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(54) **SHOE PATTERN DESIGN METHOD, SHOE
PATTERN DESIGN DEVICE, FOOT
MEASURER, AND FOOT POSITIONING
DEVICE OF FOOT MEASURER**

Publication Classification(51) **Int. Cl.⁷ A43D 1/00**(52) **U.S. Cl. 33/3 R**(76) **Inventor: Hisayo Ishimaru, Kanagawa (JP)**(57) **ABSTRACT**

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Measured size data of a foot of a user is inputted into foot size data inputting unit **31**, and provided to shoe last configuration data production unit **32**. Also, in conversion table **33**, is stored conversion data produced on the basis of the relationship between a foot size and a size of a shoe last for producing a shoe which fits in the foot determined by an experiment. Shoe last configuration data production unit **32**, by referring to conversion table **33**, produces ideal size data of a shoe last on the basis of inputted size data of a foot.

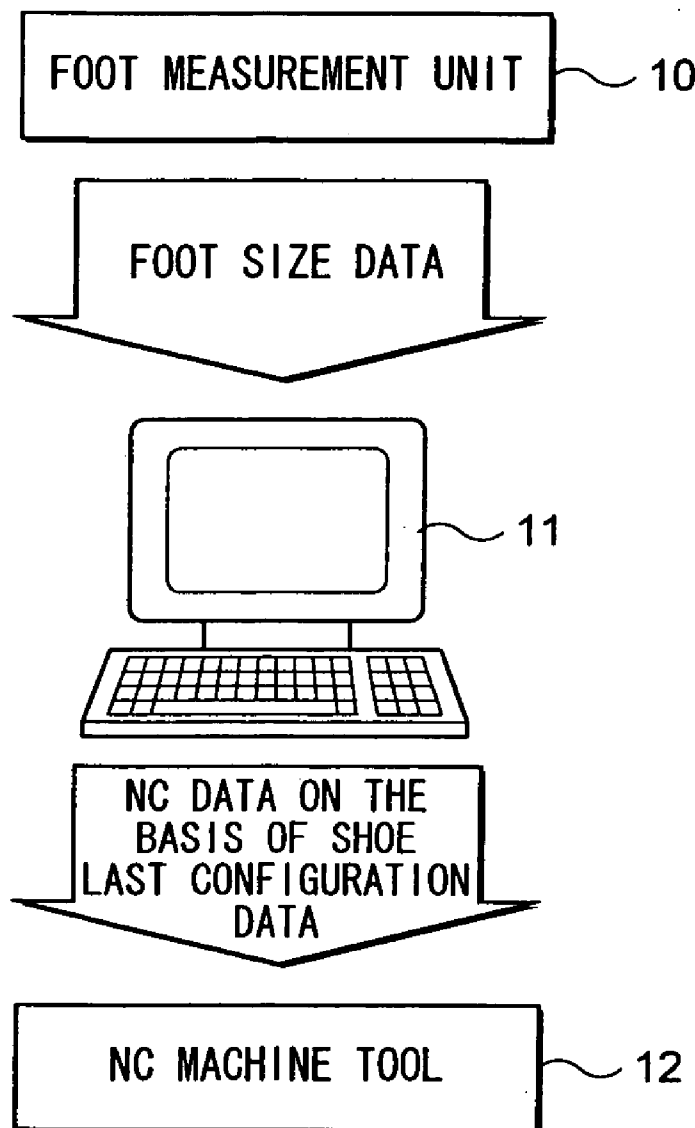
(21) **Appl. No.: 10/480,740**(22) **PCT Filed: Jun. 11, 2002**(86) **PCT No.: PCT/JP02/05775**

FIG. 1

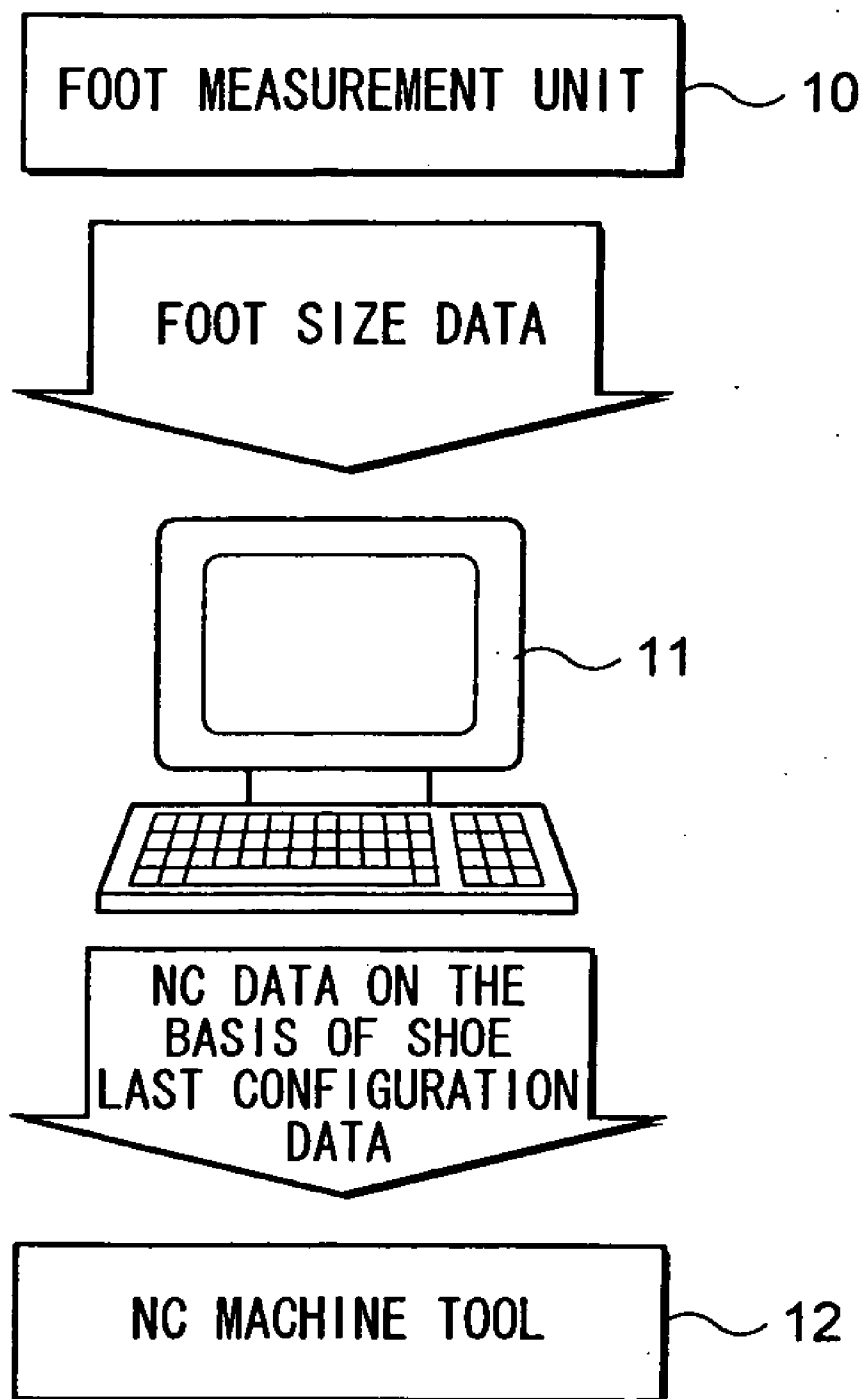


FIG. 2

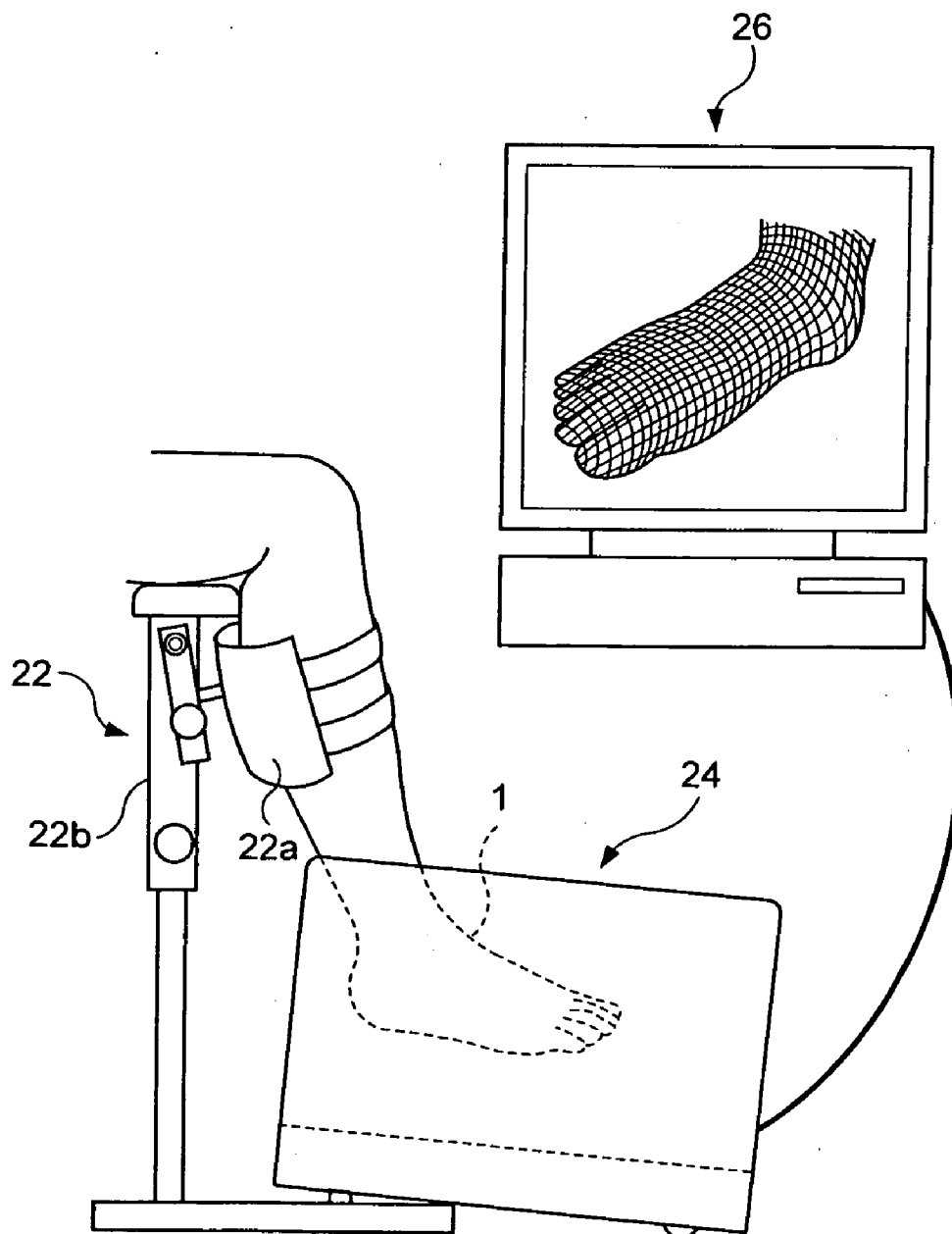


FIG. 3

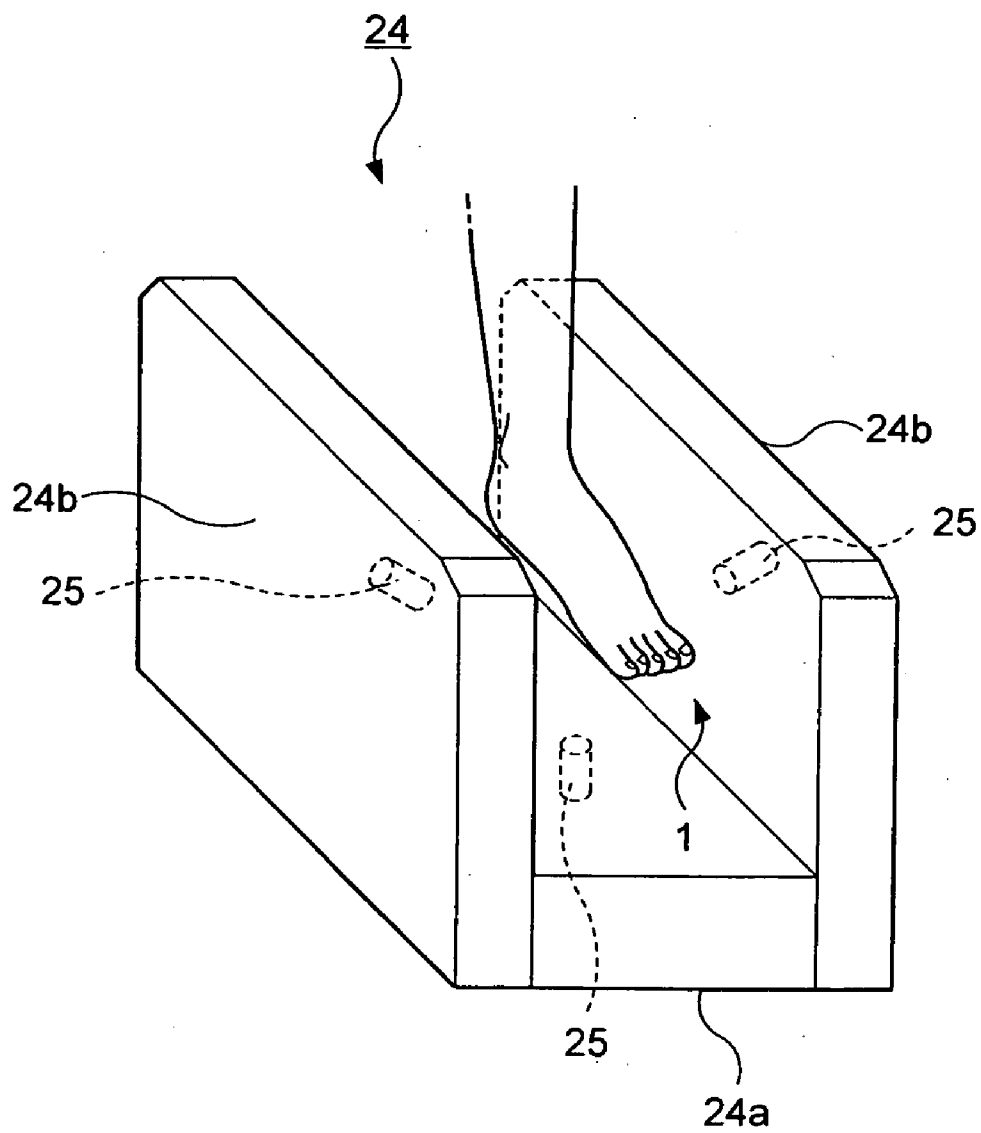


FIG. 4

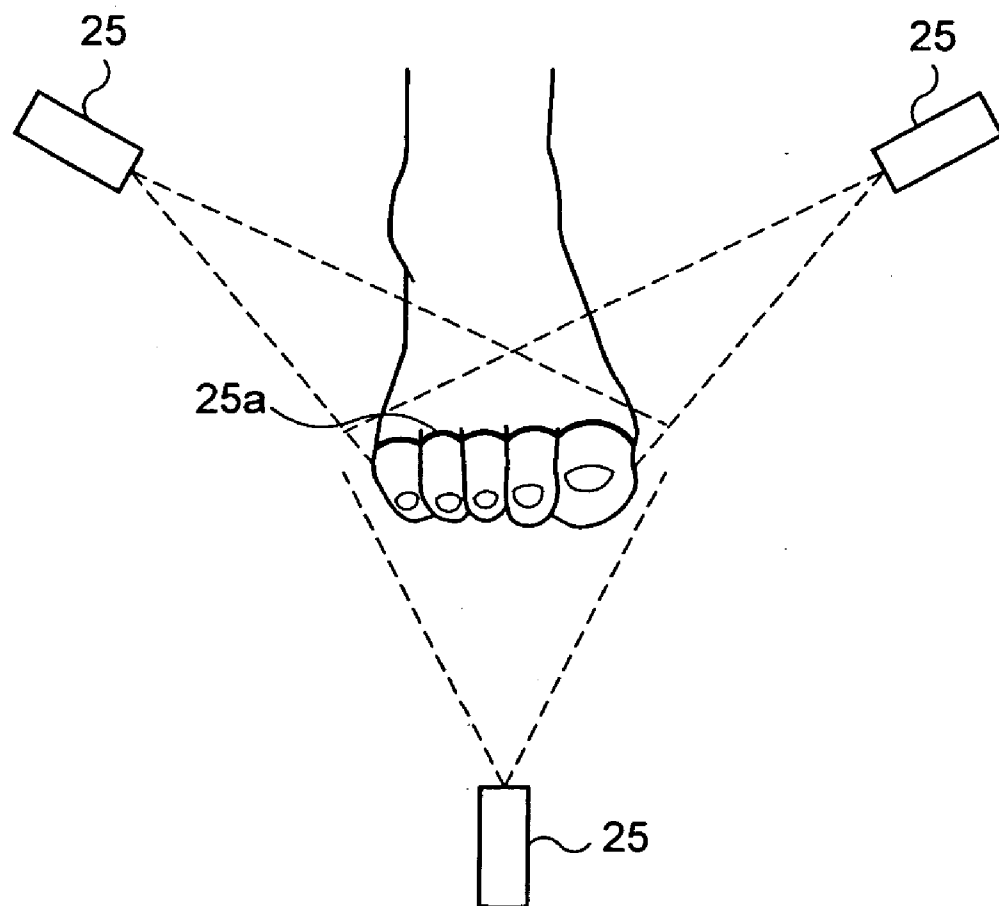


FIG. 5

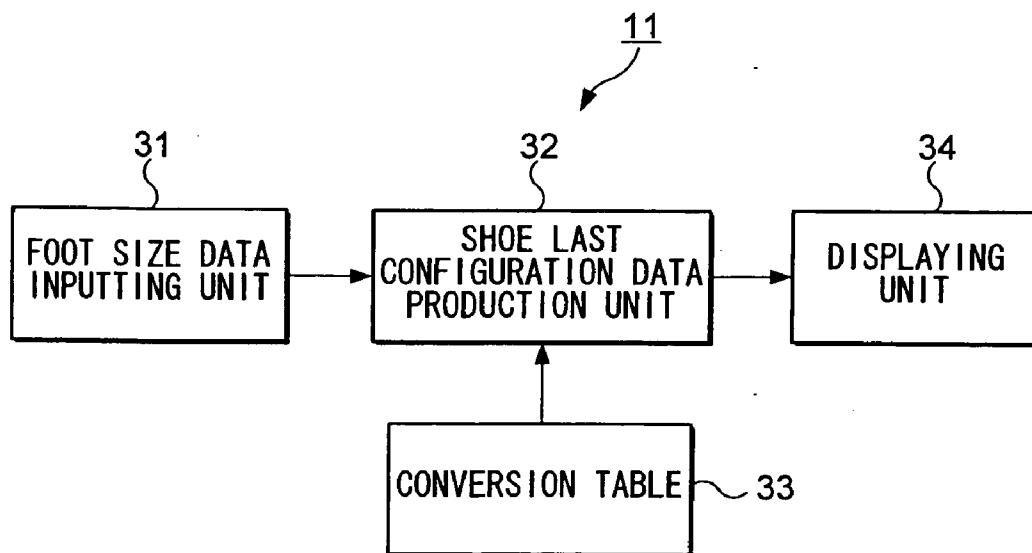


FIG. 6

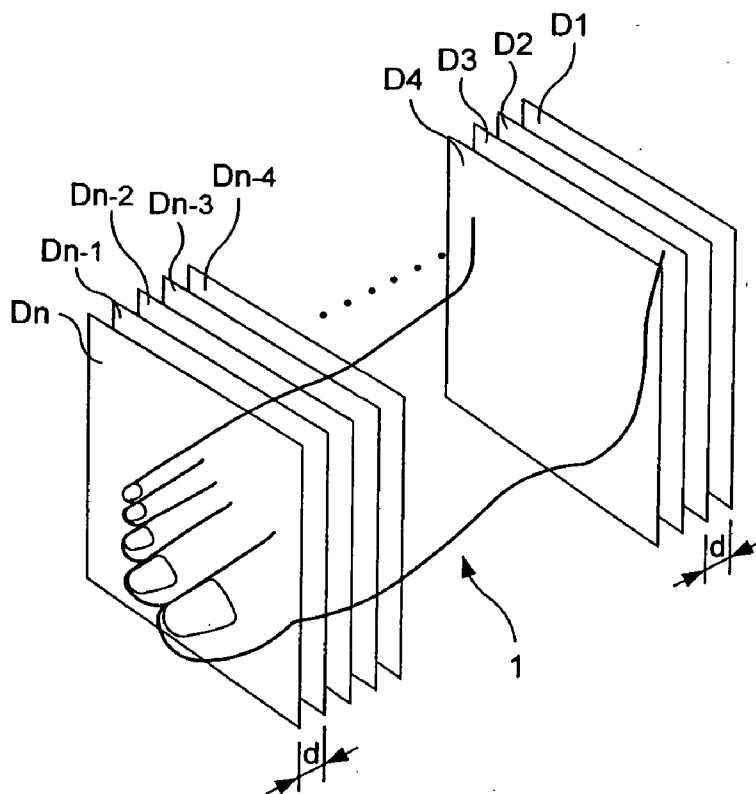


FIG. 7

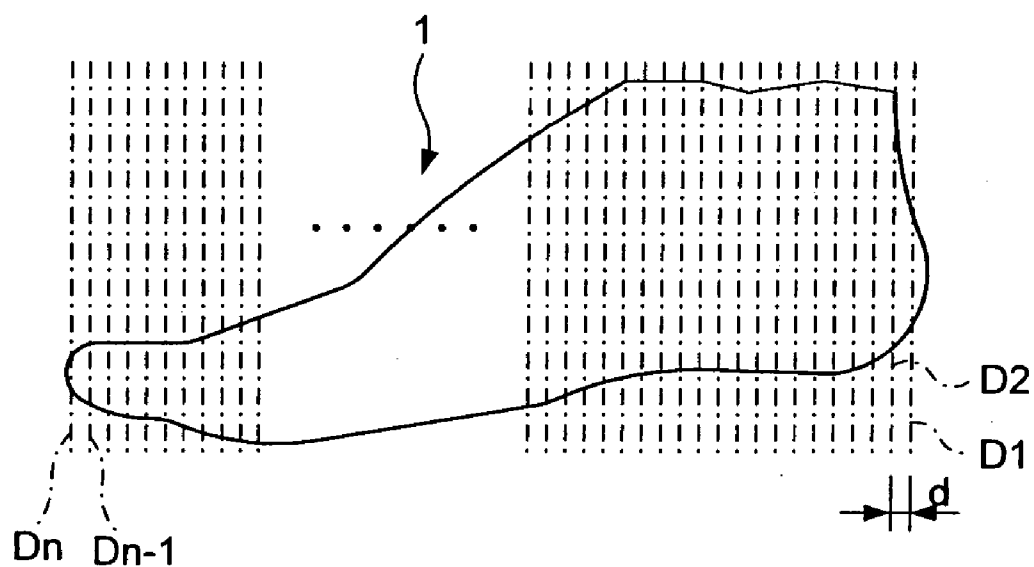


FIG. 8

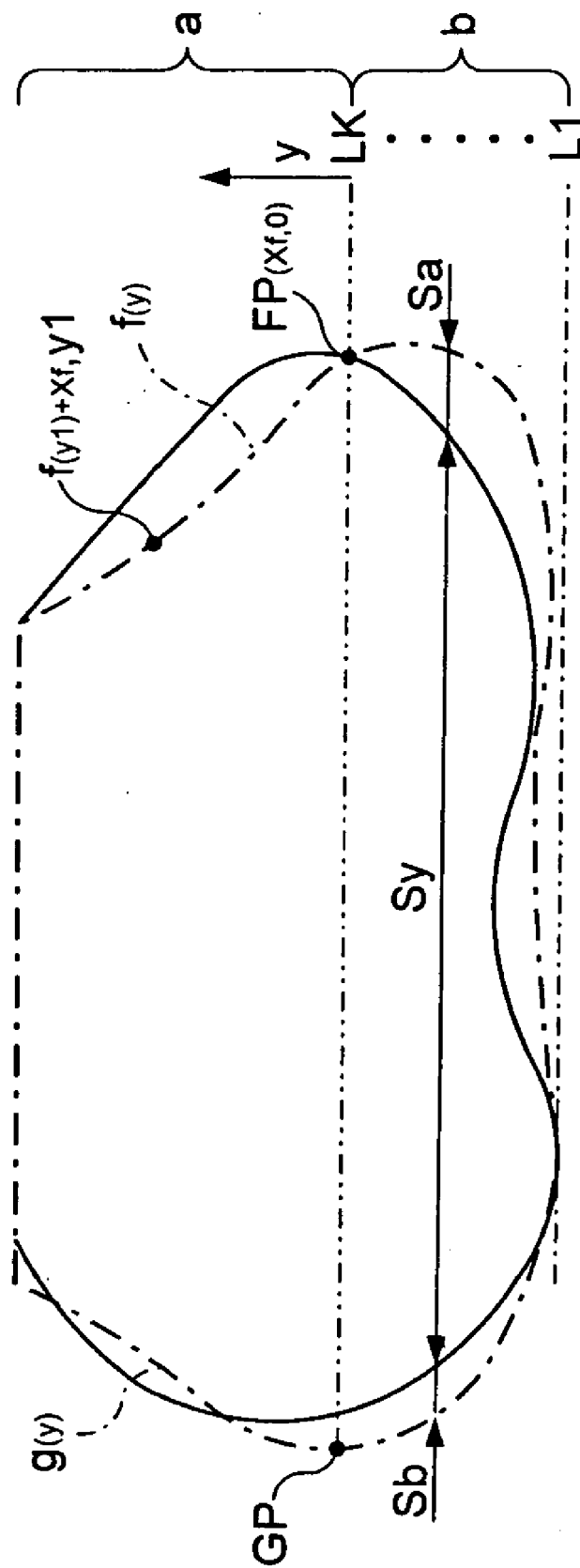


FIG. 9

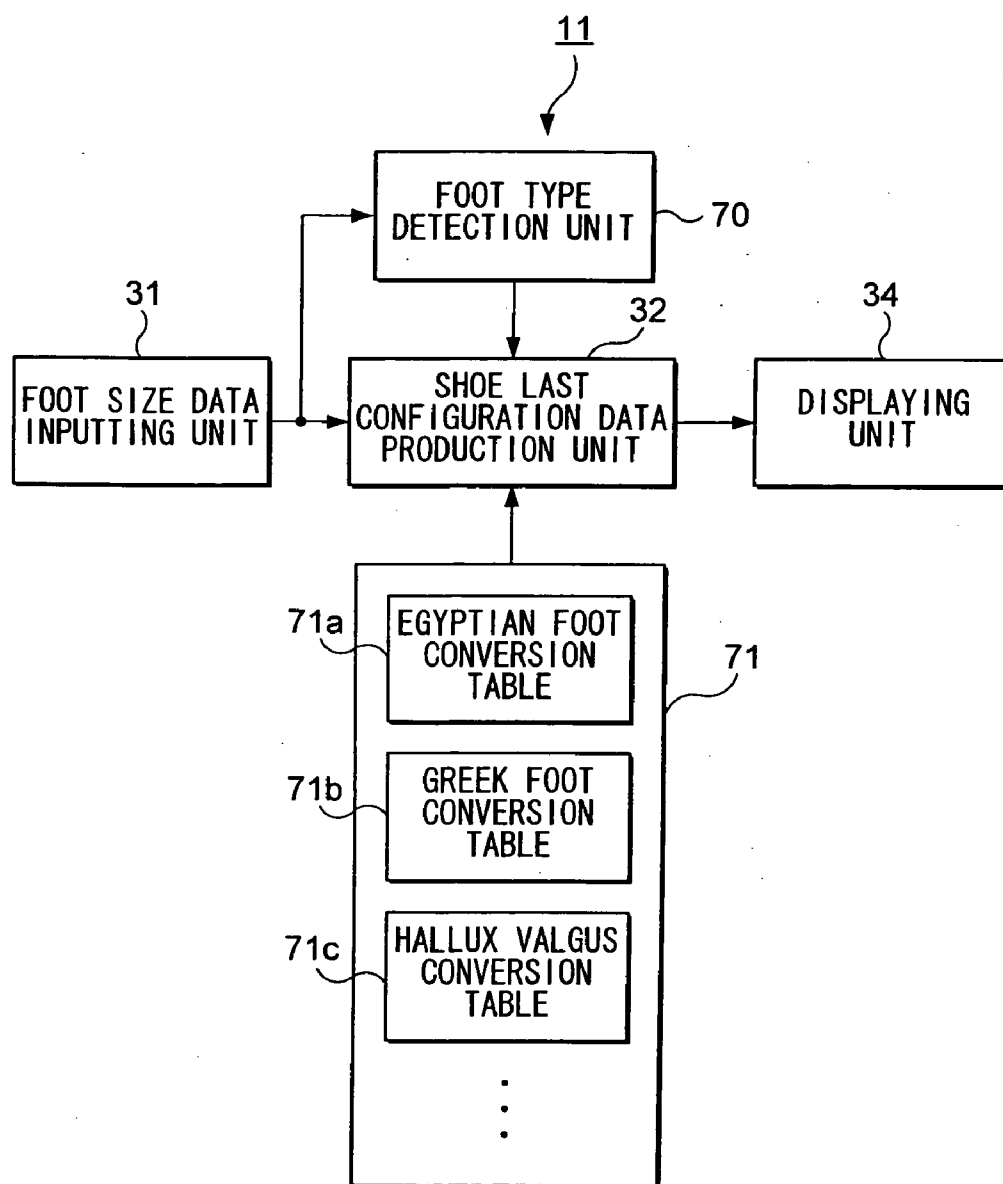


FIG. 10

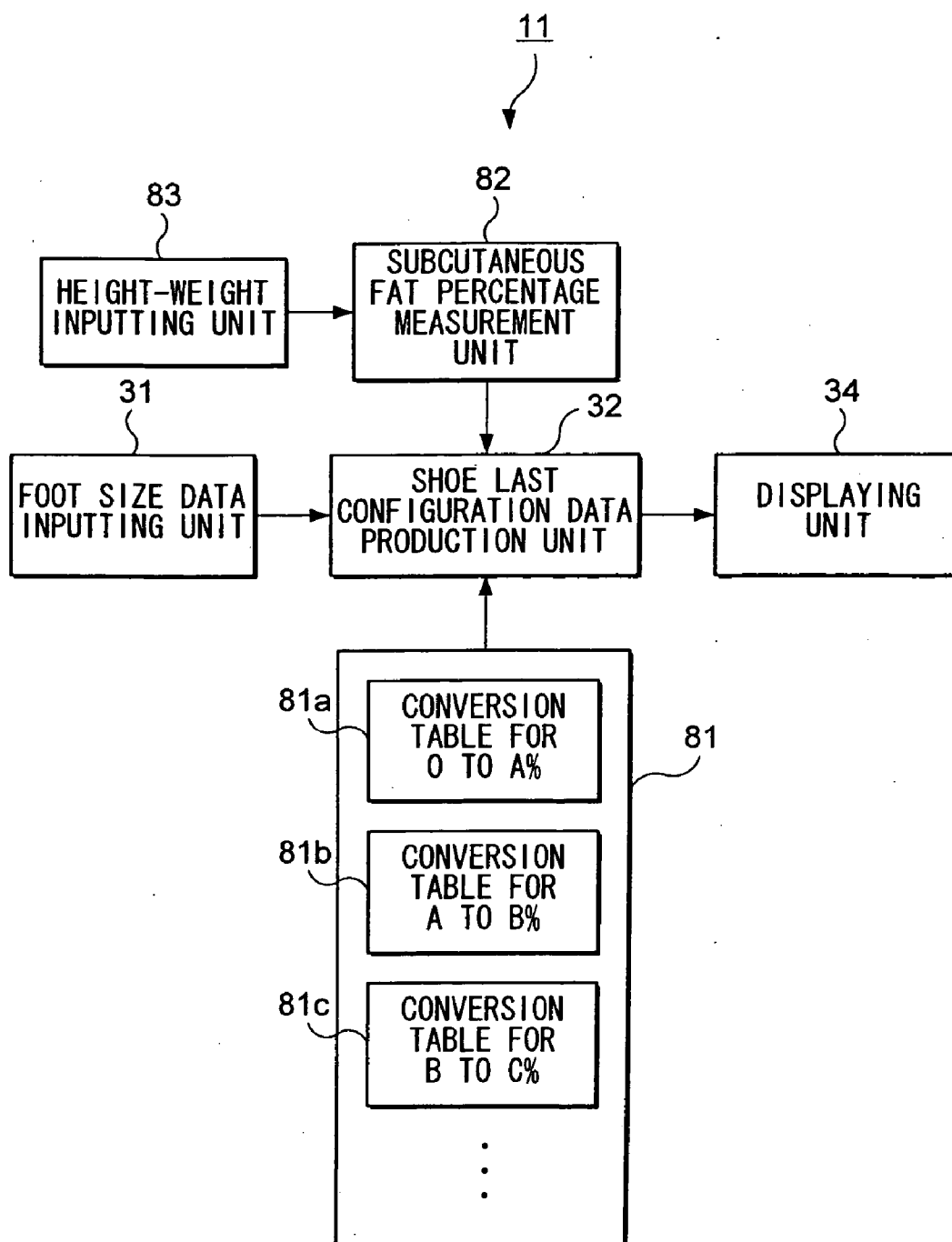


FIG. 11

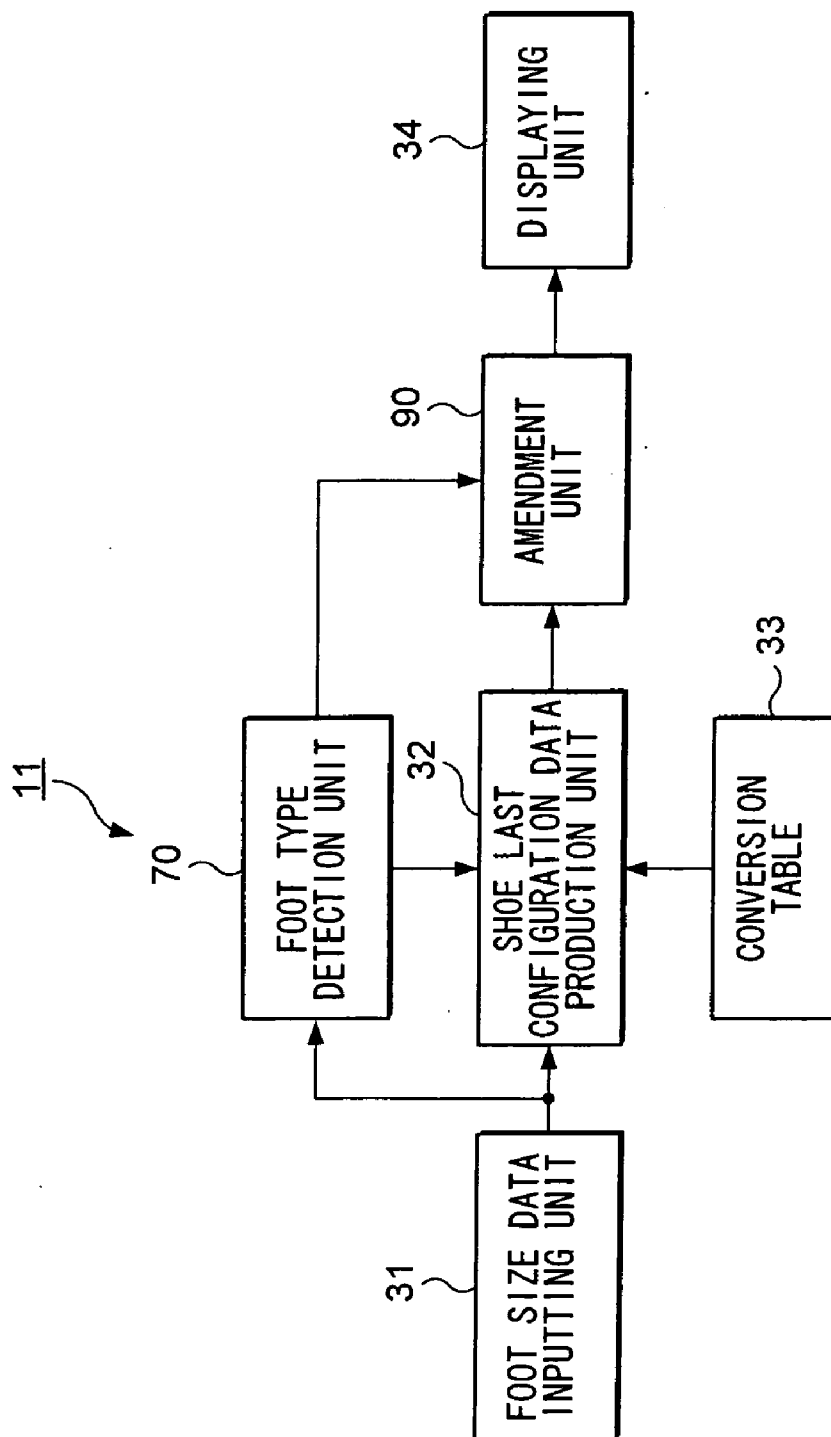


FIG. 12

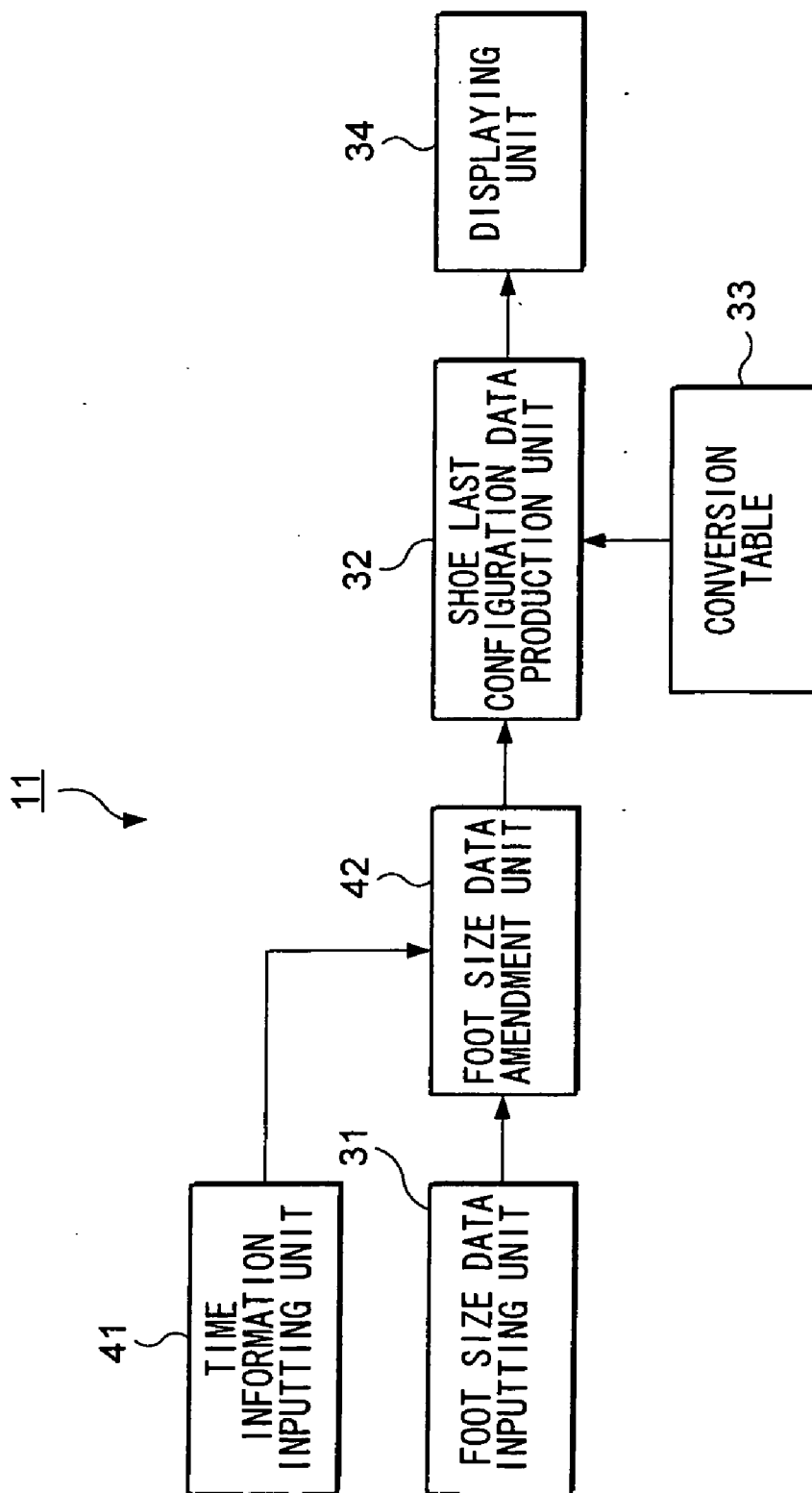
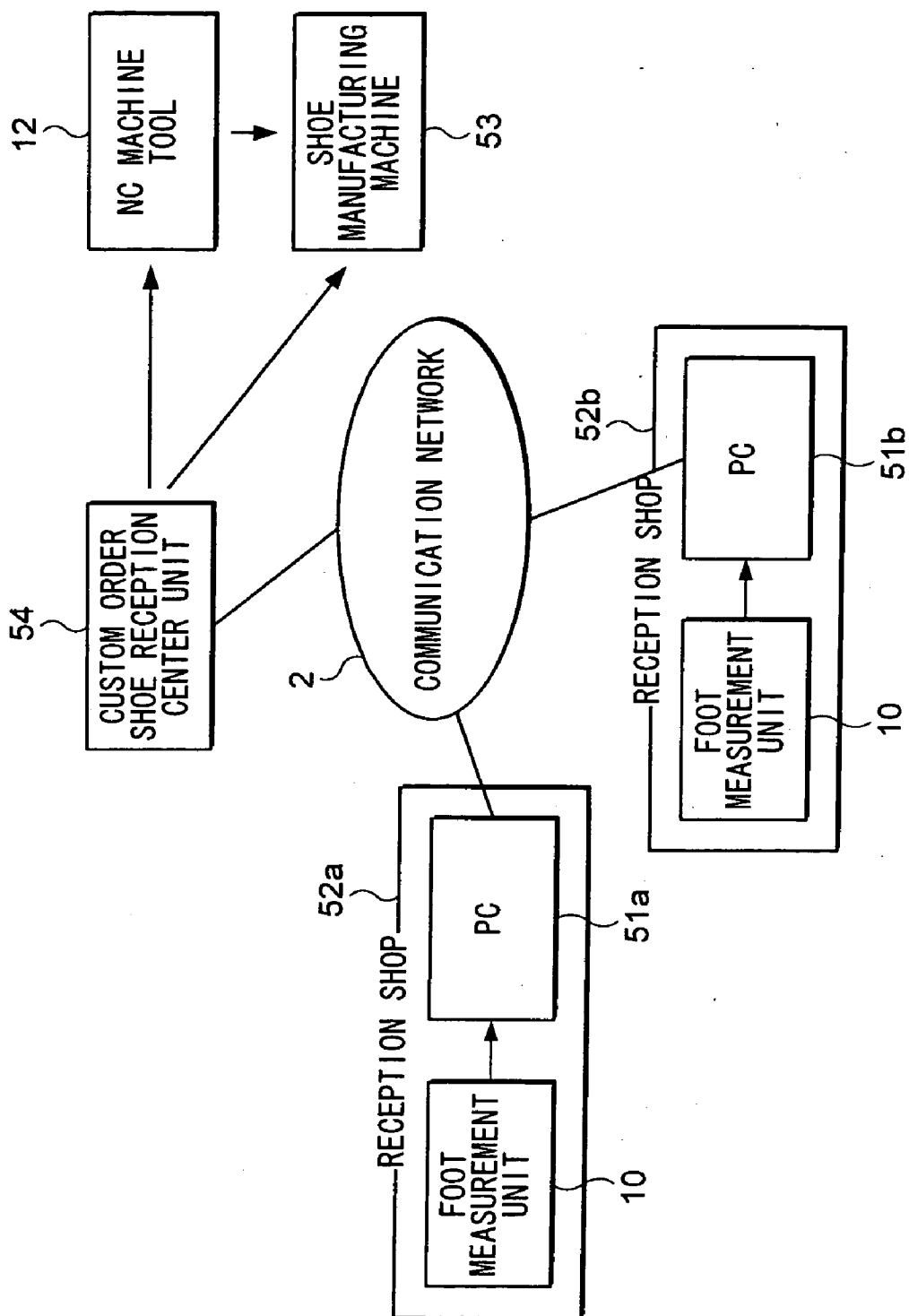


FIG. 13



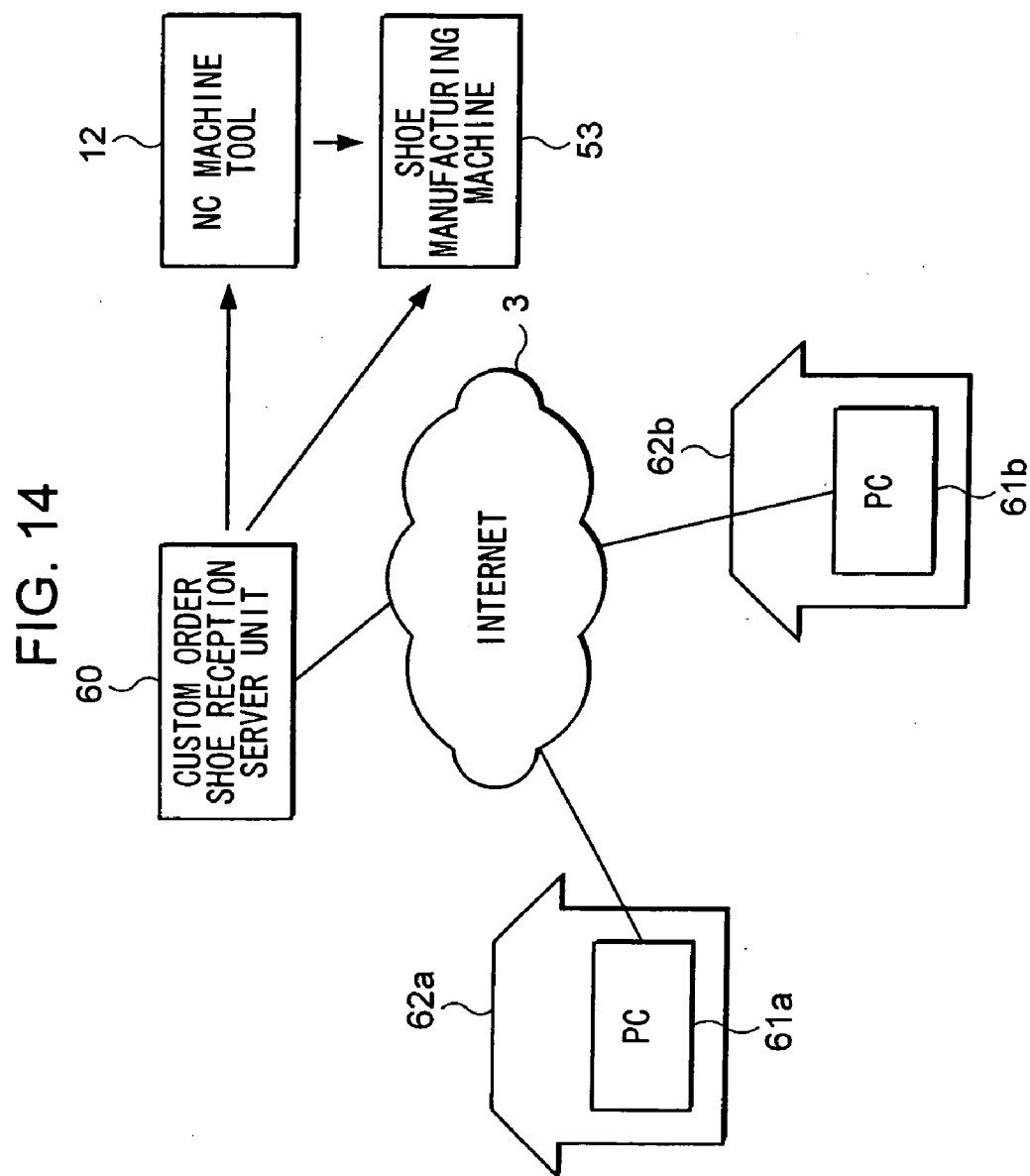


FIG. 15

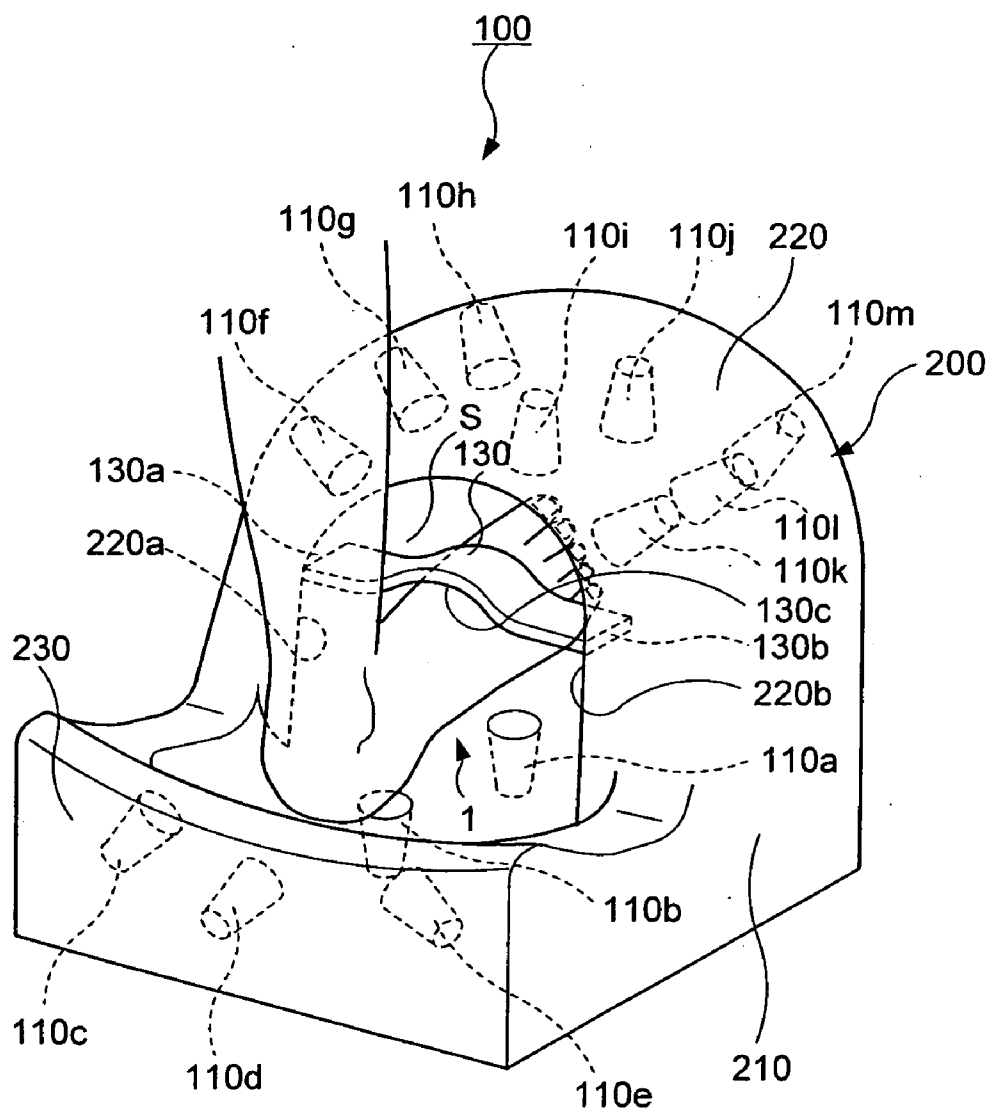


FIG. 16

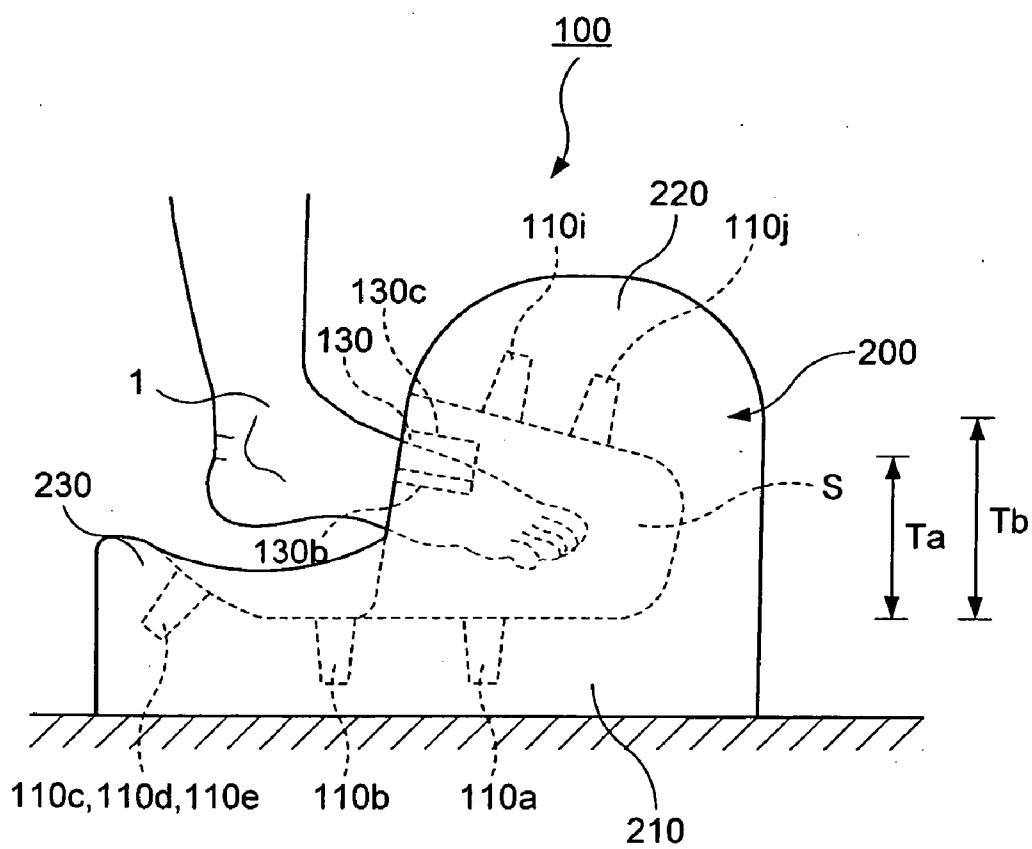


FIG. 17

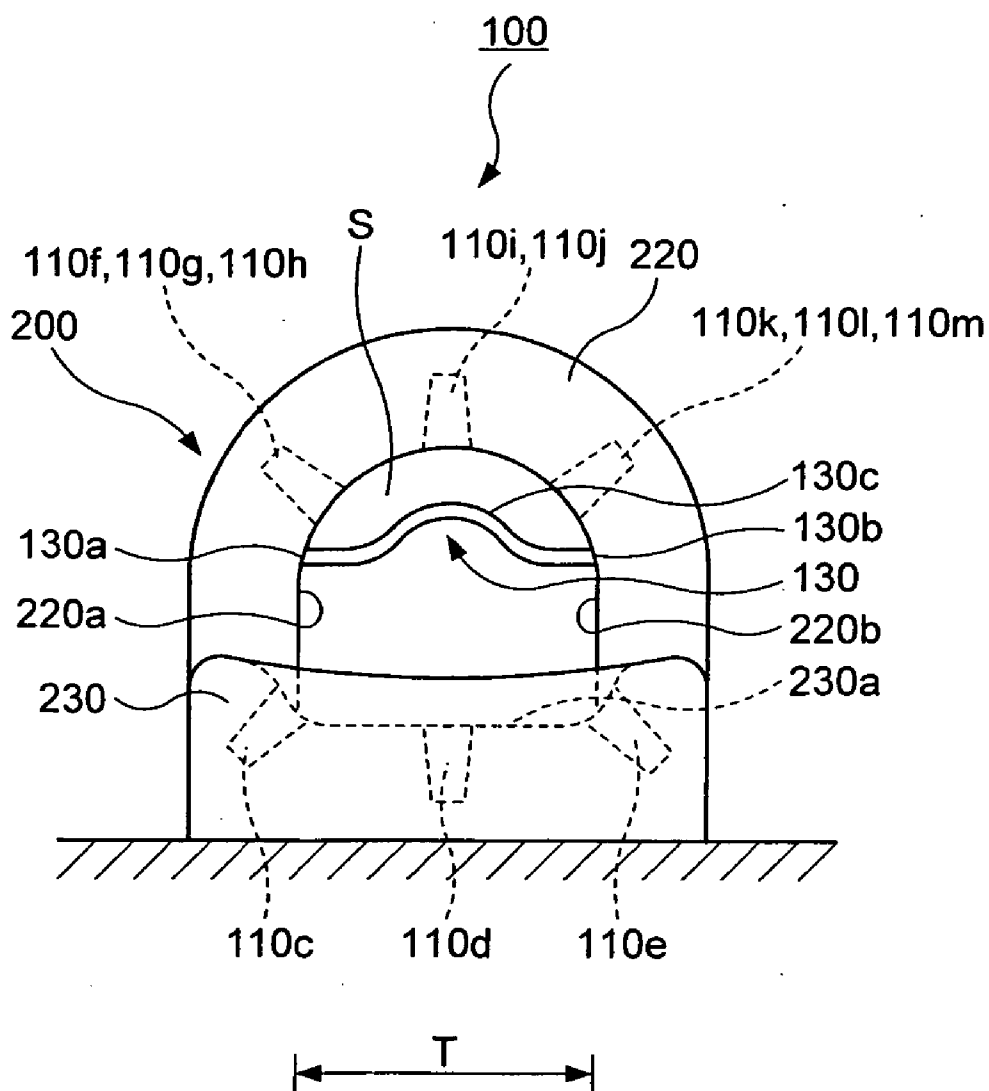


FIG. 18

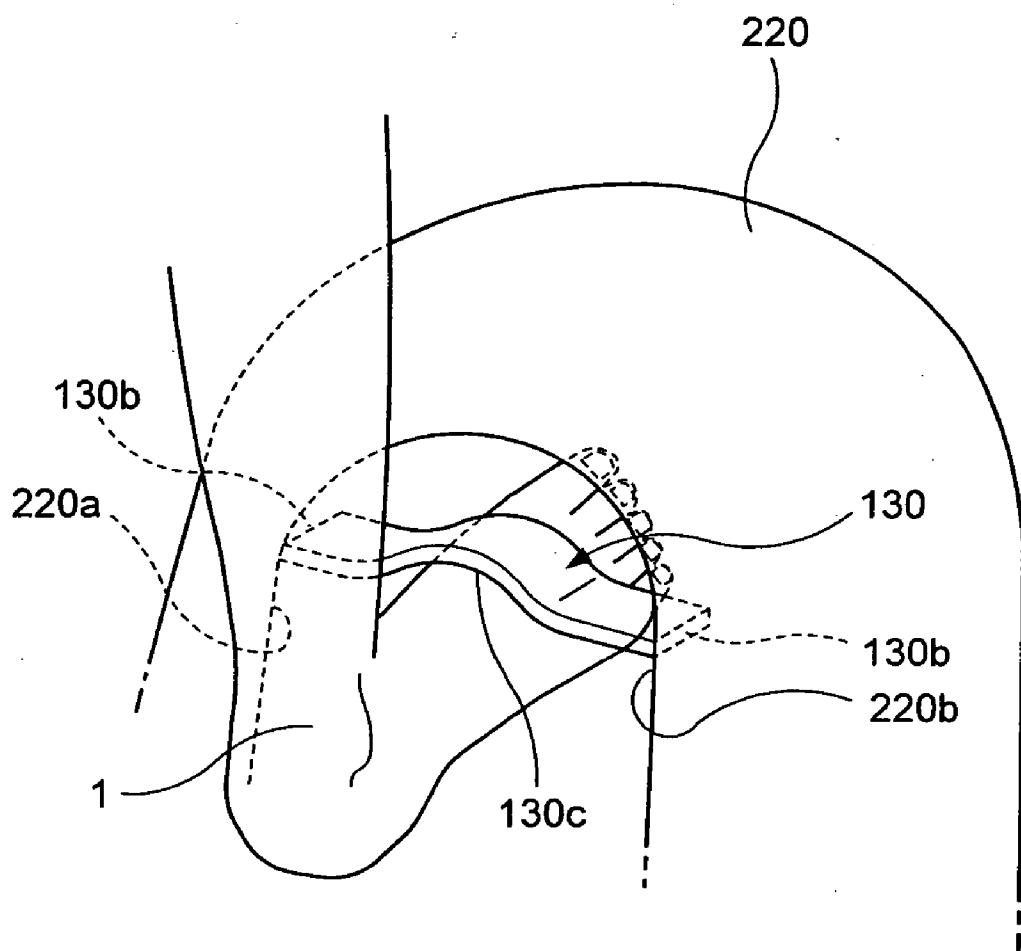


FIG. 19

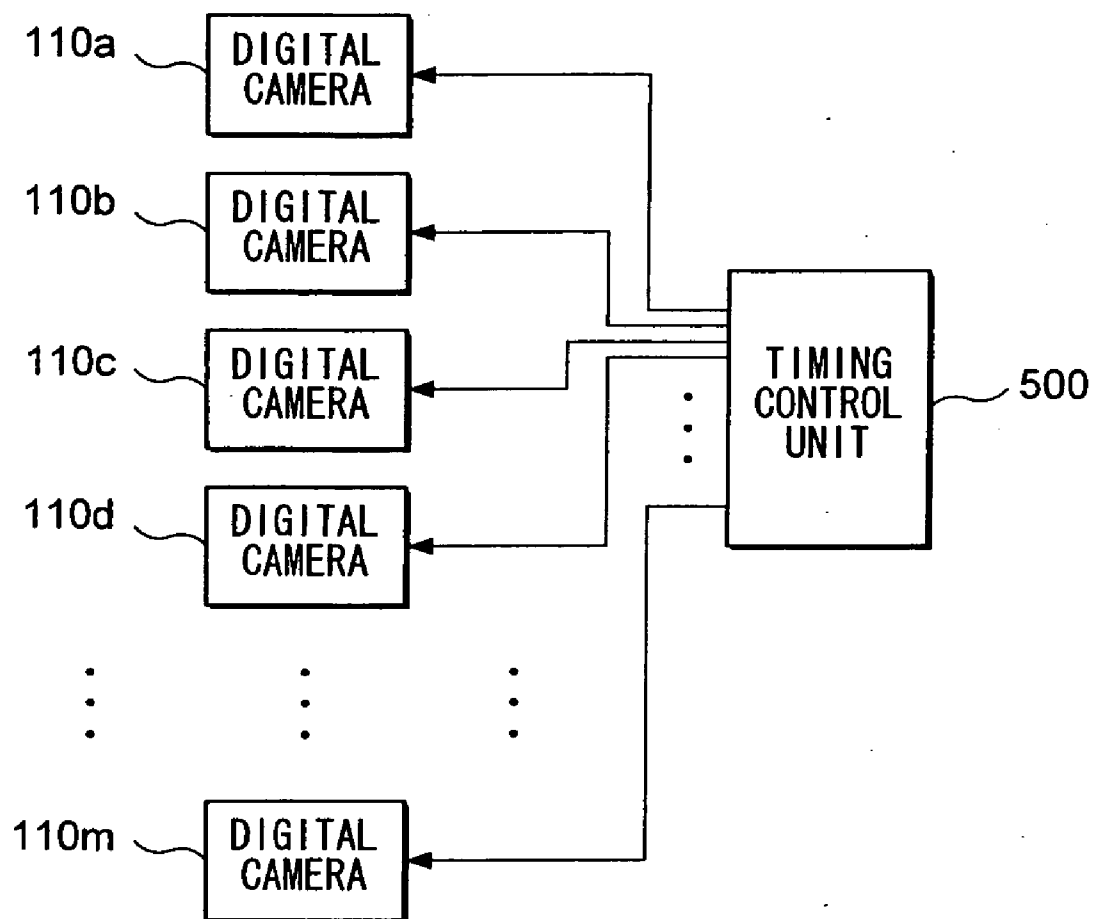


FIG. 20

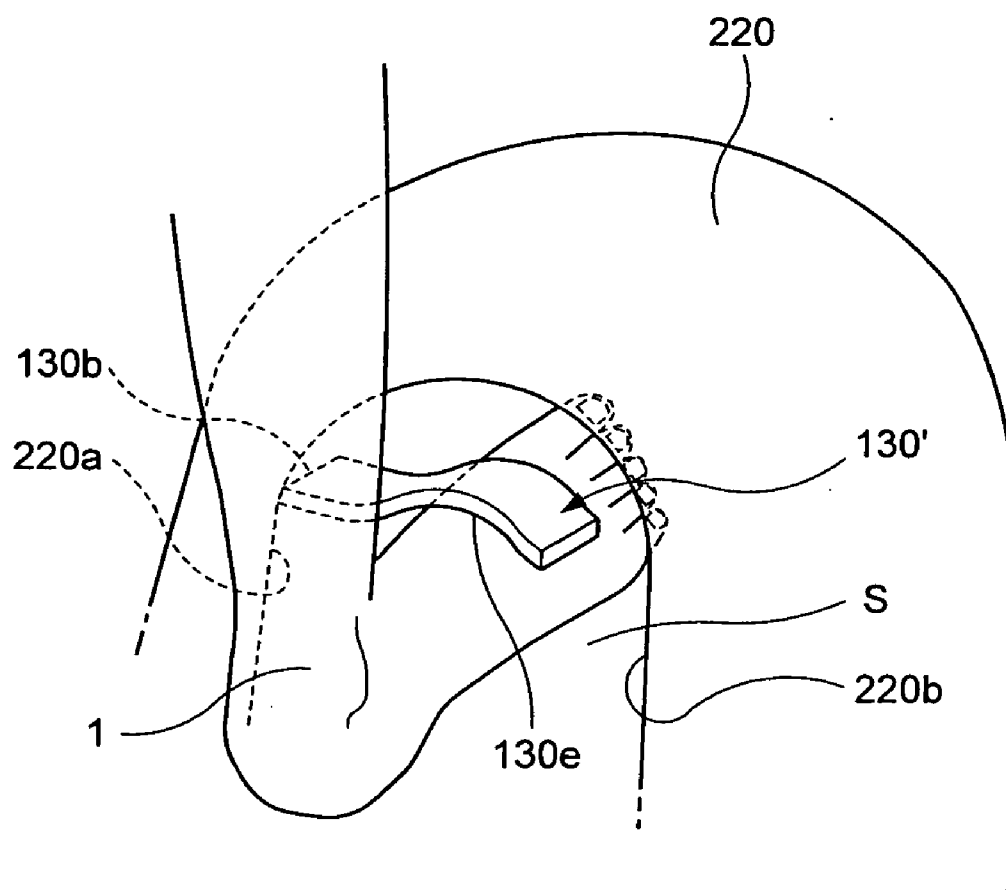


FIG. 21

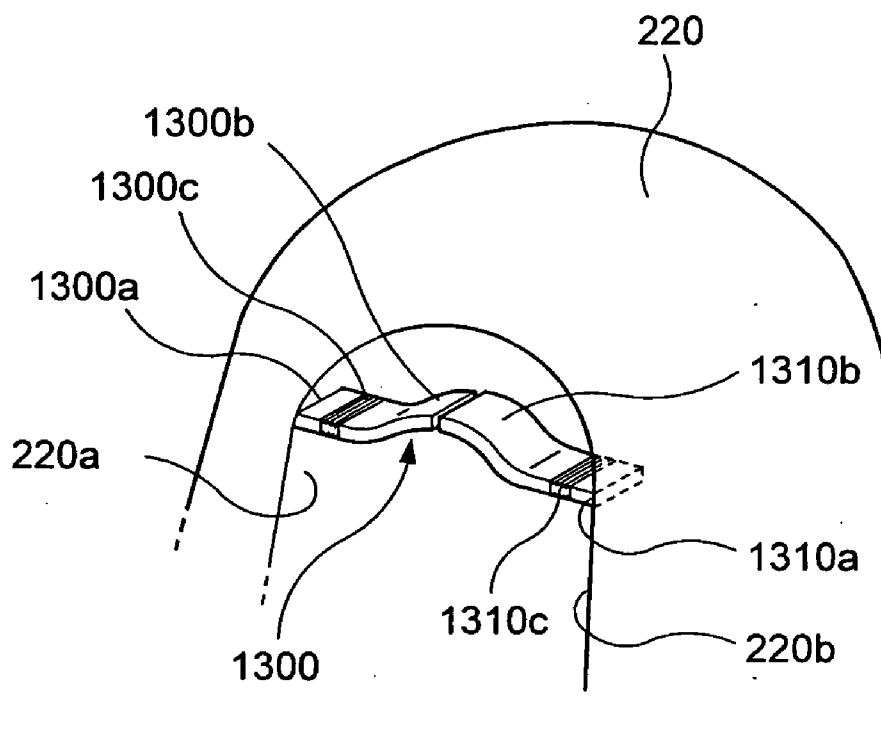
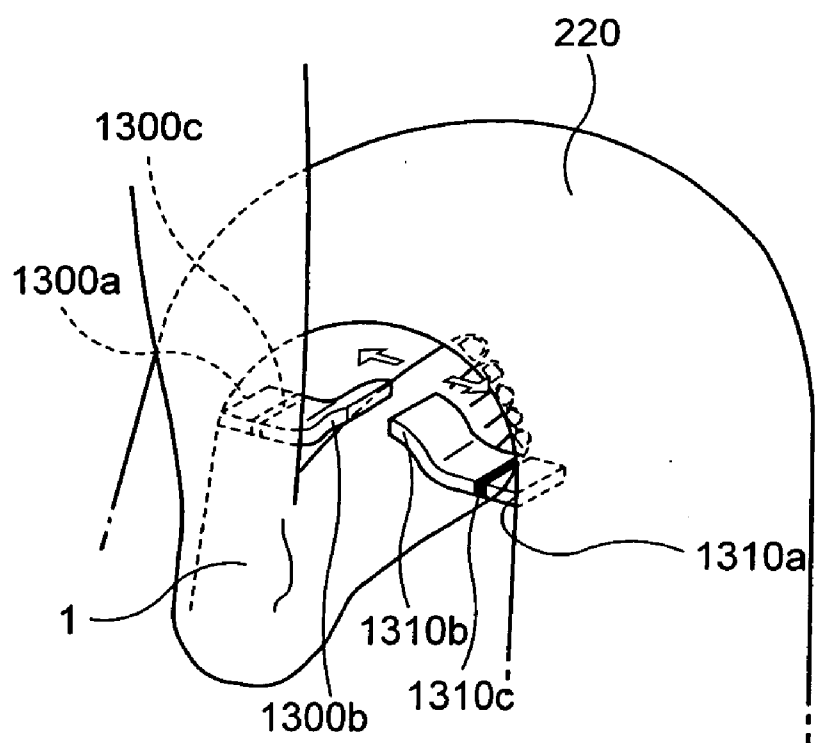


FIG. 22



**SHOE PATTERN DESIGN METHOD, SHOE
PATTERN DESIGN DEVICE, FOOT MEASURER,
AND FOOT POSITIONING DEVICE OF FOOT
MEASURER**

TECHNICAL FIELD

[0001] The present invention relates to a shoe last design method for designing a shoe last used for shoe manufacturing, a shoe last design unit, a preferable foot measurement unit for designing a shoe last, and a foot spot determination unit of a foot measuring unit.

BACKGROUND ART

[0002] A shoe last is used to make a pattern paper for producing each part of a shoe. A shoe last is also a workbench for installing an inner sole and an outsole when a shoe is assembled. A shoe last further functions as an ironing board for determining a style of a shoe by maintaining its assembled shape until the glue used in the assembly process, along with any other moisture, evaporates after the shoe is assembled. Thus, a shoe last functions in various manners when a shoe is manufactured. Further, the configuration of a shoe last determines the configuration of the completed shoe.

[0003] Shoe lasts fall into two categories: mass production shoe lasts used for mass production of shoes; and a custom order shoe last used for manufacturing a custom order shoe (where a shoe is manufactured according to the measurements of the foot of an individual user). A custom order shoe last generally is produced in accordance with the measured values of sizes (referring to sizes of several spots of the foot) of the foot (the spots below the ankle) of the user.

[0004] When a foot is measured, a troublesome process of measuring several spots of the foot of the user by using a measure is required. It is then necessary to adjust the measurements to produce a shoe last which will facilitate the manufacture of a comfortable shoe.

DISCLOSURE OF INVENTION

[0005] The present invention was developed to overcome the stated problems of the conventional art, and its objective is to facilitate production of a shoe last which does not require a toilsome operation.

[0006] To achieve the above-mentioned objective, the present invention provides a shoe last design method comprising: an inputting step for inputting size data of a foot of a user; and a shoe last configuration production step for producing, on the basis of the inputted size data of a foot, configuration data of a shoe last used for manufacturing a shoe of the user.

[0007] Also, to achieve the above-mentioned objective, the present invention provides a unit for designing a shoe last comprising: inputting means for inputting size data of a foot of a user who orders a shoe; and shoe last size configuration production means for producing configuration data of a shoe last, on the basis of the inputted size data of a foot.

[0008] Furthermore, to achieve the above-mentioned objective, the present invention provides a foot measurement unit, wherein a configuration of a foot of a user is

determined on the basis of images obtained as a result of shooting the foot of the user to be measured, comprising: foot spot determination means for placing the foot at a designated spot by placing the dorsum of the foot to be measured in contact with a foot spot determination unit of the foot measurement unit; and shooting means for shooting the foot which is placed at the designated spot by the foot spot determination means.

[0009] Also, the present invention provides a foot spot determination unit in which, during shooting, a foot is placed in a designated spot, of a foot measurement unit which measures a configuration of a foot of a user on the basis of an image obtained as a result of shooting a foot, comprising: foot spot determination means for placing the foot at a designated spot by touching the dorsum of the foot.

BRIEF DESCRIPTION OF DRAWINGS

[0010] FIG. 1 is a diagram showing an overall gross outline of a shoe last manufacturing system to which a shoe last design method of one embodiment of the present invention is applied.

[0011] FIG. 2 is a diagram showing a foot measurement unit which is a component of the above-mentioned shoe last manufacturing system.

[0012] FIG. 3 is a diagram showing a foot configuration measurement unit which is a component of the above-mentioned foot measurement unit.

[0013] FIG. 4 is an explanatory diagram explaining measurement of a foot configuration using the above-mentioned foot configuration measurement unit.

[0014] FIG. 5 is a block diagram showing a functional configuration of a personal computer system which is a component of the above-mentioned shoe last manufacturing system.

[0015] FIG. 6 is a diagram for explaining contents of a conversion table used in a shoe last configuration data production process carried out by the above-mentioned personal computer system.

[0016] FIG. 7 is a diagram for explaining contents of a conversion table used in a shoe last configuration data production process carried out by the above-mentioned personal computer system.

[0017] FIG. 8 is a diagram for explaining contents of a conversion table used in a shoe last configuration data production process carried out by the above-mentioned personal computer system.

[0018] FIG. 9 is a block diagram showing a functional configuration of a personal computer system for achieving modification of the above-mentioned shoe last design method.

[0019] FIG. 10 is a block diagram showing a functional configuration of a personal computer system for achieving another modification of the above-mentioned shoe last design method.

[0020] FIG. 11 is a block diagram showing a functional configuration of a personal computer system for achieving yet another modification of the above-mentioned shoe last design method.

[0021] FIG. 12 is a block diagram showing a functional configuration of a personal computer system for achieving yet another modification of the above-mentioned shoe last design method.

[0022] FIG. 13 is a diagram showing an overall configuration of a network system for achieving a network service using the above-mentioned shoe last design method.

[0023] FIG. 14 is a diagram showing an overall configuration of a network system for achieving a network service using the above-mentioned shoe last design method.

[0024] FIG. 15 is a perspective illustration showing an external view of a shooting unit of a foot measurement unit of the second embodiment of the present invention.

[0025] FIG. 16 is a side view showing the above-mentioned shooting unit.

[0026] FIG. 17 is a front view showing the above-mentioned shooting unit.

[0027] FIG. 18 is a perspective illustration showing a portion adjacent to a spot determination unit which is a component of the above-mentioned shooting unit.

[0028] FIG. 19 is a block diagram showing a configuration of a control unit of a modification of the above-mentioned shooting unit.

[0029] FIG. 20 is a perspective illustration showing a modification of the above-mentioned spot determination unit of the above-mentioned shooting unit.

[0030] FIG. 21 is a perspective illustration showing another modification of the above-mentioned spot determination unit of the above-mentioned shooting unit.

[0031] FIG. 22 is a perspective illustration showing another modification of the above-mentioned spot determination unit of the above-mentioned shooting unit.

BEST MODE FOR CARRYING OUT AN INVENTION

[0032] Hereinafter, preferred embodiments of the present invention will be explained in detail by referring to attached figures. In each of the following embodiments, the portion below the ankle will be referred to as a foot.

[0033] A. First Embodiment

[0034] First, as shown in FIG. 1, the shoe last manufacturing system of the present embodiment comprises foot measurement unit 10, personal computer system (shoe last design unit) 11, and NC (Numerically Controlled) machine tool 12.

[0035] Foot measurement unit 10 is a unit for producing size data showing a foot size of a user by measuring the configuration of a foot of the user. Foot measurement unit 10 uses a non-contacting type three dimensional configuration measurement unit in the present embodiment as shown in FIG. 2. As shown in FIG. 2, foot measurement unit 10 comprises tightening unit 22, foot configuration measurement unit 24, and displaying unit 26. Tightening unit 22 prevents movement of the user's foot during measurement, and comprises, as shown in the figure, rolling unit 22a to be rolled around a calf of the user, and supporting unit 22b for supporting and fixing rolling unit 22a. As shown in the

figure, rolling unit 22a is rolled around the calf of the user to prevent movement of the foot.

[0036] Foot configuration measurement unit 24, as shown in FIG. 3, comprises bottom unit 24a, and two side units 24b. Foot configuration measurement unit 24, when a calf of the user is held by tightening unit 22 (refer to FIG. 2), is placed such that foot 1 is above bottom unit 24a, and between two side units 24b, and such that foot 1 is not in contact with foot configuration measurement unit 24. On each of bottom unit 24a of foot configuration measurement unit 24, and two side units 24b, is installed a laser pointer 25 which emits a laser slit beam. Each laser pointer 25, as shown in FIG. 4, is positioned so as to emit a laser slit beam from three directions (from both sides above the top of foot 1, and below the bottom of foot 1). When each laser pointer 25 emits a laser slit beam at foot 1, one slit image 25a is projected onto foot 1 as a result of each slit beam overlapping. Slit image 25a is recorded by a video camera (not shown), and the external configuration (outline) of foot 1 of the spot where the above-mentioned slit image 25a is projected is measured by the beam cutting measuring method on the basis of the recorded image. Also, three laser pointers 25 are installed so as to be movable along the length of foot 1 (between the toes and the heel). The overall configuration of foot 1 is measured when each laser pointer 25 moves from the toes of foot 1 toward, the heel, and by sequentially emitting a laser slit beam toward foot 1. In the present embodiment, foot configuration measurement unit 24 which can measure sizes of approximately 60,000 spots of a foot is used. Displaying unit 26 comprises CRT (Cathode Ray Tube), LCD (Liquid Crystal Display) and so forth, and displays a three dimensional configuration showing the entire foot 1, the configuration being determined by each measurement made by foot configuration measurement unit 24, settings of the above-mentioned foot measurement unit 10, and so forth.

[0037] When calf of the user whose foot is measured is fixed by tightening unit 22, and foot 1 is placed between side units 24b of foot configuration measurement unit 24 in foot measurement unit 10, laser pointer 25 moves along the length of foot 1, and emits a laser slit beam at foot 1. Then, when a video camera shoots foot 1, 60,000 spots of foot 1 are measured as described above, and size data showing the result of the above-mentioned measurement can be produced. Foot measurement unit 10 of the above-mentioned configuration is only one example, and any type of a foot measurement unit can be used as long as a three dimensional configuration of foot 1 can be measured in a non-contacting manner. Foot measurement unit 10 uses a non-contacting method to prevent changes in the measured configuration of foot 1 when the measurement head and so forth of foot measurement unit 10 touch foot 1.

[0038] Referring to FIG. 1 again, in the shoe last manufacturing system, measurement data produced by foot measurement unit 10 of the above-mentioned configuration is inputted into personal computer system 11. At this stage, with regard to the method for inputting measurement data into personal computer system 11, measurement data can be forwarded to personal computer system 11 from foot measurement unit 10 by connecting foot measurement unit 10 and personal computer system 11 by a signal cable or the like. Measurement data can be inputted into personal computer system 11 by storing measurement data produced in

foot measurement unit **10** in a medium such as floppy disc, MO (Magnet-optical Disc), CD-R (Compact Disc-Recordable), and causing the reading unit (such as a floppy disc drive or CD-ROM drive) installed in personal computer system **11** to read out measurement data stored in the above-mentioned medium.

[0039] Personal computer system **11**, as a general personal computer system, comprises CPU (Central Processing Unit), ROM (Read Only Memory), RAM (Random Access Memory), a hard disc unit, operation units such as a keyboard or a mouse, and a displaying unit such as CRT or LCD. Also, in the above-mentioned hard disc, is installed CAD (Computer Aided Design) conversion software for carrying out an operation for producing measurement data showing the configuration of the shoe last for producing a shoe which will comfortably fit a foot on the basis of measurement data of the foot produced in foot measurement unit **10**. Hereinafter, a functional configuration of personal computer system **11** in which a configuration data production operation of a shoe last is achieved when the personal computer system executes the above-mentioned CAD conversion software is explained by referring to **FIG. 5**.

[0040] As shown in **FIG. 5**, personal computer system **11** comprises foot size data inputting unit **31**, shoe last configuration data production unit **32**, conversion table **33**, and displaying unit **34**. Foot size data inputting unit **31**, as mentioned above, obtains measurement data of a foot produced by foot measurement unit **10**, inputs measurement data of a foot, and provides measurement data of a foot to shoe last configuration data production unit **32**. As mentioned above, when size data of foot **1** is stored in a medium such as a floppy disc, foot size data inputting unit **31** is a reading unit such as a floppy disc drive unit.

[0041] Shoe last configuration data production unit **32**, on the basis of a foot size provided from foot size data inputting unit **31**, produces CAD data by which the measured foot is expressed in a stereoscopic configuration. Shoe last configuration data production unit **32**, on the basis of sizes of several spots of the foot expressed by produced CAD data, produces, by referring to conversion table **33**, configuration data showing the configuration of the shoe last used for the custom order shoe fitting for the above-mentioned foot **1**.

[0042] Conversion table **33** shows stored conversion data for converting sizes of several spots of a foot shown in CAD data produced on the basis of measurement data of foot **1** provided by foot size data inputting unit **31**, into the configuration of a shoe last corresponding to the above-mentioned spots. Shoe last configuration data production unit **32**, by referring to data for conversion stored in conversion table **33**, converts the inputted size data of foot **1** into configuration data of a shoe last.

[0043] Data for conversion stored in conversion table **33** is data produced on the basis of an outcome of an experiment in which the relationship between the size of foot **1** and the configuration of the shoe last for producing the shoe fitting in foot **1** is detected by using several samples. Specifically, the configuration of the user's foot is measured by the above-mentioned foot measurement unit **10**. Also, shoe last gypsum is produced by pouring gypsum into a shoe which is comfortable to the user, and the configuration of the shoe last gypsum is measured by the above-mentioned foot measurement unit **10**. Then, by overlapping the foot con-

figuration of the user and the configuration of the shoe last gypsum, "tightness and slack", in other words, the portions where the foot is tightened by the shoe, and the portions where space is created between the shoe and the foot, are determined. Data regarding several samples is obtained in this manner, and conversion table **33** is produced on the basis of the above data. Hereinafter, contents of data for conversion stored in conversion table **33** will be explained by referring to **FIGS. 6, 7** and **8**.

[0044] In measurement data showing sizes of several spots of foot **1** produced by foot measurement unit **10**, is contained information showing several sizes of the measured foot **11** but in the present embodiment, as shown in **FIG. 6** and **FIG. 7**, the foot configuration of each of a plurality of cross sectional surfaces D1 to Dn from the ankle toward the toes of foot **1** is taken in account. In conversion table **33**, is stored data for converting sizes of several parts of foot **1** in cross sectional surfaces D1 to Dn into the configuration of a shoe last.

[0045] At this stage, cross sectional surfaces D1 to Dn are produced by segmenting from the ankle to toes for each equal space d. For example, when the length between the ankle and toes of foot **1** is 240 mm, and number n of the cross sectional surface is 50 (a fixed number), the distance d between each surface is $240/50=4.8$ mm. Although the number n of surfaces can be fixed in this manner, surfaces can be segmented from the ankle by determining the distance between each surface to be a constant distance (for example, 5 mm).

[0046] By referring to **FIG. 8**, data contents for conversion with regard to surface Dm, which is one of surfaces D1 to Dn, are explained. In the figure, the solid line shows the configuration of the measured foot **1** with regard to surface Dm. The chain line shows a shoe last having an ideal configuration for the configuration of foot **1**. Conversion data stored in conversion table **33** is stored for each of a plurality of measured sizes S1 to Sk along the length of the foot as a result of segmenting by equal space the space in the surface configuration of the foot between bottom line L1 and function line Lk of the foot set for each surface (denoted by code b in the figure). As shown in the figure, the configuration of the shoe last, when the size of the foot measured along its length of a certain foot is Sy, is a size determined by adding to Sy slack portion Sa on the right of the figure and slack portion Sb on the left of the figure. In this case, in conversion table **33**, is stored ratio data of Sa to Sy. For example, data such as $Sa=Sy*0.05$ (* denotes multiplication) is stored, and when foot size Sy is determined, size Sa of the slack portion can be calculated. In the same manner, with regard to slack portion Sb on the left, ratio data such as $Sb=Sy*0.03$ is stored, and the length of size Sb of the slack portion can be calculated by foot size Sy. Such ratio data is stored for each size on the horizontal line between S1 and Sk, and a plurality of configurations of the shoe last toward the horizontal direction can be calculated on the basis of size data of the foot. In conversion table **33**, is stored ratio data for calculating the configuration of the shoe last for each of the surfaces D1 to Dn.

[0047] Also, in conversion table **33**, is stored a specific function for determining the configuration of the shoe last which is above function line Lk (denoted by code a in the figure). With regard to the size above the function line Lk,

the height y from function line L_k is inputted into the above-mentioned specific function $f(y)$ and $g(y)$. Then, the calculation result of the function is the coordinate of the horizontal direction (the direction of x). The configuration of the shoe last in the surface is calculated from the horizontal direction on surface D_m . At this stage, the specific function required can be linear function (in other words, the straight line), quadratic function, cubic function or a function of higher degree than quartic function. In other words, any function by which a configuration, close to the configuration of the ideal shoe last calculated by an experiment is calculated can be adopted. The reference position of the coordinate calculated by function $f(y)$ becomes the coordinate of the x direction of point FP calculated by the above-mentioned ratio data. In other words, when $y=0$, $f(0)=(\text{the coordinate of the } x \text{ direction of } FP)$. When the coordinate value of the x direction of FP on the surface is x_f , the x coordinate of the configuration line of the shoe last at height Y_1 is $f(y_1)+x_f$. In the same manner, the reference position of the coordinate calculated by function $g(y)$ is the coordinate of the x direction of point GP calculated by the above-mentioned ratio data. In conversion table 33, are stored information showing the height of function line L_k , and the function for calculating the configuration of the shoe last above function line L_k for each surface D_1 to D_n .

[0048] In conversion table 33, instead of storing the above-mentioned ratio data, area ratio data showing the ratio between the cross sectional area of each of the surfaces D_1 to D_n , and the ideal cross sectional area of a shoe last calculated experimentally can be stored. Then, by calculating the cross sectional area of the shoe last fitting on the basis of area ratio data stored for each of the cross sectional areas of each of surfaces D_1 to D_n , which in turn are calculated on the basis of size data of the foot, the measured size of each part of the foot can be converted into the configuration of the calculated cross sectional area of the shoe last. Also, the configuration of the ideal shoe last can be calculated on the basis of a plurality of parameters, besides the above-mentioned cross sectional area, such as the peripheral length of foot 1 (the length of the border line of the surface), the foot length between the toes and the ankle, the width (the horizontal length in FIG. 8), and the height (the vertical length in FIG. 8) which are expressed by each of surfaces D_1 to D_n . For example, the surface configuration of the ideal shoe last is determined on the basis of the above-mentioned surface area, peripheral length and height expressed by a certain surface D_m . Then, for each of surfaces D_1 to D_n , after determining the surface configuration of the ideal shoe last, the ideal shoe last configuration is determined on the basis of each of the surface configurations denoted by each of surfaces D_1 to D_n of foot 1 by connecting each surface configuration. In other words, in conversion table 33, is required data for converting data of the foot size into the configuration of the ideal shoe last which is experimentally calculated.

[0049] Shoe last configuration data production unit 32, on the basis of size data of a foot provided by foot size data inputting unit 31, obtains configuration data of a shoe last on the basis of the size data of the foot for each of surfaces D_1 to D_n , and produces configuration data of the entire shoe last matching the inputted size data of the foot.

[0050] In displaying unit 34, as mentioned above, are displayed a stereoscopic image of a shoe last on the basis of

CAD data for stereoscopically showing the shoe last corresponding to configuration data of the shoe last which is produced by shoe last configuration data production unit 32, and a stereoscopic image of a foot on the basis of CAD data for stereoscopically showing the foot corresponding to size data of the foot provided by the above-mentioned foot size data inputting unit 31. At this stage, a designer operating personal computer system 11, when he/she determines that the configuration of the shoe last automatically produced by shoe last configuration data production unit 32 needs to be corrected by using a mouse or a keyboard, can input a correction command by referring to displaying unit 34. For example, when information such as the design of the shoe to be manufactured, the height of the heel, the type of the foot (such as Egyptian foot, Greek foot, hallux valgus, or pes latus), or fleshiness of the user's foot (for example, the percentage of subcutaneous fat) is available, the designer can input a correction command accordingly.

[0051] Also, in personal computer system 11, is installed CAD/NC conversion software for converting CAD data stereoscopically showing an image of a shoe last and so forth into NC data for numerically controlling NC machine tool 12. Personal computer system 11, by executing the CAD/NC conversion software, converts CAD data stereoscopically showing the shoe last in accordance with configuration data of the shoe last produced in the above-mentioned manner into NC data for processing by NC machine tool 12 the shoe last of the configuration denoted by the configuration data.

[0052] Referring to FIG. 1 again, in the present shoe last manufacturing system, NC data corresponding to configuration data of the shoe last produced by personal computer system 11 is inputted into NC machine tool 12. At this stage, as a method for inputting NC data into NC machine tool 12, NC data can be forwarded to NC machine tool 12 from personal computer system 11 by connecting personal computer system 11 and NC machine tool 12 by a signal cable and so forth. NC data also can be inputted into NC machine tool 12 by storing NC data produced by personal computer system 11 in a medium such as floppy disc, MO, or CD-R, and reading out NC data stored in the medium by a reading unit or the like installed in NC machine tool 12.

[0053] NC machine tool 12 cuts shoe last material such as woods, metal, or plastic, and produces a shoe last on the basis of NC data produced by personal computer system 11. At this stage, NC data provided to NC machine tool 12 is data for controlling NC machine tool 12 to carry out the cutting operation in accordance with the configuration of the shoe last which matches the user's foot as calculated by the above-mentioned personal computer system 11. Hence, the shoe last produced by NC machine tool 12 is preferable shoe last for producing a shoe which is comfortable for the user.

[0054] In the shoe last designing method of the present embodiment, personal computer system 11 automatically determines the configuration of the shoe last for producing a shoe which is comfortable for the user by providing size data of the user's foot to personal computer system 11, and NC data is produced for producing a shoe last of the above-mentioned configuration. In the present embodiment, configuration data of the shoe last is produced on the basis of the foot size, by referring to conversion table 33 produced on the basis of the relationship between foot sizes determined by an experiment using several samples and the

configuration of the shoe last which seems most suitable. Therefore, by providing the NC data to NC machine tool 12, a preferable shoe last for manufacturing a shoe which is comfortable for the user can be produced.

[0055] Conventionally, the user's foot measurements cannot be used without modification to produce a custom order shoe last for the manufacture of a comfortable shoe. Processes such as determining the configuration by relying upon experience, intuition and so forth in accordance with the measured foot size, and producing the shoe last in accordance with the determined configuration are required for a shoe last producer. Further, when a skilled producer produces a shoe last, a shoe last of an appropriate configuration can be produced for manufacturing a shoe on the basis of the measured foot size of the user, but a shoe producer without much experience might not be able to produce a shoe last of an appropriate configuration. Also, there are relatively few skilled producers of shoe lasts. Consequently, it is relatively expensive to produce a shoe last for manufacturing a custom order shoe.

[0056] On the other hand, in the present embodiment, the configuration of the preferable shoe last which is normally determined by a skilled producer by relying upon his/her experience or intuition can automatically be determined by using personal computer system 11; therefore, the above-mentioned processes are not required for a shoe last producer. Furthermore, the cost of producing a shoe last can be decreased; hence, the production cost for a custom order shoe can be decreased.

[0057] B. Modification of the First Embodiment

[0058] The present invention is not limited by the above-mentioned first embodiment, but various kinds of modifications such as those explained below are possible.

[0059] (Modification 1)

[0060] In the above-mentioned embodiment, the configuration of the shoe last is adjusted by a manual inputting operation in accordance with information such as the design of the shoe, the height of the heel, the type of the foot (such as Egyptian foot, Greek foot, hallux valgus, or pes latus), or fleshiness of the user's foot (for example, the percentage of subcutaneous fat), but the configuration of the shoe last taking the above-mentioned information into account can automatically be determined.

[0061] A preferred configuration of personal computer system 11 will be explained by referring to FIG. 9. As shown in the figure, personal computer system 11 of the present modification comprises foot size data inputting unit 31, shoe last configuration data production unit 32, and displaying unit, which are the same as those of the above-mentioned embodiment. Personal computer system 11 of the present modification also comprises conversion table group 71 instead of conversion table 33 of the above-mentioned embodiment, and foot type detection unit 70.

[0062] Foot type detection unit 70 detects the type of the foot on the basis of foot size data provided by foot size data inputting unit 31. At this stage, the type of the foot can be Egyptian foot, Greek foot, hallux valgus, pes latus, and so forth. The above-mentioned types are classified on the basis of the external configuration of the foot. Hence, CAD data stereoscopically showing the external configuration of the

foot is produced as mentioned above on the basis of size data of the foot provided by foot size data inputting unit 31. Then, by comparing the foot configuration expressed by the CAD data and the pre-stored external configurations of each type of foot, the foot type which most resembles the foot configuration on the basis of size data is detected as the foot type of the user. Foot type detection unit 70, outputs to shoe last configuration data production unit 32 foot type information showing the foot type of the user detected in this manner.

[0063] Conversion table group 71 has conversion tables for each foot type (Egyptian foot conversion table 71a, Greek foot conversion table 71b, hallux valgus conversion table 71c, and so forth) which can be detected by the above-mentioned foot type detection unit 70. Conversion table group 71 contains Egyptian foot conversion table 71a, Greek foot conversion table 71b, hallux valgus conversion table 71c, and so forth, conversion data being produced on the basis of the relationship between sizes of feet of each type, and the configuration of the ideal shoe last calculated by an experiment using several samples. In each conversion table are stored ratio data for conversion for each of surfaces D1 to Dn, function data and so forth as conversion table 33 of the above-mentioned embodiment.

[0064] When shoe last configuration data production unit 32 produces a configuration data of a shoe last on the basis of size data of a foot provided by foot size data inputting unit 31, it chooses one conversion table from several conversion tables in conversion table group 71 in accordance with foot type information provided by foot type detection unit 70, and produces configuration data of a shoe last by referring to the chosen conversion table. For example, when foot type information showing that the foot type of the user is Egyptian foot is provided by foot type detection unit 70, shoe last configuration data production unit 32 chooses Egyptian foot conversion table 71a from conversion table group 71, and produces shoe last configuration data by referring to Egyptian foot conversion table 71a.

[0065] By installing conversion table group 71 and foot type detection unit 70, the configuration of the preferable shoe last taking the type of the user's foot into account can be automatically determined.

[0066] (Modification 2)

[0067] Also, shown in FIG. 10 is the functional configuration of personal computer system 11 for executing the shoe last configuration data production process by which configuration data of shoe last, taking fleshiness of the user's foot (for example, the percentage of subcutaneous fat) into account, can be automatically produced. As shown in the figure, personal computer system 11 of the present modification comprises foot size data inputting unit 31, shoe last configuration data production unit 32, and displaying unit which are the same as those in the above-mentioned embodiment. Personal computer system 11 of the present modification also comprises conversion table group 81 instead of conversion table 33 of the above-mentioned embodiment, height-weight inputting unit 83, and subcutaneous fat percentage measurement unit 82.

[0068] Height-weight inputting unit 83 receives data showing the height and the weight of the user, and provides the data to subcutaneous fat percentage measurement unit 82. In the present modification, size measurement of the foot

by the above-mentioned foot measurement unit **10** is carried out. Then, information showing the height and the weight of the user is obtained and provided to personal computer system **11**.

[0069] Subcutaneous fat measurement unit **82**, on the basis of information on the height and the weight of the user provided by height-weight inputting unit **83**, infers a subcutaneous fat percentage of the user's foot, and outputs subcutaneous fat percentage information showing the subcutaneous percentage to shoe last configuration data production unit **32**.

[0070] Conversion table group **81** has a conversion table for each range of the subcutaneous fat percentage (0 to A %, A % to B %, B % to C % and so forth). Conversion table **81a** for 0 to A %, conversion table **81b** for A to B %, conversion table **81c** for B to C % and so forth have conversion data produced on the basis of the relationship between the foot size of the user, of the subcutaneous fat percentage within each corresponding range, and the configuration of the ideal shoe last calculated by an experiment. In each of the conversion tables are stored ratio data for conversion for each of surfaces D1 to Dn, function data and so forth, as in the above-mentioned conversion table **33**.

[0071] When shoe last configuration data production unit **32** produces configuration data of a shoe last on the basis of size data of a foot provided from foot size data inputting unit **31**, it chooses one conversion table from among several conversion tables in conversion table group **81** in accordance with subcutaneous fat percentage information provided from subcutaneous fat percentage measurement unit **82**, and produces configuration data of a shoe last by referring to the chosen conversion table.

[0072] For example, when information showing that subcutaneous fat percentage of the user's foot is x % ($A < x < B$) is provided by subcutaneous fat percentage measurement unit **82**, shoe last configuration data production unit **32** chooses conversion table **81b** for A to B % from conversion table group **81**, and produces shoe last configuration data by referring to conversion table **81b** for A to B %.

[0073] By installing conversion table group **81**, subcutaneous fat percentage measurement unit **82** and height-weight inputting unit **83**, the configuration of the most appropriate shoe last taking the subcutaneous fat percentage of the user's foot into account can be automatically determined.

[0074] (Modification 3)

[0075] Also, instead of choosing any one of conversion tables from conversion table group **81** by inferring the subcutaneous fat percentage of the user's foot from the user's height and weight as mentioned above, fleshiness of the foot (such as being soft or hard) can be inferred by comparing size data obtained non-contactingly by the above-mentioned foot measurement unit **10**, and size data obtained from a foot on the ground. In other words, when a foot is on the ground, the configuration of the foot changes from the condition when the foot is not in contact with any surface since the foot must bear the weight of the user (the sole spreads). By comparing the size of the foot when the foot is not in contact with any surface, and when the foot is on the ground, and detecting the change in the configuration, fleshiness of the foot can be inferred. Then, by referring to a prepared conversion table for each type of fleshiness of the

foot (for example, 5 types such as soft, somewhat soft, normal, somewhat hard, hard), configuration data of the shoe last can be produced by choosing the conversion table in accordance with the inferred fleshiness.

[0076] (Modification 4)

[0077] As mentioned above, both size data of the foot obtained when the foot is not in contact with any surface, and when the foot is on the ground can be used, but configuration data of the appropriate shoe last can be produced when size data of the foot obtained by any one of the described measurement methods is inputted. In this case, the conversion table for when the foot is not in contact with any surface for producing shoe last configuration data from size data of the foot measured when the foot is not in contact with any surface, and the conversion table for producing shoe last configuration data from size data of the foot measured when the foot is on the ground need to be prepared. At this stage, in the conversion table for when the foot is not in contact with any surface, is stored conversion data produced on the basis of the relationship between the foot size measured when the foot is not in contact with any surface and the configuration of the ideal shoe last calculated by an experiment carried out using a described method. Also, in the conversion table for when the foot is on the ground is stored conversion data produced on the basis of the relationship between the foot size measured when the foot is on the ground, and the configuration of the ideal shoe last calculated by an experiment. Then, from foot measurement unit **10** to personal computer system **11**, measurement method identification data showing whether data is measured when the foot is not in contact with any surface or on the ground is provided along with measurements of the foot size. Then configuration data of the shoe last can be produced by referring to the conversion table corresponding to the measurement method identified by the measurement method identification data.

[0078] (Modification 5)

[0079] Configuration, fleshiness and so forth of a foot differ according to the race of the user (northern European, southern European, southern Asian, eastern Asian), and a conversion table can be prepared for each race.

[0080] Then, configuration data of the shoe last can be produced by choosing a conversion table in accordance with the race information by asking the user to provide the race information when the foot size is measured.

[0081] (Modification 6)

[0082] When a shoe last configuration data production process is carried out, in which the design of the ordered shoe (for example, a design where the tip of the shoe is square), or configuration data of the shoe last (for example, taking the height of the heel and so forth into account) can automatically be produced, shoe last data can be produced by preparing a conversion table for classification of a plurality of designs of shoes or the height of each heel (for example, 0 to 1 cm, 1 cm to 2 cm), choosing a conversion table in accordance with the designated design or height of the heel, and referring to the chosen conversion table.

[0083] (Modification 7)

[0084] In the above-mentioned modification, when configuration data of a shoe last taking into account information

such as the design of the shoe, the height of the heel, the type of the foot (such as Egyptian foot, Greek foot, hallux valgus, or pes latus), fleshiness of the user's foot (for example, subcutaneous fat percentage) is produced, a plurality of conversion tables are prepared, and when the foot type is Greek foot, the conversion table corresponding to Greek foot is chosen and referred to. By preparing several conversion tables in this manner, configuration data of shoe lasts taking into account the several types of information mentioned above can be produced, but on the basis of configuration data of the shoe last produced by shoe last configuration data production unit 32 of the first embodiment mentioned above, the basic configuration data can be amended by taking into account information such as the design of the shoe, the height of the heel, the type of the foot (such as Egyptian foot, Greek foot, hallux valgus, or pes latus), or fleshiness of the user's foot (such as the subcutaneous fat percentage).

[0085] Shown in FIG. 11 is a functional configuration of personal computer system 11 used for executing a shoe last configuration data production process by which configuration data of the shoe last can be automatically produced by amending the basic configuration data by taking the type of the foot into account. As shown in the figure, personal computer system 11 of the present modification comprises foot type detection unit 70 and amendment unit 90 in addition to foot size data inputting unit 31, shoe last configuration data production unit 32, conversion table 33 and displaying unit 34 which are the same as those in the above-mentioned embodiment.

[0086] Foot type detection unit 70 detects the foot type on the basis of the data provided by foot size data inputting unit 31. At this stage, the foot type refers to Egyptian foot, Greek foot, hallux valgus, or pes latus and so forth, and types of feet can be classified on the basis of the external configuration of the foot. Hence, CAD data for stereoscopically expressing the external configuration of the foot is produced from data provided by foot size data inputting unit 31 as mentioned above, and by comparing the foot configuration expressed by the CAD data to the pre-stored external configuration of each type of foot, the foot type of the configuration most resembling the foot configuration on the basis of the size data is determined to be the foot type of the user. Foot type detection unit 70 outputs foot type information, showing the foot type of the user detected in this manner, to amendment unit 90.

[0087] As in the first embodiment, shoe last configuration data production unit 32, by referring to conversion table 33, produces configuration data of the shoe last on the basis of data inputted by foot size data inputting unit 31. In the present embodiment, on the basis of configuration data of the shoe last, shoe last configuration data production unit 32 outputs to amendment unit 90 the produced configuration data of the shoe last (hereinafter, referred to as basic configuration data) to carry out amendment in accordance with the foot type such as Egyptian foot, Greek foot, hallux valgus, or pes latus.

[0088] Amendment unit 90 carries out an amendment process to basic configuration data provided by shoe last configuration data production unit 32 in accordance with foot type information detected by foot type detection unit 70. For carrying out the amendment process mentioned above,

amendment unit 90 has data for each foot type, and carries out an amendment process by using data for amendment in accordance with foot type information provided by foot type detection unit 70. Data for amendment of a shoe last for each type of foot is produced, by determining how the basic configuration data should be amended to produce a shoe last having an ideal configuration on the basis of the relationship between foot size of each foot type and the configuration of the ideal shoe last experimentally calculated, and the above data is produced on the basis of that amendment. Data for amendment mentioned above is, for example, data shown in FIG. 8 such that size Sa of the slack portion and size Sb of the slack portion are enlarged by 2% respectively.

[0089] By installing foot type detection unit 70 and amendment unit 90 mentioned above, the configuration of the most appropriate shoe last, taking the user's foot type into account, can be automatically determined. Also, the basic configuration data produced by shoe last configuration data production unit 32 can be amended by taking into account information explained in the above-mentioned various modifications such as the design of the shoe, the height of the heel, or fleshiness of the user's foot (such as subcutaneous fat percentage), instead of the foot type. For example, when the design of the shoe is a shoe with a shoestring, the basic configuration data is amended by taking tightness of the shoestring into account. Also, the design of the shoe and the desired color of the shoe can be taken into account.

[0090] (Amendment 8)

[0091] Foot sizes of human beings differ depending on the time of day when measurement is carried out. For example, foot sizes of human beings become larger in the afternoon than in the morning due to swelling and so forth. Hence, when configuration data of a shoe last is produced on the basis of size data of a foot provided by foot measurement unit 10 as in the embodiment mentioned above, it is preferable to take into account the time when the foot size is measured. At this stage, in the embodiment mentioned above, configuration data of a shoe last can be produced by taking the time information into account by providing to personal computer system 11 information on the time of day when the foot size is measured to produce size data of the foot along with size data of the foot provided from foot measurement unit 10.

[0092] As shown in FIG. 12, personal computer system 11 preferable to the present modification comprises time information inputting unit 41 and foot size data amendment unit 42 in addition to foot size data inputting unit 31, shoe last configuration data production unit 32, conversion table 33 and displaying unit 34 as in the above-mentioned embodiment.

[0093] Time information inputting unit 41, as mentioned above, obtains and inputs information showing the time when the foot is measured, for producing foot size data provided by foot measurement unit 10. Then, information showing the time is provided to foot size data amendment unit 42.

[0094] Foot size data amendment unit 42 amends foot size data provided by foot size data inputting unit 31 in accordance with time information provided by time information inputting unit 41. For carrying out amendment mentioned

above, foot size data amendment unit **42** stores a table for size amendment storing the foot size measured at the basic time (for example, 2:00 pm), and data showing the average amount of fluctuation of the size determined on the basis of the foot sizes measured at different times (for example, every one hour such as 0:00, 1:00, 2:00) for each of various parts of the foot. Then, when information showing a time other than the basic time is provided, size data in which sizes of several parts of the foot shown in foot size data provided by foot size data inputting unit **31** is amended accordingly.

[0095] Shoe last configuration data production unit **32**, on the basis of foot size data amended by foot size data amendment unit **42**, produces configuration data of the shoe last by referring to conversion table **33**. At this stage, data for conversion stored in conversion table **33**, is data produced on the basis of the relationship between foot size measured at the basic time, and the configuration of the ideal shoe last.

[0096] By installing time information inputting unit **41** and foot size data amendment unit **42** in this manner, the configuration of the most appropriate shoe last taking into account the time when the foot is measured can be automatically determined.

[0097] In the present modification, configuration data of a shoe last taking into account the time when measurement is carried out is produced by providing to shoe last configuration data production unit **32** foot size data provided by foot size data inputting unit **31** after amendment of the data by foot size data amendment unit **42**; however, the produced configuration data of the shoe last can be amended in accordance with time information after foot size data is provided to shoe last configuration data production unit **32** by foot size data inputting unit **31**, and producing configuration data of the shoe last.

[0098] (Modification 9)

[0099] Also, in the shoe last design method of the present invention, personal computer system **11** can automatically produce shoe last configuration data by using foot size data; therefore, even if a user lives in a region where there is no producer of shoe lasts, by using the shoe last design method of the present invention, a network service by which a custom shoe can be ordered via a communication network can be provided.

[0100] Hereinafter, configuration of a preferable system for achieving the network service mentioned above will be explained by referring to **FIG. 13**. As shown in the figure, the system comprises personal computer (PC) **51a** which is connected to communication network **2**, personal computer (PC) **51b**, custom order shoe reception center unit **54**, NC machine tool **12**, and shoe manufacturing machine **53**.

[0101] Each of personal computers **51a** and **51b** is installed in reception shops **52a** and **52b** for receiving an order of a custom order shoe from a user. In the reception shops **52a** and **52b**, is installed foot measurement unit **10** which is described in the above-mentioned embodiment. The number of reception shops of the above-mentioned configuration being connected to communication network **2** is not necessarily restricted to two.

[0102] In the system of the above configuration, the operation of the system when a user orders a custom order shoe at a reception shop such as **52a** or **52b** (in this case, **52a**) is as follows.

[0103] First, the user's foot is measured by foot measurement unit **10**, and size data of the user's foot is produced. Then size data of the user's foot is provided to personal computer **51a**. Personal computer **51a**, in addition to measuring the foot, displays images of shoes of several types of designs or color which can be used for manufacturing a custom order shoe on the displaying unit (LCD or CRT), and prompts the user to select a design and color of a shoe. At this stage, a clerk inputs information into personal computer **51a** based on the customer's selection.

[0104] When the inputting operation is completed, the clerk accesses custom order shoe reception center unit **54** via communication network **2** by using personal computer **51a**. Then, when communication connection is established between personal computer **51a** and custom order shoe reception center unit **54** via communication network **2**, personal computer **51a** transmits to custom order shoe reception center unit **54** order information containing foot size data, design data, color data and so forth, and client information (such as the name and the address to which the custom order shoe is to be shipped).

[0105] When custom order shoe reception center unit **54** receives order information transmitted from personal computer **51a** via network **2**, it produces configuration data of the shoe last by executing the same process as that of personal computer system **11** of the above-mentioned embodiment on the basis of size data contained in the order information, and produces NC data for producing the shoe last denoted by the size data. Then, the produced NC data is provided to NC machine tool **12**. Also, custom order shoe reception center unit **54** provides to shoe manufacturing machine **53** data showing design and color, and client information contained in the received order information.

[0106] In NC machine tool **12**, the shoe last is produced on the basis of NC data provided by custom order shoe reception center unit **54** as in the embodiment described above. Then, the produced shoe last is provided to shoe manufacturing machine **53**. In shoe manufacturing machine **53**, the shoe is produced on the basis of the shoe last provided from NC machine tool **12**, and data showing the design and coloration of the shoe provided from custom order shoe reception center unit **54**. Then, the manufactured shoe is shipped to the address contained in client information. By going through the process mentioned above, the custom order shoe the user orders at reception shop **52a** is manufactured, and shipped to the address designated by the user. The shoe shipped to the user is the shoe of the design and color specified by the user, and has the size which fits in the user's foot. In the above-mentioned system, the shoe comfortable to the user preference and foot can be provided in this manner.

[0107] (Modification 10)

[0108] Also, in the above-mentioned modification, the user orders a custom order shoe by going to a shop such as reception shop **52a** or **52b**, but the user can place an order with custom order shoe reception server unit **60** from home and so forth. Hereinafter, the configuration of a preferable system of the present modification will be explained by referring to **FIG. 14**.

[0109] As shown in the figure, the system comprises personal computer (PC) **61a** connected to the Internet **3**,

personal computer (PC) **61b**, custom order shoe reception server unit **60**, NC machine tool **12**, and shoe manufacturing machine **53**.

[0110] Each of personal computers **61a** and **61b** is installed in the user's home **62a** and **62b**. Several computers are connected to the Internet **3**, but, for simplicity, only two computers are shown in the figure.

[0111] In the system of the above configuration, the operation in which the user places an order for a custom order shoe from home such as **62a** or **62b** (in this case, home **62a**) is as follows.

[0112] First, when an order is placed for a custom order shoe, the size of the user's foot needs to be measured. However, since it is difficult to bring foot measurement unit **10** shown in FIG. 2 into home **62a**, size data of the foot needs to be obtained by a different method. The following method may be used. The user notifies a service provider that he/she will place an order for a custom order shoe by a certain method (for example, by accessing the Web site of the service provider by using the Internet). Then the service provider sends to the user's home **62a** a measurement unit by which the foot size can be easily measured in home **62a**. As such a measurement unit, for example, a measurement unit of a sock-type can be used. A sock-type measurement unit can be worn on the user's foot in the same manner as an ordinary sock. When the user puts the sock on, sensors installed on several spots of the sock (such as distortion sensors) detect the amount of deformation of the sock, and produce size data of the user's foot on the basis of the detected outcome. When size data of the foot produced by the method mentioned above is inputted into personal computer **61a**, the user accesses the Web page in custom order shoe reception server unit **60** via Internet **3** by use of personal computer **61a**. On the hard disc of custom order shoe reception server unit **60**, is stored a Web page for reception for receiving an order of a custom order shoe from the user via the Internet **3**. The user accesses the Web page for reception by using personal computer **61a**. At this stage, on the displaying unit of the personal computer which accesses the Web page, are displayed images of shoes of several designs or colors which can be manufactured. The configuration of the image is such that the user is prompted to determine a shoe of what kind of design and coloration he/she wants to order. The user selects the design and color of the shoe and inputs the information into personal computer **61a**. The user also inputs user information such as the name of the user, the address where the custom order shoe is shipped to, and a credit card number. Then order information containing data of the design and coloration, user information and size data of the foot is transmitted from personal computer **61a** to custom order shoe reception server unit **60** via Internet **3**.

[0113] Custom order shoe reception server unit **60**, when receiving order information from personal computer **61a**, produces configuration data of the shoe last by executing the same process as of personal computer system **11** of the above embodiment on the basis of size data of the foot contained in the order information, and produces NC data for producing the shoe last denoted by the size data. Then, the produced NC data is provided to NC machine tool **12**. Also, custom order shoe reception server unit **60** provides to

shoe manufacturing unit **53** data showing the design and color contained in the received order information, and user information.

[0114] In NC machine tool **12**, the shoe last is produced on the basis of NC data provided by custom order shoe reception server unit **60** as in the above embodiment. Then the produced shoe last is provided to shoe manufacturing machine **53**. In shoe manufacturing machine **53**, the shoe is manufactured on the basis of the shoe last provided by NC machine tool **12** and data denoting the design and color of the shoe provided from custom order shoe reception server unit **60**. Then, the manufactured shoe is shipped to the shipping address contained in user information. By going through the process mentioned above, the custom order shoe ordered by the user at home **62a** is manufactured, and is shipped to the shipping address specified by the user. At this stage, the shoe shipped to the user is in the design and color designated by the user, and comfortable to the user. In the above-mentioned system, the shoe fitting in the user's preference and foot can be provided in this manner.

[0115] C. Second Embodiment

[0116] In the first embodiment, as a foot measurement unit, a type by which the calf is held in place while a foot is shot is exemplified. By the foot measurement unit mentioned above, the shoe manufacturer does not have to carry out a troublesome operation such as measuring the user's foot using a measure. For precise measurement, the user needs to keep the foot still at the spot where the foot is shot while shooting is carried out; therefore, in the foot measurement unit of the first embodiment, the configuration is such that shooting is carried out by fixing the calf and so forth by use of a tightening unit so as not to interrupt shooting. However, in the configuration mentioned above, the foot itself is not fixed; hence, the foot may move during shooting, and the foot size may not be measured precisely as a result. In this case, shoe last produced on the basis of the measured foot size may produce an uncomfortable shoe. Therefore, in the present embodiment, a foot measurement unit by which more precise measurement of the foot size can be carried out is explained.

[0117] As shown in FIGS. 15 to 17, foot measurement unit **10'** of the present embodiment comprises shooting unit **110** for shooting foot **1** from a plurality of directions by a plurality of digital cameras by fixing foot **1** to be measured at a designated spot.

[0118] Shooting unit **100** comprises a plurality of digital cameras **110a**, **110b**, **110c** . . . **110m** in which a flash light unit which flashes during shooting is installed, spot determination unit **130** for determining the designated spot of foot **1** to be measured, digital cameras **110a**, **110b**, **110c**, **110d** . . . **110m** and retention unit **200** for fixing and retaining spot determination unit **130**. Shooting unit **100** outputs image data of foot **1** which is shot from a plurality of directions by each of digital cameras **110a**, **110b**, **110c** . . . **110m** to the computer system (not shown) via a cable and so forth. Then, analysis for each image is carried out by the computer system, and the configuration of foot **1** to be measured is determined.

[0119] Retention unit **200** is a unit which mainly consists of three units, in other words, base unit **210**, cavity forming unit **220**, and heel unit **230**. Base unit **210** is the unit installed

in the ground and so forth when shooting unit **100** is used. Base unit **210** is a flat rectangular portion having thickness in which a digital camera can be mounted. In base unit **210**, two digital cameras **110a** and **110b** are mounted as shown in **FIG. 15** and **FIG. 16** in spots opposite to the bottom of foot **1** which is placed at a designated spot. Digital cameras **110a** and **110b** are fixed and retained at each spot. Digital cameras **110a** and **110b** shoot the bottom of foot **1**.

[0120] Heel unit **230** is the portion mounted toward the top of base unit **210** at the heel of foot **1** which is placed at a designated spot. Surface **230a** of heel unit **230** (refer to **FIG. 17**) is a curved surface. The curved surface curves to face foot **1** whose designated spot is determined. In heel unit **230**, are mounted digital cameras **110c**, **110d**, and **110e** to shoot foot **1** whose designated spot is determined from the heel side, and each of cameras is fixed and retained at each spot. Each of digital cameras **110c**, **110d**, and **110e** shoots foot **1** from behind obliquely toward the left, from directly behind, and from behind obliquely toward the right.

[0121] Cavity forming unit **220** is a portion covering the toe end of foot **1** whose designated spot is determined. Cavity forming unit **220** forms cavity **S** into which foot **1** is inserted along with base unit **210**. Width **T** of Cavity **S** is approximately 0.15 m (refer to **FIG. 17**). Height **Ta** of cavity **S** on the toe side is approximately 0.08 m (refer to **FIG. 16**). Height **Tb** of Cavity **S** on the dorsum side is 0.13 m (refer to **FIG. 16**). Hence, the cavity is sufficiently large for a man's foot to be inserted. The size of the cavity formed by cavity forming unit **220** and base unit **210** is not limited to the above-mentioned size. The size of cavity **S** should be such that foot **1** to be measured can easily be inserted.

[0122] In cavity forming unit **220** mentioned above, are mounted digital cameras **110f**, **110g**, **110h**, **110i**, **110j**, **110k**, **110l**, and **110m** for shooting foot **1**, placed at the designated spot, from its dorsum side. Digital cameras **110f**, **110g**, **110h**, **110i**, **110j**, **110k**, **110l**, and **110m** are fixed and retained at each of their designated spots. Digital cameras **110f**, **110g**, and **110i** are mounted above and behind the dorsum of foot **1** obliquely toward the left. Digital cameras **110k**, **110l**, and **110m** are mounted above and behind the dorsum of foot **1** obliquely toward the right. Digital cameras **110j**, and **110j** are mounted above the dorsum of foot **1**. Digital cameras shoot foot **1** from each direction of mounted digital cameras.

[0123] In internal units **220a** and **220b** covering sides of foot **1** in cavity forming unit **220**, are fixed both end units **130a** and **130b** of spot determination unit **130**. The central portion of spot determination unit **130** is tangent unit **130c** which curves to project upwards. Tangent unit **130c** is in a curved configuration which resembles the dorsum of the foot. When foot **1** to be measured is placed at the designated spot, the user places the dorsum of foot **1** to be measured beneath tangent unit **130c** as shown in **FIG. 18**. By placing the dorsum of foot **1** beneath tangent unit **130c** as mentioned above, foot **1** can be naturally placed at the designated spot shown in **FIG. 15** and **FIG. 16**. Also, in the present embodiment, by curving tangent unit **130c** of spot determination unit **130**, the dorsum of foot **1** fits in the curved unit, and foot **1** can be prevented from moving when foot **1** is shot by digital cameras **110a** to **110m**.

[0124] Also, when the dorsum of foot **1** is placed beneath tangent unit **130c** of spot determination unit **130**, foot **1** is not in contact with any surface above base unit **210**. In other

words, in spot determination unit **130**, the spot of foot **1** is determined as a spot without touching any surface. When several digital cameras are used to measure the foot configuration in this manner, foot **1** hardly exerting any force can be shot by placing foot **1** in a spot which is not in contact with any surface, and the configuration of foot **1** hardly exerting any force (i.e. foot **1** without deformation) can be measured on the basis of the image obtained in the above manner.

[0125] Also, in shooting unit **100** mentioned above, a plurality of digital cameras **110a** to **110m** are fixed at predetermined spots in retention unit **200**. The spot of foot **1** is fixed at approximately the constant spot during shooting by spot determination unit **130**. In other words, the relationship of spots between foot **1** whose spot is determined by spot determination unit **130** to be measured, and digital cameras **110a** to **110m** always is approximately constant. Hence, every time foot **1** is measured, an operation such as adjusting the spots of digital cameras **110a** to **110m** by shifting is not necessary. Shooting foot **1** from several directions especially is preferable for improving precision of measurement, but several digital cameras are required to shoot from several directions. When the number of digital cameras increases, the operation of adjusting the spot becomes more troublesome. However, in shooting unit **100**, since the relationship of spots between foot **1** whose spot is fixed, and digital cameras **110a** to **110m** is approximately constant, a toilsome operation for adjusting the spot is not required even if several digital cameras are used.

[0126] Also, since the operation for adjusting the spots of several digital cameras **110a** to **110m** is not required as mentioned above, shooting by several digital cameras **110a** to **110m** can begin immediately after foot **1** is fixed at the designated spot by spot determination unit **130**. Also, shooting can end in a short period of time (shooting time when shooting is carried out by each of digital cameras **110a** to **110m** all at once). (Shooting ends momentarily if shooting is carried out by each of digital cameras **110a** to **110m** the same time.) Hence, for the user whose foot is measured, the burden such as fixing foot **1** at a designated spot for a long period of time is alleviated. Alleviation of the burden is great especially when the spot of foot **1** is not in contact with any surface as in the present embodiment.

[0127] Also, in the present embodiment, since foot **1** is fixed at a designated spot by placing the dorsum of foot **1** beneath spot determination unit **130**, a spot determination unit and so forth necessary for shoe last production are not required for the bottom side, toes and so forth of foot **1**. In other words, there is no unit covering toes or the bottom side of the foot necessary for shoe last production, and only the dorsum of foot **1** whose measurement is not necessary for shoe last production is covered by spot determination unit **130**. Hence, spot determination unit **130** for determining the spot of foot **1** does not hinder shooting of foot **1** by digital cameras **110a** to **110m**.

[0128] D. Modification of Second Embodiment

[0129] The present invention is not limited to the above-mentioned embodiment. Various modifications such as the ones described below are possible.

[0130] (Modification 1)

[0131] In the above-mentioned embodiment, by mounting several digital cameras **110a** to **110m** in retention unit **200**,

foot **1** is shot from a plurality of directions by several digital cameras **110a** to **110m**. In this case, when shooting is carried out by digital cameras **110a** to **110m** all at once, clear images might not be obtained due to the flash units of digital cameras facing each other. For preventing the deterioration of images due to flash units, a control unit shown in **FIG. 19** can be mounted in foot measurement unit **10**.

[0132] As shown in the figure, the control unit is equipped with timing control unit **500** for controlling the timing of shooting by each of digital cameras **110a** to **110m**. Timing control unit **500** outputs the signal for commencement for ordering each of digital cameras **110a** to **110m** the commencement of shooting. Timing control unit **500** controls the timing of commencement for shooting by each of digital cameras **110a** to **110m** by the timing described below.

[0133] As shown in **FIGS. 15** to **17**, in shooting unit **100**, digital cameras **110i** and **110j**, and digital cameras **110a** and **110b** face each other. When shooting is simultaneously carried out by the above cameras, good images might not be obtained by flash units of the digital camera placed in front.

[0134] Therefore, timing control unit **500** outputs a commencement signal to shift the timing of commencement for shooting by digital cameras **110a** and **110b**, and digital cameras **110i** and **110j** by a designated amount of time (one or two seconds). At this stage, with regard to other digital cameras, for example, for digital cameras **110f**, **110g**, **110h**, **110k**, **110l**, **110m** placed above foot **1**, timing control unit **500** can output the commencement signal at the same timing as of digital cameras **110i**, and **110j**. For digital cameras **110c**, **110d**, and **110e** placed below foot **1**, the commencement signal is outputted at the same timing as that of digital cameras **110a** and **110b**.

[0135] (Modification 2)

[0136] Also, the configuration of spot determination unit **130** for fixing foot **1** at the designated spot, and the method for installing spot determination unit **130** in retention unit **200** are not limited to those explained in the above embodiment. Any configuration of spot determination unit **130**, and method for installing spot determination unit **130** in retention unit **200** can be adopted as long as the spot of foot **1** can be determined by placing the dorsum of foot **1**.

[0137] For example, as shown in **FIG. 20**, the configuration can be such that one end unit **130d** of spot determination unit **130** is fixed on the surface of any one of internal units **220a** and **220b** (shown in the figure is internal unit **220a**), and the other end is tangent unit **130e** in a curved configuration.

[0138] Also, as shown in **FIG. 21**, the configuration can be such that the spot of foot **1** is determined by using two units such as spot determination units **1300** and **1310** installed in each of internal units **220a** and **220b**. As shown in the figure, end units **1300a** and **1310a** of spot determination units **1300** and **1310** are fixed to internal units **220a** and **220b**, the configuration of end units **1300b**, and **1310b** is curved toward the top. By placing the dorsum of foot **1** on the curved portion formed by end units **1300b** and **1310b** of spot determination units **1300** and **1310**, foot **1** can be placed at the designated spot.

[0139] Also, in approximately the central portion of spot determination units **1300** and **1310**, are installed contraction

unit **1300c** and **1310c** which contract. Inside contraction units **1300c** and **1310c**, is installed a biasing means such as a spring. In a normal state, end unit **1300b** is pressed toward end unit **1310b**, and end unit **1310b** is pressed toward end unit **1300b** (the stretched state). In this state, the curved configuration formed by end units **1300b** and **1310b** is smaller than the curve formed by tangent unit **130c** of the embodiment mentioned above. Under this configuration, when the dorsum of foot **1** to be measured is inserted into the curved portion, contraction units **1300c** and **1310c** shrink in accordance with the size of the dorsum of inserted foot **1** as shown in **FIG. 22**. Also, end units **1300b** and **1310b** can shift toward the direction of which end units **1300b** and **1310b** spread from each other by keeping the dorsum of foot **1** placed on end units **1300b** and **1310b**. By using spot determination units **1300** and **1310** mentioned above, individual differences of the size of foot **1** to be measured can be assimilated. Therefore, despite the differences of the size of the foot to be measured, end units **1300b** and **1310b** are constantly placed on the dorsum of foot **1**, and the movement of foot **1** can be deterred during shooting.

[0140] (Modification 3)

[0141] Also, in the embodiment mentioned above, retention unit **200** having three units such as base unit **210**, cavity forming unit **220**, and heel unit **230** retains spot determination unit **130**, and relationship of the spots between the spot of foot **1** which is determined by spot determination unit **130** and the spots of each of digital cameras **110a** to **110m** becomes approximately constant. However, the configuration of retention unit **200** is not limited to the one explained in the embodiment mentioned above. The configuration of retention unit **200** can be in any configuration as long as the relationship of spots between the spot of foot **1** and the spots of each of digital cameras becomes approximately constant. Also, the configuration of retention unit can be such that cavity **S** and so forth are not formed.

[0142] (Modification 4)

[0143] In the above-mentioned embodiment, shooting unit comprising digital cameras **110a** to **110m**, spot determination unit **130** and retention unit **200** is explained, but only spot determination unit **130** can be separately sold. In this case, spot determination unit **130** can be used in a condition such that spot determination unit **130** is retained by retention means other than retention unit **200**.

[0144] (Modification 5)

[0145] In the embodiment mentioned above, digital cameras are used as means for shooting foot **1**, but foot **1** can be shot by placing units other than digital cameras in the manner exemplified above. For example, foot **1** can be shot by an ordinary camera. Then the picture image as a result of shooting by the ordinary camera can be read in as image data by a scanner and so forth, and analytical process for measuring the configuration can be carried out to the image data. Also, in the embodiment mentioned above, the number of digital cameras can be a number sufficient to obtain a plurality of images necessary for determining the configuration of foot **1**. In other words, since images of at least four surfaces; the top (the dorsum), the bottom (the sole), and both sides of foot **1** need to be obtained, there should be one camera for each of the surfaces, in other words, four cameras overall.

1. A method for designing a shoe last, comprising:

an inputting step for inputting size data of a foot of a user;
and

a shoe last configuration production step for producing,
on the basis of said inputted size data of a foot,
configuration data of a shoe last used for manufacturing
a shoe of said user.

2. A shoe last design method of claim 1,

wherein in said shoe last configuration production step,
said configuration data of a shoe last is produced by
referring to a conversion table storing data for convert-
ing sizes of a plurality of spots of a foot into sizes of a
plurality of spots of a shoe last corresponding to said
plurality of spots of said foot.

3. A shoe last design method of claim 1,

wherein in said shoe last configuration production step, on
the basis of size data of said foot of said user, foot type
data denoting a configuration of said foot is produced,
and on the basis of said foot configuration data and said
size data of said foot, said configuration data of said
shoe last is produced.

4. A shoe last design method of claim 3,

wherein in said shoe last configuration production step,
said configuration data of a shoe last is produced by
determining a conversion table to be referred to in
accordance with said foot type data produced, from
among conversion tables in which data for converting
sizes of a plurality of designated spots of a foot set forth
for each of said types of configuration of a foot into
sizes of a plurality of spots of a shoe last corresponding
to said plurality of spots of said foot, and by referring
to a determined conversion table.

5. A shoe last design method of claim 1,

wherein in said inputting step, appearance data indicating
an appearance of a shoe to be manufactured is further
inputted, and

wherein in said shoe last configuration production step,
said configuration data of a shoe last is produced on the
basis of said size data of a foot, and of said appearance
data.

6. A shoe last design method of claim 5,

wherein in said shoe last configuration production step,
said configuration data of a shoe last is produced by
determining a conversion table to be referred to in
accordance with said appearance data inputted from
among conversion tables storing data for converting
sizes of a plurality of spots of a foot set forth for each
of a plurality of said appearances of a shoe into sizes of
a plurality of spots of a shoe last corresponding to said
plurality of spots of said foot, and by referring to a
determined conversion table.

7. A shoe last design method of claim 1,

wherein in said inputting step, physical data containing
the height and the weight of said user is further input-
ted, and

wherein in said shoe last configuration production step,
said size data of a shoe last is produced on the basis of
said size data of a foot, and said physical data.

8. A shoe last design method of claim 7,

wherein in said shoe last configuration production step,
said configuration data of a shoe last is produced by
determining a conversion table to be referred to in
accordance with said physical data inputted from
among conversion tables storing data for converting
sizes of a plurality of spots of a foot set forth for a
plurality of sets of said physical data into sizes of a
plurality of spots of a shoe last corresponding to said
plurality of spots of said foot, and by referring to a
determined conversion table.

**9. A shoe last design method of claim 1, further compris-
ing:**

an obtaining step for obtaining size data of a foot while
said foot is not in contact with any surface, and

wherein in said inputting step, size data of a foot obtained
in said obtaining step is inputted.

10. A shoe last design method of claim 1,

wherein in said inputting step, measurement method data
denoting a type of a measurement method of said size
data of a foot is further inputted, and

wherein in said shoe last production step, said configu-
ration data of a shoe last is produced on the basis of said
size data of a foot, and said measurement method data.

11. A shoe last design method of claim 10,

wherein in said shoe last configuration production step,
said configuration data of a shoe last is produced by
determining a conversion table to be referred to in
accordance with said measurement method data input-
ted from among conversion tables storing data for
converting sizes of a plurality of spots of a foot set forth
for a plurality of types of said measurement method
into sizes of a plurality of spots of a shoe last corre-
sponding to said plurality of spots of said foot, and by
referring to a determined conversion table.

12. A shoe last design method of claim 1,

wherein in said inputting step, measurement time data
denoting measurement time when said size data of a
foot is obtained is further inputted,

and in said shoe last production step, configuration data of
a shoe last is produced on the basis of said size data of
a foot, and said measurement time data.

**13. A shoe last design method of claim 1 further com-
prising:**

a reception step for receiving size data of a foot trans-
mitted via a communication network,

wherein in said inputting step, size data of a foot received
in said reception step is inputted.

**14. A shoe last design method according to any one of
claims 1 to 13 further comprising:**

an outputting step for outputting configuration data of a
shoe last produced in said shoe last configuration
production step.

15. A method for designing a shoe last comprising:

a first step for measuring a cross-sectional surface con-
figuration at a plurality of spots of a foot of a user;

a second step for producing cross-sectional surfaces of
said shoe last which corresponds to a foot configuration

denoted by configurations of a plurality of cross-sectional surfaces measured in said first step for each of configurations of a said plurality of cross-sectional surfaces;

a third step for producing said configuration of a shoe last by combining each cross-sectional surface of a shoe last produced in said second step; and

a fourth step for producing said configuration data of a shoe last from a configuration of a shoe last produced in said third step.

16. A shoe last design method of claim 15,

wherein in said second step, a configuration of a cross-sectional surface corresponding to said measured configuration of a cross-sectional surface is produced by referring to a conversion table containing data for converting a measured configuration of a cross-sectional surface into a configuration of a cross-sectional surface of a shoe last corresponding to said configuration of a cross-sectional configuration, and by adjusting each of a cross-sectional area, height, and width of a foot of said user denoted by a configuration of a cross sectional surface measured in said first step,

17. A unit for designing a shoe last comprising:

inputting means for inputting size data of a foot of a user who orders a shoe; and

shoe last configuration production means for producing configuration data of a shoe last, on the basis of said inputted size data of a foot.

18. A foot measurement unit, wherein a configuration of a foot of a user is determined on the basis of images obtained as a result of shooting a foot of said user to be measured, and size data of said foot is outputted, comprising:

foot spot determination means for placing said foot at a designated spot by placing the dorsum of said foot to be measured in contact with a foot spot determination unit of said foot measurement unit; and

shooting means for shooting said foot which is placed at said designated spot by said foot spot determination means.

19. A foot measurement unit of claim 18,

wherein said shooting means comprises a plurality of image shooting means, and

wherein each of said image shooting means shoots said foot from different directions.

20. A foot measurement unit of claim 18 further comprising:

a retention unit for retaining said foot spot determination means and each of said image shooting means,

wherein the relationship of spots between said foot spot determination unit and each of said image shooting means is fixed.

21. A foot measurement unit of claim 20,

wherein said retention unit has a portion to cover a periphery of toes of a foot which is placed at said designated spot, and

wherein at least one of said image shooting means is fixed to said portion to cover a periphery of toes of a foot.

22. A foot measurement unit of claim 19,

wherein said image shooting means comprises flash means for flashing during shooting, further comprising:

timing control means for controlling timing of shooting by said image shooting means whereby timing of shooting of said foot differs in a case that image shooting means are facing each other differs.

23. A foot measurement unit of claim 18,

wherein in said foot spot determination means, a portion touching the dorsum of said foot curves.

24. A foot measurement unit of claim 18,

wherein said designated spot where said foot spot determination means determines is a spot in which said foot is in the air.

25. A foot spot determination unit in which, during shooting, a foot is placed in a designated spot, of a foot measurement unit which measures a configuration of a foot of a user on the basis of an image obtained as a result of shooting a foot, and outputs size data of said foot, comprising:

foot spot determination means for placing said foot at a designated spot by touching the dorsum of said foot.

26. A foot spot determination unit of a foot measurement unit of claim 25,

wherein in said foot spot determination means, a portion touching the dorsum of said foot curves.

27. A foot spot determination unit of a foot measurement unit of claim 25 or 26,

wherein said designated spot determined by said foot spot determination means is a spot in which a sole of a foot is not in contact with any surface.

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