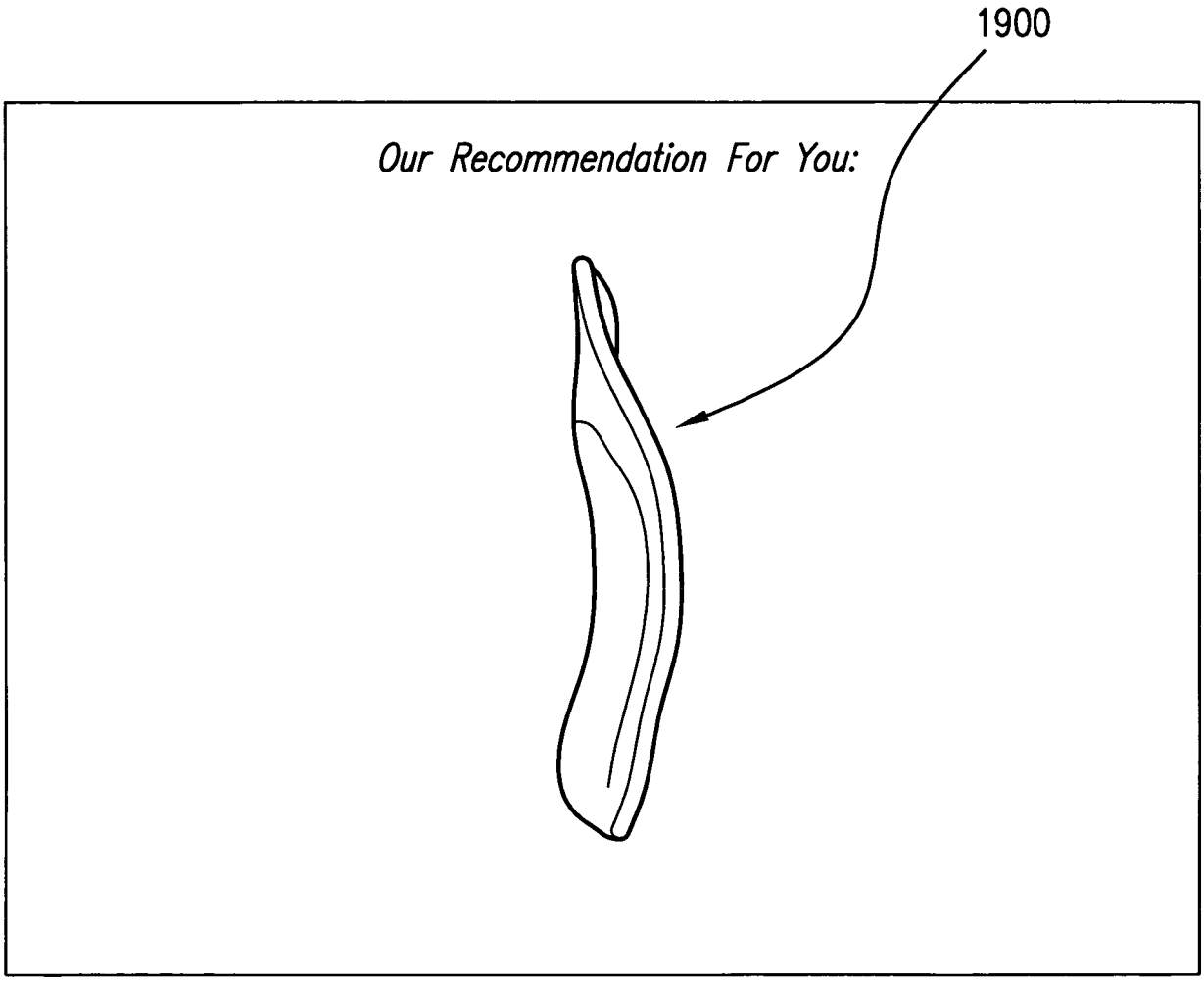

FIG.19

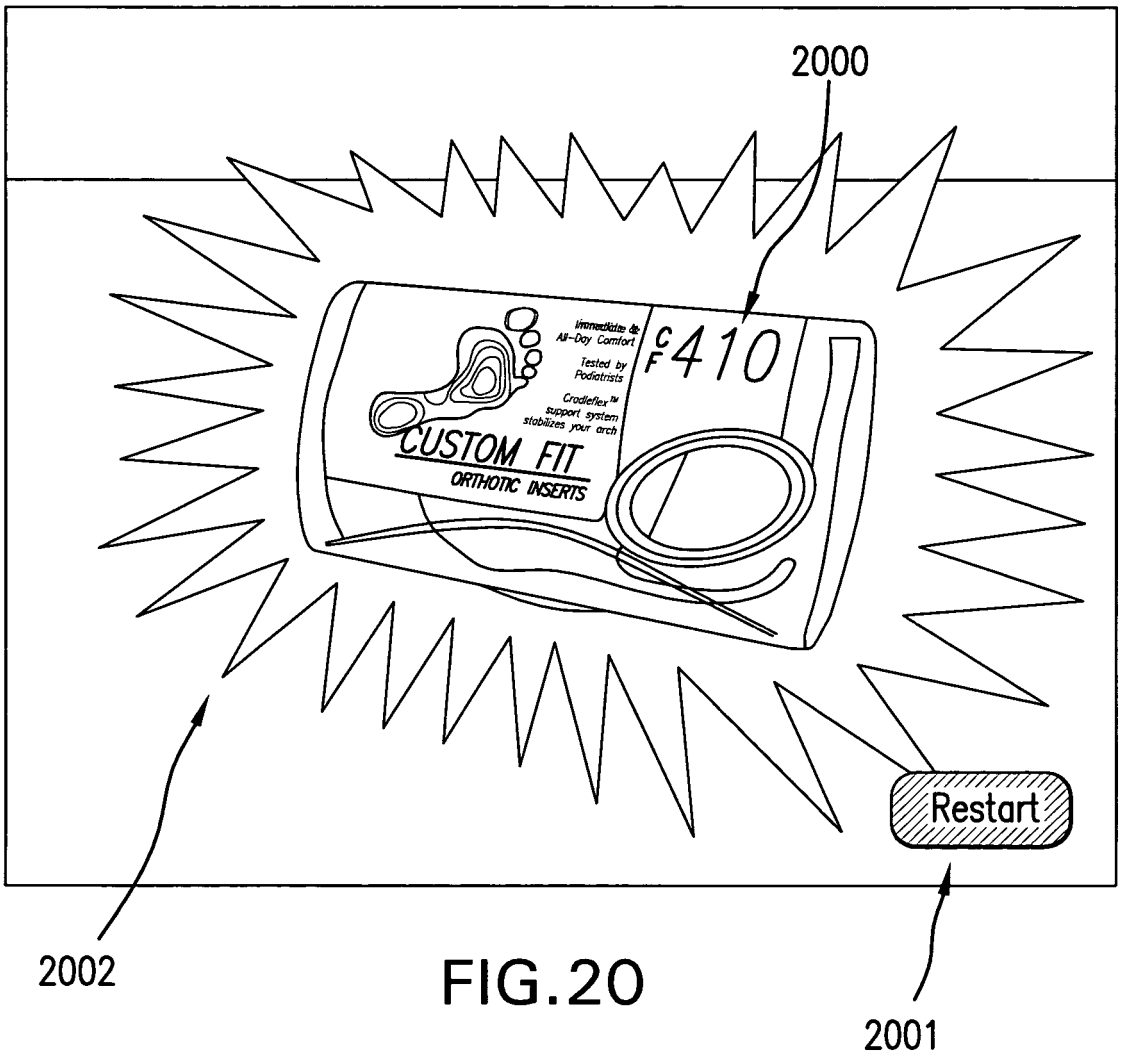
2000
Immediate All-Day Comfort
Tested by Podiatrists
Cradleflex™ support system stabilizes your arch
CUSTOM FIT
ORTHOTIC INSERTS
CF410
Restart
2002
2001

FIG.20

REFERENCES CITED IN THE DESCRIPTION

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- US 6331893 B **[0009]**
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- JP H03247305 A **[0012]**
- JP 2005192744 A **[0012]**
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- US 6964205 B **[0029]**
- US 52497906 A **[0077]**

专利名称(译)	足部测量仪器		
公开(公告)号	EP2063779B1	公开(公告)日	2019-04-24
申请号	EP2007838636	申请日	2007-09-21
[标]申请(专利权)人(译)	先灵-普劳健康护理产品公司		
申请(专利权)人(译)	先灵葆雅保健品，INC.		
当前申请(专利权)人(译)	拜耳保健消费品公司		
[标]发明人	XIA BIN HOWLETT HAROLD A LUNDY CHARLES E JR		
发明人	XIA, BIN HOWLETT, HAROLD, A. LUNDY, CHARLES, E., JR.		
IPC分类号	A61B5/107 A61B5/103 A43D1/02 A43B7/14 A43B7/22 A43B17/02 A43D999/00 A61B5/00 G06Q20/20 G06Q30/02 G06Q30/06		
CPC分类号	A43B7/142 A43B7/144 A43B7/223 A43B17/023 A43D1/02 A43D999/00 A61B5/1036 A61B5/1074 A61B5/6892 A61B5/7264 A61B2562/0247 A61B2562/046 G06Q20/20 G06Q30/02 G06Q30/06		
代理机构(译)	BIP专利		
优先权	11/524745 2006-09-21 US 11/524979 2006-09-21 US		
其他公开文献	EP2063779A2		
外部链接	Espacenet		

摘要(译)

一种自助服务终端设备，其可以基于从压力传感器收集的压力测量值或计算的生物力学数据估计（例如足弓的足部长度，重量和高度）来为人选择推荐的足部护理产品。压力测量值和计算的生物力学数据估计值可以用于确定脚是否在压力传感器上没有穿孔并且还将人分组到分类的子组中。压力测量和计算的生物力学数据估计也可用于选择推荐的足部护理产品。

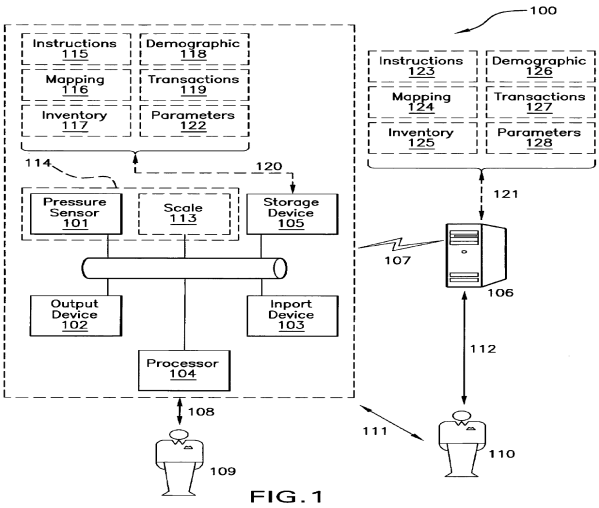

FIG.1