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(54) **Method for developing a series of shoe lasts distributed on a series of sizes starting from a base last**

Verfahren zur Entwicklung einer Serie von in einer Serie von Grössen verstreuten Schuhleisten von einem Grundleisten aus

Procédé de développement d'une série de formes réparties en une série de pointures à partir d'une forme de base

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Description

[0001] The present invention relates to a method for developing a series of shoe shapes, also called shoe lasts, from a base shoe shape provided in a basic shoe size, according to the preamble of claim 1.

[0002] Particularly but not exclusively, the invention relates to a method applied to the scale manufacturing of a series of shoes distributed in a series of different sizes, from one base shoe shape provided in a basic shoe size, and the following description is made with reference to this application field for convenience of illustration only.

Prior Art

[0003] As it is well known in this technical field, in order to manufacture shoe in large and very large scales, it is necessary to have shoe shapes previously performed on the basis of a predetermined shoe design and in the several shoe sizes to be manufactured. This shoe design will be hereinafter referred to as the "base shoe shape".

[0004] In the state of the art, each shoe shape is realized by mechanically removing material from a preformed blank of plastics that is obviously provided in a somewhat larger overall size than the finished shoe shape. This machining is carried out, for example, on tool machines known as "Donzelli lathes", which are equipped with a special measuring head or gauge for reading the shoe design to be produced, and with a number of machining heads, usually four machining heads.

[0005] These lathes incorporate a mechanical scaling system, and can produce a full range of right/ left shoe sizes from a single base shoe shape which has been realized by a skilled shoe designer or a stylist, for example.

[0006] A compound arrangement of gears and levers allows the dimensions of the base shoe shape to be scaled along three Cartesian axes. Basically all such lathes include levers that enable this scaling to be effected on the basis of predetermined mechanisms and cinematic relations, long known in the industry.

[0007] It should be noted, however, that this machining procedure does not take into proper account the anatomy and morphology of an evolving human foot, which changes somewhat with both the type and the foot size of an individual.

[0008] Consequently, the shoe design or shoe shape maker is obliged to apply corrections during the machining process, in order to produce a series of shoe shapes that would adhere to the evolution of the foot in an anatomically accurate shape. Such corrective actions are left to the operator's judgement and are bound by the machine limitations. Thus, it is not possible to guarantee the production of accurate copies of a series of shoe shapes that span a range of shoe sizes, maintaining the original style.

[0009] In addition, there exist at present a bewildering variety of shoe size systems, and of subjective shoe shape measuring methods, which often leads to a total lack of communication when the info must circulate among a certain number of subjects.

[0010] Over the years, for example, shoe manufacturers that had planned their production to suit equipment and systems tailored to their own requirements, due to changes of the manufacturing processes, are now to share their information with outside suppliers of tools, parts, or services that may be using different measurement systems and methods.

[0011] This substantial inconsistency of the measurement systems and tooling paradoxically denies the ability to obtain values that are comparable, i.e. to establish the same measurements by the different subjects involved in carrying out the same measurement.

[0012] A prior art method for making shoe lasts is known from the US 4,884,309 which involves digitizing on the fly a large number of sample points on the outer surface of a model last to produce a model last digital file, and grading the model last digital file to produce one or more graded last digital files. Each of the graded last digital files is used to produce a graded shoe last.

[0013] A further prior art method of deriving patterns for shoe manufacture, which corresponds to the preamble of the enclosed claim 1, is known from the EP 0019459A1. The method consists in using a computer to operate on three-dimensional co-ordinate information concerning the shape of the shoe last to produce three-dimensional co-ordinate information. Such information is subjected to a grading program which produces three-dimensional co-ordinate information for different sizes.

[0014] Neither known method discloses however how to develop a series of shape of different sizes starting from a base shape ensuring perfect match to the morphology and anatomy of the human foot through the full range of shoe sizes.

[0015] The underlying technical problem of this invention is to provide a new method for developing a series of shoe shapes, distributed in a series of shoe sizes, with appropriate features to enable shoe shapes to be manufactured, exactly matching the foot morphology and anatomy, while maintaining their likeness to a base shoe shape through the various sizes provided. This method also improves simpler shoe designing and manufacturing procedures and lower production costs.

Summary of the Invention

[0016] The solvent idea of this invention is that of using CAD software to gather the spatial coordinates of a base shoe shape and apply them to different shoe sizes of said base shoe shape using parameters that fully emulate, or at least very closely track, the morphological evolution of the human foot.

[0017] Once a shoe shape is obtained for each shoe size, by running a CAM system in an NC tool machinery, shoe shapes can be manufactured in very large scales on conventional tool machines, thereby substantially manufacturing exact copies of each CAD shoe shape in the whole range of shoe sizes.

[0018] Based on this idea, the technical problem is solved by a shoe shape developing method as defined in the attached Claim 1 foll.

[0019] The features and advantages of the method and the shoe shape according to this invention will become apparent from the following description of embodiments thereof, given by way of example and not of limitation with reference to the accompanying drawings.

Brief Description of the Drawings**[0020]**

- Figure 1 shows a perspective and schematic view of a shoe shape obtained by the method of this invention.
- Figure 2 shows a side view of the shoe shape shown in Figure 1, and of ancillary items in the forms of a top pad and an insole.
- Figure 3 shows a perspective view of a virtual shoe shape obtained on a computer means using CAD software for data gathering, according to the invention.
- Figure 4 shows a side and schematic view of a shoe shape 1 that brings out the shoe shape contour lines and projected length.
- Figure 5 shows a schematic view of a base shoe shape of basic shoe size, as being subjected to an operation of data gathering by a computer means on which CAD software is run, according to the method of this invention.
- Figure 5A shows a detail of the embodiment of Figure 5.
- - Figures 6A, 6B and 6C show side, top and again side views, respectively, of a shoe shape that brings out distance, axes, and reference planes thereof.
- Figures 7, 8 and 9 show plots illustrating the qualitative relationships and dimensional ratios along the X, Y and Z axes of the shoe shapes as re-constructed by the inventive method to match varying sizes of shoe intended for child, lady and gentleman use, respectively.

Detailed Description

[0021] With reference to the drawings, particularly to the embodiment shown in Figure 3 thereof, a shoe shape is generally shown at 1 in schematic form which has been developed in accordance with the developing method of this invention.

[0022] The shoe shape 1 differs from shoe shapes manufactured with prior methods in that it matches with the true anatomy and morphology of the foot, and exactly corresponds to a template provided in the form of a base shoe shape 2 spanning a desired range of shoe sizes.

[0023] As better explained hereinafter, a base shoe shape of basic shoe size is a shoe shape directed to duplicate an average foot as closely as possible, so that it would fit the widest possible variety of real feet.

[0024] As is well known in this technical field, the shoe shape 1 is a tool used for manufacturing a number of shoes of the same type on shoe-making machines, e.g. of the kind of a top pad assembling machine employed to mount the top pad of uppers onto a shoe insole. Such machines include an operator station where the shoe shape is centrally supported while the uppers is fitted onto the shoe shape with the insole facing up and the toe end facing the operator.

[0025] To make all the aspects of this invention more clearly understood, it may be useful to first define certain distances and geometric references used through the remainder of this specification. These references are indicated in Figures 6A, 6B and 6C as follows:

- Main Axis A: this is a vertical line drawn through the center of a circle inscribed into the rearward portion of the top pad;
- Shoe shape Height B: this is the height above the horizontal plane of the point where the main axis A meets the top pad, with the shoe shape/insole assembly in normal trim;
- Stride C: this is the height above the horizontal plane of the end point of the shoe shape/insole assembly in normal trim;
- Contour Line D: this is a line described on the shoe shape by the top edge of the insole, i.e. giving the profile of the shoe welt, or in other words, the bottom seam when molding over the uppers;
- Sole Height E: this is the thickness of the sole as measured at the middle of the plant rest line;
- Heel Height F: this is the sum of the shoe shape height B and the sole height E ($F=B+E$);
- Insole Thickness G: this is the thickness dimension of the insole and includes two measurements:

G', being the thickness at the intersection with the main axis, and

G", being the thickness at the stride line.

[0026] The method of this invention, comprising a sequence of steps that lead to developing, starting from a base shoe shape 2 provided in a basic shoe size, a series of shoe shapes distributed in a series of shoe sizes, will now be described.

[0027] In conformity with the French shoe size system presently in use, a so-called French size 21 or 22 is usually selected as a basic size for child shoe; size 37 or 38 for lady shoe; and size 41 or 42 for gentleman shoe. The need to use a multiplicity of base shoe shapes is explained, in fact, by the current development system showing departures that are the deeper the farther a shoe shape evolves from the base shoe shape.

[0028] In order to determinate a base shoe shape 2 that can be useful in this invention, a panel of shoe manufacturers were queried, each being representative of a specific typology of shoes and being known and operative on the market since a long time. Each shoe manufacturer submitted some typical shoe shapes, selected among the most successful and that had been longest in demand.

[0029] It should be noted here that many shoe styles had been produced for decades, with continual improvements to the shoe shapes in order to make them anatomically more foot friendly and improve the supporting ultimate function of the shoe.

[0030] Sometimes the path of this development has been on occasions a devious one, resulting in frequent steps back due to some leading stylists promoting shapes that care nothing for the foot anatomy.

[0031] However, a review of the huge production of shoe shapes from the 1950s to this date revealed that certain shapes had maintained their popularity and known cyclic revival. It can be shown that such shapes conform to good ergonomic rules, and they are the ones that have been considered in this invention.

[0032] Thus, from an evaluation of the various shapes that had enjoyed consistent commercial success through the years, a common factor has emerged which is closely related to the proper anatomical evolution of the foot.

[0033] Accordingly, this analytic stage was followed by a stage of measuring and recording the spatial coordinates of the base shoe shapes of basic shoe size for a large number of significant shapes. This process brought forth a few common aspects that seem to be at the root of the commercial success of such shapes.

[0034] It was found that different shoe shapes, corresponding to different designs, had many features in common, especially as regards a peculiar similarity of volumes, lines and fit in some important areas of the foot.

[0035] This similarity has been condensed into a mathematical law, to be hereafter described, which is thought to reflect with good approximation the real evolution of the human foot. By application of this mathematical law, in accordance with the method of this invention, a set of shoe shapes covering a range of shoe sizes is obtained which closely emulate the evolution of the human foot, thereby consigning to obsolescence the innumerable evolution charts currently used in the shoe industry. In this way, to a shoe design can be given practical implementation in a simpler manner, and the range of potential users of the article increased with little need of reiterate tries for fit.

[0036] The method of this invention comprises a first step of gathering data concerning the base shoe shape 2 of basic shoe size. The base shoe shape may be supplied, as is usual, by a shoe designer or a stylist using conventional techniques, or be an otherwise classical shape in the industry.

[0037] For all these alternatives, the method of this invention comprises a step of digitizing the base shoe shape of basic size.

[0038] More particularly, the surface 3 of the base shoe shape 2 of basic size is accurately gauged to obtain spatial

coordinates x_B , y_B and z_B of each point P_B on that surface, using gauges and CAD means of data gathering.

[0039] In essence, a gauge 15 is run across the true surface of the base shoe shape along paths that allow the object to be accurately re-constructed. The gauge 15 is essentially a computer-controlled or manually operated mechanical type of gauge; alternatively, the physical surface 3 of the base shoe shape 2 could be laser scanned. The gauge 15 is controlled by the computer means to vary the reading intervals between areas of different criticality of the surface 3.

[0040] It is very important that the characterizing measurements and significant profiles taken from the base shoe shape be unsubject to the personal judgement of an operator. For this reason, the gauge 15 is arranged to be controlled by a computer means 10 running CAD simulation programs. The base shoe shape 2 of basic size is therefore digitized, or rather, reconstructed in digital form using a 3D data gathering technique.

[0041] Preferably in the method of this invention, the surface 3 is contacted in a direct manner. In fact, data gathering by a mechanical gauge is usually sufficiently precise, although more hardware and time intensive.

[0042] As said before, optical systems could be used instead, although these are bound to introduce local distortion due to reflective and/or interference effects, which makes the surface reconstruction unavoidable.

[0043] In all cases, the outcome of this data gathering step is a data file that can be analyzed in a 3D CAD setting. The surface 3 of the base shoe shape 2 is re-constructed in digital form, and possible digitizing process errors can be corrected by the CAD program.

[0044] Methodical tests performed by the Applicant show that a true match of re-constructed surfaces 4 with the true surfaces 3 can be achieved.

[0045] Advantageously, the step of re-constructing the surface 3 of the base shoe shape 2 in a 3D CAD setting allows correspondence and compatibility with shoe manufacturing operations ahead of and after the method to be maintained. For example, during the data gathering step, the same contour lines as are traditionally used by shoe designers and the same sections as manually measured by them to physically produce the shoe shape according to traditional methods, can be tracked.

[0046] Of course, there is no reason why a base shoe shape 2 already available in digital form for CAD processing could not be used instead, as by retrieving the necessary data from some storage means set apart from the computer 10. However, this would involve changes to the ways of working of the shoe makers or the designers of the base shoe shapes. The method of this invention allows instead the co-operation with the traditional stylist or shoe designer to be preserved, and the work to proceed along the same references as have been conventionally used in measuring base shoe shapes, but with an hitherto unknown degree of accuracy.

[0047] Once the base shoe shape 2 is re-constructed in digital form, the computer 10 will display on its screen 9 a virtual or simulated surface 4 in three dimensions, whereon each point P_B along its Cartesian spatial coordinates x_B , y_B and z_B can be exactly indicated.

[0048] In essence, the design of a base shoe shape of basic shoe size according to the invention may be traditionally realized by a shoe designer or a stylist. Alternatively, a given shoe shape may be derived from an existing design duly processed through CAD software.

[0049] In the former case, greater styling freedom is afforded, while in the latter, special features that are not to be forfeited and/or are distinctive of a manufacturer can be reproduced on a new shoe shape.

[0050] The re-constructed base shoe shape can be divided in three different surfaces: top, side and bottom surfaces 5, 6 and 7 that, once merged together, produce a three-dimensional object as shown in Figure 4.

[0051] Each portion of the new shoe shape 1 is re-constructed by using a different technique that is specific to the CAD software employed and the type of surface of interest, and by using guidelines 13 that reproduce in digital form a manual template traditionally used by the shoe designer.

[0052] The guidelines 13 used for re-constructing a variety of shoe shapes may be suitably interpolated to produce a new shoe shape. This allows the manufacturer to maintain important elements on a number of shoe shapes and for several seasons.

[0053] For example, by storing the data about the guidelines 13 used to reconstruct the shoe shape into a memory 8 incorporated to or associated with the computer means 10, a database of shoe shapes 1 can be created for later use in providing a new shoe shape with appropriate volumes, perhaps limited to a specified region thereof.

[0054] CAD software makes substituting one or more guidelines 13 of a structure with corresponding guidelines of another structure a comparatively easy task, thereby obtaining near-perfect morphing of both, as well as using a totally new style in some regions of a shoe shape, and maintaining its basic structure.

[0055] The construction guidelines shown in Figure 3 are exemplary of the underlying principle that a surface 4 of the shoe shape 1 can be adequately described by the data of its construction lines, and that such data can be utilized by CAM machinery to perform certain machining operations on both the shoe shape 1 and the shoe obtained therefrom.

[0056] Advantageously, this allows the length (X axis) and width (Y axis) real developments of the plant surface, as well as the shoe shape perimeter in its significant regions, such as the fit, instep, heel-to-metatarsus-to-tarsus ratio, heel height, stride, etc., to be also obtained.

[0057] In this context, studies carried out by the Applicant have surprisingly shown that some classical rules of me-

chanical development currently employed to produce a shoe shape in a range of shoe sizes lead to the degree of comfort being degraded progressively. In essence, as shoe size changes, the spatial match of the containing shoe to the contained foot is lost. This is due to the foot shape evolving non-linearly, and rather undergo deep changes as the age of a human progresses.

[0058] The increase in width and thickness of the foot follows an arcuate pattern, as against a length increase that is constant. For example, in the graphs of Figures 7, 8 and 9, there are plotted lines representing rates of increase along the Y axis (width) and the Z axis (thickness) of the foot against a constant rate of increase along the X axis (length) that is equal to 0.5 cm. It can be seen that the increase patterns of the foot width and thickness are arcuate, in respect of a constant rate of length increase.

[0059] In the state of the art, the progressive degradation of a shoe shape character has been fought by manufacturers of shoe shapes with remedies that were suggested by independent experience. Such remedies were applied at the stage of scaling (developing) a shoe shape, and have eventually resulted in an uncontrolled production of shoe shapes that only match the actual volume of the foot in a few sizes.

[0060] Advantageously in this invention, regular series of development parameters from a basic size have been established which ensure perfect match to the foot through the full range of shoe sizes.

[0061] Note should be taken in this respect of that a constant rate of increase of the foot length (X axis) parallels a lower rate of increase of the foot width, and an even lower increase of the foot thickness. In fact, the shape of the foot becomes more elongate as length increases.

[0062] On the other hand, as length decreases, the foot tends more towards plump proportions, and in the extreme, its right and left discriminating features become hazy.

[0063] This rules out all possibilities of reproducing an anatomically correct evolution on current Donzelli lathes, due to these being unable to discriminate between the Y and Z axes.

[0064] Developing shoe shapes by computer means running CAD software produces faithful replicas of the human foot sizes, and retains the proportion of users that can be offered a given design in all its sizes.

[0065] On the contrary, with the current mechanical development process, the proportion of potential users tapers toward both the larger and the smaller sizes, making it necessary to try repeatedly for a fit, thereby greatly complicating things for the manufacturer or restricting the user's choice.

[0066] With a whole series of shoe shapes available in digital form, a shoe manufacturer is able to order from respective suppliers shoe components that are consistent with one another, and can be assured of their full compatibility. This avoids the need for adjustment of each component in a process that often results today in the shoe shape undergoing substantial alteration and the shoe shape/foot match being missed.

[0067] The change in width and thickness is, as mentioned before, different along the Y axis from that along the Z axis, and is a function of the absolute values of these quantities and their closeness to the basic shoe size used as a reference.

[0068] The mathematical formula that applies to the variations of the base shoe shape 2 of basic size along the X, Y and Z axes will now be given in detail.

[0069] Preferably, the rate of increase along the X axis that sets the shoe size of the shoe shapes is assumed to be constant, although this should not be taken to limit the Applicant's rights.

[0070] In essence, this invention provides a novel shoe size measurement system based on the metric system and expressed in cm and as length increments of 0.5 cm. Therefore, each shoe size is expressed by a number descriptive of length in cm (e.g., 20; 20.5; 21; and so on).

[0071] Length is represented by the true plant surface as developed along its longitudinal axis, less possible styling attachments to the shoe shape, as shown in Figure 4.

[0072] It will therefore be understood that size relates to the foot that a shoe can accommodate, not to the length of the shoe itself.

[0073] This assists a consumer in his/her choice of a suitable size irrespective of a shoe style.

[0074] The variations of points of the spatial co-ordinates for at least another shoe shape in the range of shoe sizes are obtained by using dynamic coefficients differentiated along each of the three Cartesian axes of the shoe shape development.

[0075] These coefficients are:

c_x : a coefficient of development along X (length);

c_y : a coefficient of development along Y (width); and

c_z : a coefficient of development along Z (thickness).

[0076] An integer n will be used to indicate the positive or negative distance of a given shoe size from the basic size.

[0077] The coefficients c_x , c_y and c_z are functions of n according to the following formulae:

$$C_x = 1 + f(n)$$

$$C_y = 1 + f(n) - f(n \bullet | n |)$$

$$C_z = 1 + f(n) - f(n \bullet | n |)$$

[0078] Preferably, but not limited to, the above functions of the integer n are multiplication functions by predetermined numerical parameters (a , b , c , d , e), as per the following relations:

$$C_x = 1 + n \bullet a$$

$$C_y = 1 + n \bullet b - n \bullet | n | \bullet c$$

$$C_z = 1 + n \bullet d - n \bullet | n | \bullet e$$

[0079] The numerical parameters a , b , c , d and e , which multiply the n term, may vary according to a manufacturer's own requirements, without this invalidating the method.

[0080] The values of c and e may differ from each other, but could be made to coincide instead.

[0081] For example, the following set of relations could be written:

$$C_x = 1 + n(1.9 \bullet 10^{-2})$$

$$C_y = 1 + n(2.45 \bullet 10^{-2}) - n \bullet | n | (5 \bullet 10^{-4})$$

$$C_z = 1 + n(1.45 \bullet 10^{-2}) - n \bullet | n | (5 \bullet 10^{-4})$$

[0082] In 3D CAD software, once the basic size is known, all the sizes in the range can be obtained by scaling the basic size according to the three coefficients of the above formulae.

[0083] It should be noted that the coefficients of development from a child base shoe shape would be greatly different from those used for a gentleman base shoe shape, although the frame of the mathematical formula remains unchanged. In fact, in developing from a child base shoe shape, the frames of the formulae are the same, and only the numerical terms change, because the morphological evolution that is typical of the development is quite different from the simple scaling toward adult age.

[0084] Here again, the following set of relations could be written, for example:

$$C_x = 1 + n(3.2 \cdot 10^{-2})$$

$$C_y = 1 + n(3.06 \cdot 10^{-2}) - n \cdot |n| (6 \cdot 10^{-4})$$

$$C_z = 1 + n(2.85 \cdot 10^{-2}) - n \cdot |n| (5 \cdot 10^{-4})$$

[0085] In particular, these numerical parameters may vary within ranges of values as follows:

a constant variation along X	$(3.5 \div 1.5) \cdot 10^{-2}$
b 1st degree variation along Y	$(3.5 \div 2.0) \cdot 10^{-2}$
c 2nd degree variation along Y	$(4.0 \div 7.0) \cdot 10^{-4}$
d 1 st degree variation along Z	$(3.0 \div 1.0) \cdot 10^{-2}$
e 2nd degree variation along Z	$(4.0 \div 7.0) \cdot 10^{-4}$

[0086] The apparent complexity of the formulae is outbalanced by the advantage that charts giving absolute values along x, y and z for each size in the range are made unnecessary, while any shoe shape can be given the basic size property and be used as the starting reference for the development.

[0087] A set basic size will therefore maintain the style and peculiarities that mark the national shoe culture and the traditions of the individual brands, while by developing under new parameters, the same styling can be maintained through the whole series, such as was not feasible with mechanical development methods.

[0088] Major advantages of the method of this invention for developing shoe shapes and all the component parts that are integrated to it, are:

- reduced need to manufacture a design for different fits;
- automated shoe shape production cycle, with reduced manual work requirements;
- consistent long-term reproducibility;
- easy combination of different lines;
- batch development made feasible, with substantial savings in component parts;
- different fits can be produced economically, with the plant kept unchanged;
- elimination of fastenings, as a result of using an integrated insole;
- easy re-cycling and re-use of the shoe shapes;
- possibility of separating the designing department from the production premises;
- protected construction data: a shoe shape can only be made as a copy;
- automated shoe production cycle, reducing manual work costs.

Claims

1. A method for developing a series of shoe shapes distributed in a series of shoe sizes from a base shoe shape (2) provided in a basic shoe size, comprising the following steps:

- gathering the spatial coordinates (x_B, y_B, z_B) of points on the base shoe shape (2) of basic size using gauges (15) associated with a first computer means (10) on which CAD programs are run, or obtaining said spatial coordinates (x_B, y_B, z_B) from a storage unit;
- obtaining, from the spatial coordinates (x_B, y_B, z_B) of points on the base shoe shape (2) of basic size, the spatial coordinates (x_n, y_n, z_n) of points on at least another shoe shape in the series, by using said computer means equipped with predetermined calculation formulae; wherein the obtained spatial coordinates (x_n, y_n, z_n) of points on said at least another shoe shape in the series are stored in said storage unit,

characterized in that said calculation formulae link the spatial coordinates (x_n, y_n, z_n) of points on said at least another shoe shape in the series to the spatial coordinates (x_B, y_B, z_B) of points on the base shoe shape (2) by a relation of proportionality of predetermined coefficients of development (c_x, c_y, c_z) which are functions of an integer (n) denoting the positive or negative distance of a given size in the range with respect to the basic size, according to the following formulae:

$$C_x = 1 + f(n)$$

$$C_y = 1 + f(n) - f(n \bullet |n|)$$

$$C_z = 1 + f(n) - f(n \bullet |n|)$$

where $|n|$ is the absolute value of n.

2. Method according to Claim 1, **characterized in that**, said functions of said integer (n) are multiplication functions by predetermined numerical parameters (a, b, c, d, e), as per the following relations:

$$C_x = 1 + n \bullet a$$

$$C_y = 1 + n \bullet b - n \bullet |n| \bullet c$$

$$C_z = 1 + n \bullet d - n \bullet |n| \bullet e$$

3. Method according to Claim 2, **characterized in that** the parameter (a) of constant length variation along the X axis varies within the range of $(3.5 \div 1.5) \bullet 10^{-2}$.
4. Method according to Claim 2, **characterized in that** the parameter (b) of first-degree width variation along the Y axis varies within the range of $(3.5 \div 2.0) \bullet 10^{-2}$.
5. Method according to Claim 2, **characterized in that** the parameter (d) of first-degree thickness variation along the Z axis varies within the range of $(3.0 \div 1.0) \bullet 10^{-2}$.
6. Method according to Claim 2, **characterized in that** the parameter (c) of second-degree width variation along the Y axis varies within the range of $(4.0 \div 7.0) \bullet 10^{-4}$.
7. Method according to Claim 2, **characterized in that** the parameter (e) of second-degree thickness variation along the Z axis varies within the range of $(4.0 \div 7.0) \bullet 10^{-4}$.

8. Method according to Claim 2, **characterized in that** the values of said parameters (c, e) of second degree variation along the Y and Z axes may be coincident.
9. Method according to Claim 2, **characterized in that** the values of said parameters (a, b, c, d, e) are increased to develop shoe shapes for child sizes from those for developing lady/gentleman shoe shapes.
10. Method according to Claim 1, **characterized in that** said gauges (15) measure the surface (3) of said base shoe shape (2) in combination with said computer means (10) on which CAD programs are run.
11. Method according to Claim 1, **characterized in that** said first computer means comprises a computer unit on which CAD/CAM programs are run, and said storage unit.
12. Method according to Claim 1, **characterized in that** said storage unit contains a database.

Patentansprüche

1. Verfahren zur Entwicklung einer Serie von Schuhformen, die in einer Serie von Schuhgrößen verteilt sind, von einer Grundsuhform (2), die in einer Grundsuhgröße vorgesehen ist, wobei das Verfahren die folgenden Schritte aufweist:

- Erfassen der räumlichen Koordinaten (x_B, y_B, z_B) von Punkten an der Grundsuhform (2) einer Grundgröße unter Verwendung von Messgeräten (15), die mit einer ersten Rechneinrichtung (10) verbunden sind, auf der CAD-Programme ablaufen, oder Erhalten der räumlichen Koordinaten (x_B, y_B, z_B) von einer Speichereinheit;
- Erhalten, von den räumlichen Koordinaten (x_B, y_B, z_B) von Punkten an der Grundsuhform (2) einer Grundgröße, der räumlichen Koordinaten (x_n, y_n, z_n) von Punkten an zumindest einer weiteren Schuhform in der Serie unter Verwendung von der Rechneinrichtung, die mit einem vorbestimmten Berechnungsschema ausgestattet ist; wobei die erhaltenen räumlichen Koordinaten (x_n, y_n, z_n) von Punkten an der zumindest einen weiteren Schuhform in der Serie in der Speichereinheit gespeichert werden,

dadurch gekennzeichnet, dass

das Berechnungsschema die räumlichen Koordinaten (x_n, y_n, z_n) von Punkten an der zumindest einen weiteren Schuhform in der Serie mit den räumlichen Koordinaten (x_B, y_B, z_B) von Punkten an der Grundsuhform (2) durch ein Proportionalitätsverhältnis von vorbestimmten Entwicklungskoeffizienten (c_x, c_y, c_z), die Funktionen einer Ganzzahl (n) sind, die einen positiven oder negativen Abstand einer gegebenen Größe in dem Bereich mit Bezug auf die Grundgröße bezeichnet, gemäß dem nachstehenden Schema verknüpft:

$$C_x = 1 + f(n)$$

$$C_y = 1 + f(n) - f(n \cdot |n|)$$

$$C_z = 1 + f(n) - f(n \cdot |n|)$$

in denen $|n|$ der absolute Wert von n ist.

2. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die Funktionen der Ganzzahl (n) Multiplikationsfunktionen mit vorbestimmten numerischen Parametern (a, b, c, d, e) gemäß der nachstehenden Verhältnisse sind:

$$C_x = 1 + n \cdot a$$

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$$C_y = 1 + n \cdot b - n \cdot |n| \cdot c$$

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$$C_z = 1 + n \cdot d - n \cdot |n| \cdot e.$$

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3. Verfahren gemäß Anspruch 2, **dadurch gekennzeichnet, dass** sich der Parameter (a) einer konstanten Längenänderung entlang der X-Achse innerhalb des Bereichs von (3, 5 bis 1,5) • 10⁻² ändert.

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4. Verfahren gemäß Anspruch 2, **dadurch gekennzeichnet, dass** sich der Parameter (b) einer Breitenänderung ersten Grades entlang der Y-Achse innerhalb des Bereichs von (3,5 bis 2,0) • 10⁻² ändert.

5. Verfahren gemäß Anspruch 2, **dadurch gekennzeichnet, dass** sich der Parameter (d) einer Dickenänderung ersten Grades entlang der Z-Achse innerhalb des Bereichs von (3,0 bis 1,0) • 10⁻² ändert.

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6. Verfahren gemäß Anspruch 2, **dadurch gekennzeichnet, dass** sich der Parameter (c) einer Breitenänderung zweiten Grades entlang der Y-Achse innerhalb des Bereichs von (4,0 bis 7,0) • 10⁻⁴ verändert.

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7. Verfahren gemäß Anspruch 2, **dadurch gekennzeichnet, dass** sich der Parameter (e) einer Dickenänderung zweiten Grades entlang der Z-Achse innerhalb des Bereichs von (4,0 bis 7,0) • 10⁻⁴ ändert.

8. Verfahren gemäß Anspruch 2, **dadurch gekennzeichnet, dass** die Werte der Parameter (c, e) einer Änderung zweiten Grades entlang der Y- und der Z-Achse übereinstimmen können.

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9. Verfahren gemäß Anspruch 2, **dadurch gekennzeichnet, dass** die Werte der Parameter (a, b, c, d, e) erhöht werden, um Schuhformen für Kindergrößen von denen zur Entwicklung von Frauen-/Herrenschuhformen zu entwickeln.

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10. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die Messgeräte (15) die Fläche (3) der Grundschuhform (2) in Verbindung mit der Rechneinrichtung (10) messen, auf der CAD-Programme ablaufen.

11. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die erste Rechneinrichtung eine Rechneinheit, auf der CAD-/CAM-Programme ablaufen, und die Speichereinheit aufweist.

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12. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die Speichereinheit eine Datenbank beinhaltet.

Revendications

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1. Procédé de développement d'une série de formes de chaussures réparties en une série de pointures à partir d'une forme de chaussure de base (2) fournie dans une pointure de base, comprenant les étapes suivantes consistant à :

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- rassembler les coordonnées spatiales (x_B, y_B, z_B) des points sur la forme de chaussure de base (2) de pointure de base en utilisant des gabarits (15) associés à un premier moyen informatique (10) sur lequel sont exécutés des programmes de CAO, ou en obtenant lesdites coordonnées spatiales (x_B, y_B, z_B) depuis une unité de mémoire ;

- obtenir, à partir des coordonnées spatiales (x_B, y_B, z_B) des points sur la forme de chaussure de base (2) de pointure de base, les coordonnées spatiales (x_n, y_n, z_n) des points sur au moins une autre forme de chaussure

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dans la série, en utilisant ledit moyen informatique muni de formules de calcul prédéterminées ; dans lequel les coordonnées spatiales obtenues (x_n , y_n , z_n) des points sur ladite au moins autre forme de chaussure dans la série sont stockées dans ladite unité de mémoire,

caractérisé en ce que lesdites formules de calcul relient les coordonnées spatiales (x_n , y_n , z_n) des points sur ladite au moins autre forme de chaussure dans la série aux coordonnées spatiales (x_B , y_B , z_B) des points sur la forme de chaussure de base (2) par un rapport de proportionnalité des coefficients prédéterminés de développement (c_x , c_y , c_z) qui sont des fonctions d'un nombre entier (n) indiquant la distance positive ou négative d'une pointure donnée dans la plage par rapport à la pointure de base, selon les formules suivantes :

$$C_x = 1 + f(n)$$

$$C_y = 1 + f(n) - f(n \bullet |n|)$$

$$C_z = 1 + f(n) - f(n \bullet |n|)$$

où $|n|$ est la valeur absolue de n .

2. Procédé selon la revendication 1, **caractérisé en ce que** lesdites fonctions dudit nombre entier (n) sont des fonctions de multiplication par des paramètres numériques prédéterminés (a , b , c , d , e), suivant les rapports suivants :

$$C_x = 1 + n \bullet a$$

$$C_y = 1 + n \bullet b - n \bullet |n| \bullet c$$

$$C_z = 1 + n \bullet d - n \bullet |n| \bullet e$$

3. Procédé selon la revendication 2, **caractérisé en ce que** le paramètre (a) de variation de longueur constante le long de l'axe X varie dans la plage de $(3,5 \div 1,5) \cdot 10^{-2}$.
4. Procédé selon la revendication 2, **caractérisé en ce que** le paramètre (b) de variation de largeur de premier degré le long de l'axe Y varie dans la plage de $(3,5 \div 2,0) \cdot 10^{-2}$.
5. Procédé selon la revendication 2, **caractérisé en ce que** le paramètre (d) de variation d'épaisseur de premier degré le long de l'axe Z varie dans la plage de $(3,0 \div 1,0) \cdot 10^{-2}$.
6. Procédé selon la revendication 2, **caractérisé en ce que** le paramètre (c) de variation de largeur de second degré le long de l'axe Y varie dans la plage de $(4,0 \div 7,0) \cdot 10^{-4}$.
7. Procédé selon la revendication 2, **caractérisé en ce que** le paramètre (e) de variation d'épaisseur de second degré le long de l'axe Z varie dans la plage de $(4,0 \div 7,0) \cdot 10^{-4}$.
8. Procédé selon la revendication 2, **caractérisé en ce que** les valeurs desdits paramètres (c , e) de variation de second degré le long des axes Y et Z peuvent être identiques.

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9. Procédé selon la revendication 2, **caractérisé en ce que** les valeurs desdits paramètres (a, b, c, d, e) sont augmentées pour développer les formes de chaussure pour les pointures pour enfants à partir de celles destinées à développer les formes de chaussures pour femmes/hommes.

5 10. Procédé selon la revendication 1, **caractérisé en ce que** lesdits gabarits (15) mesurent la surface (3) de ladite forme de chaussure de base (2) en combinaison avec ledit moyen informatique (10) sur lequel sont exécutés des programmes de CAO.

10 11. Procédé selon la revendication 1, **caractérisé en ce que** ledit premier moyen informatique comprend une unité informatique sur laquelle sont exécutés des programmes de CAO/FAO, et ladite unité de mémoire.

12. Procédé selon la revendication 1, **caractérisé en ce que** ladite unité de mémoire contient une base de données.

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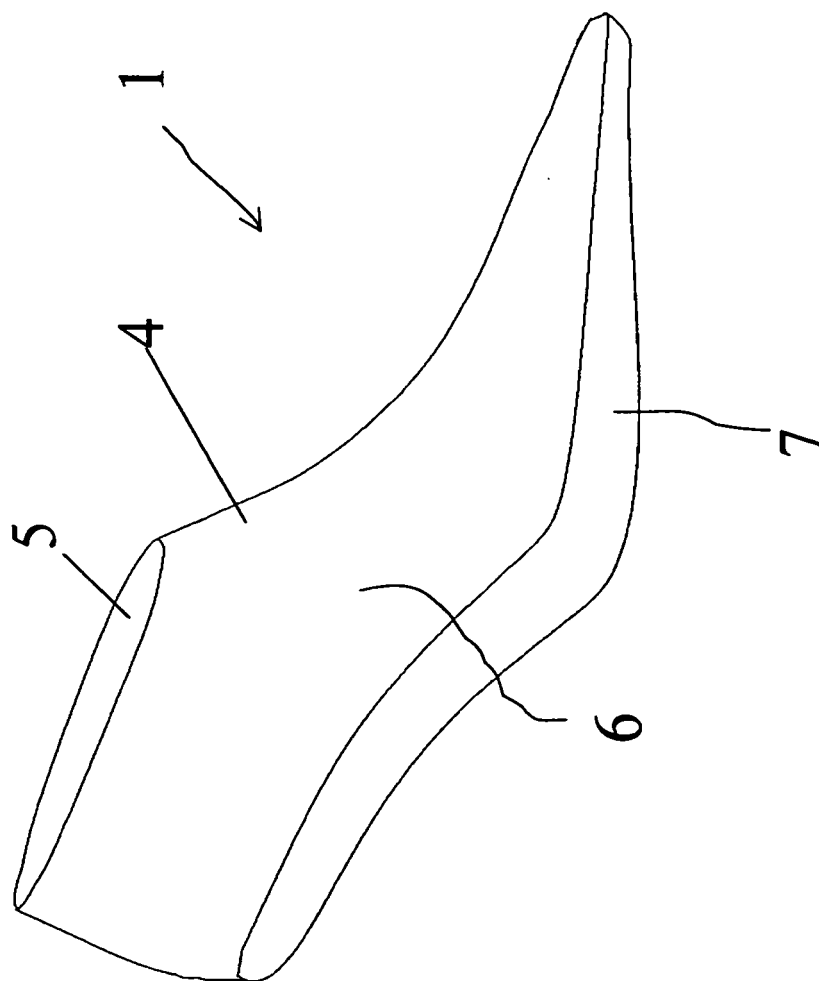


FIG. 1

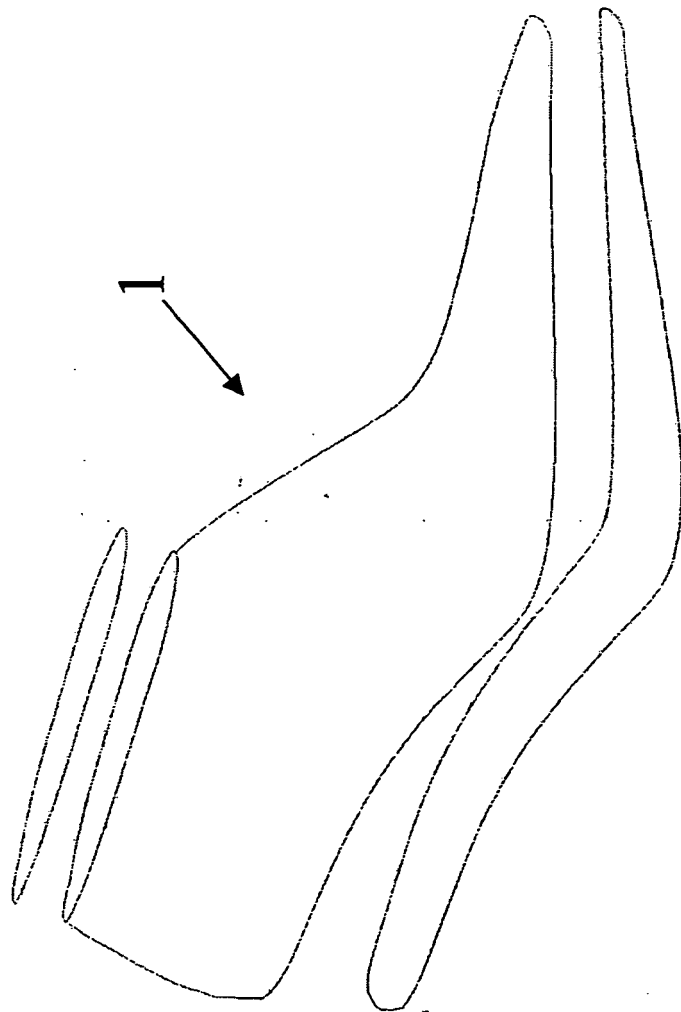


FIG. 2

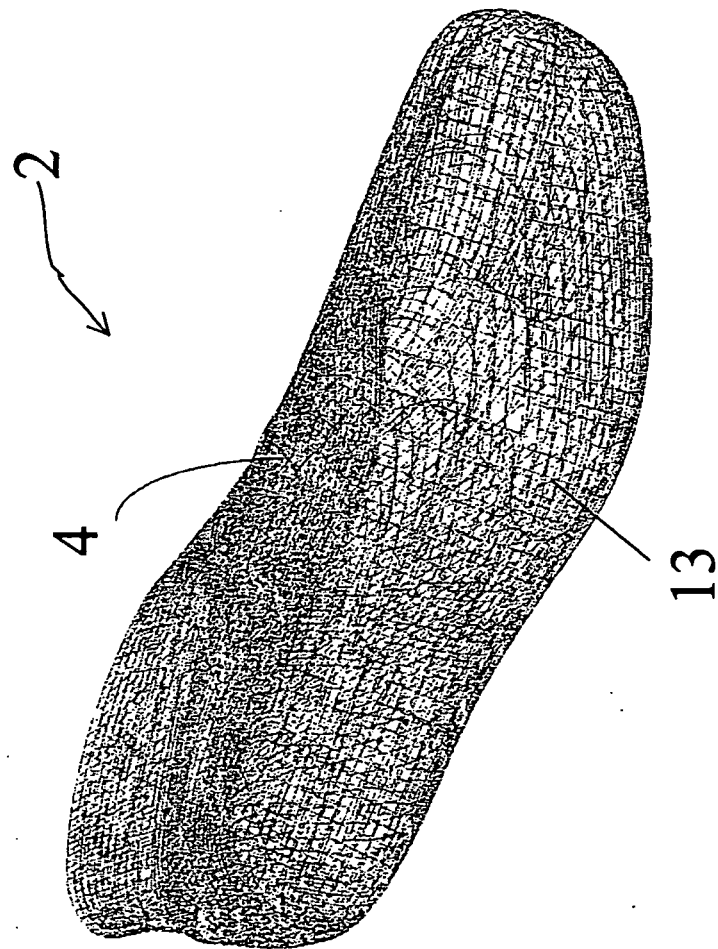


FIG. 3

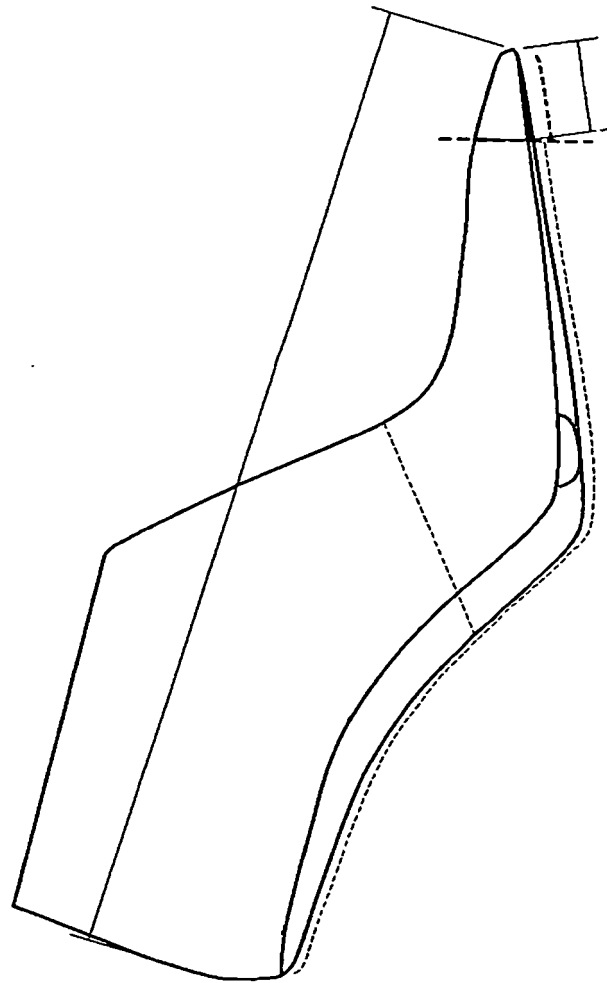
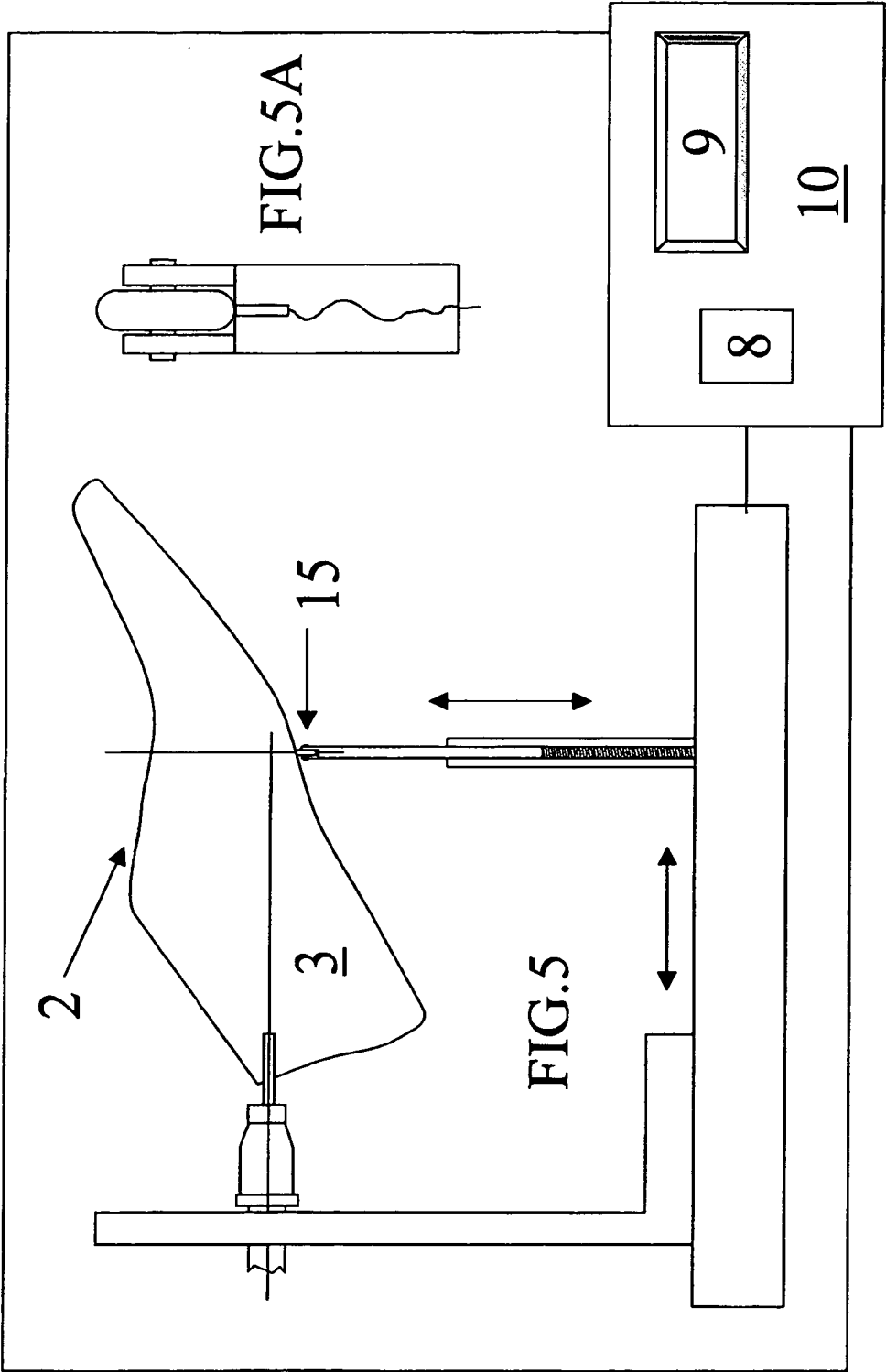
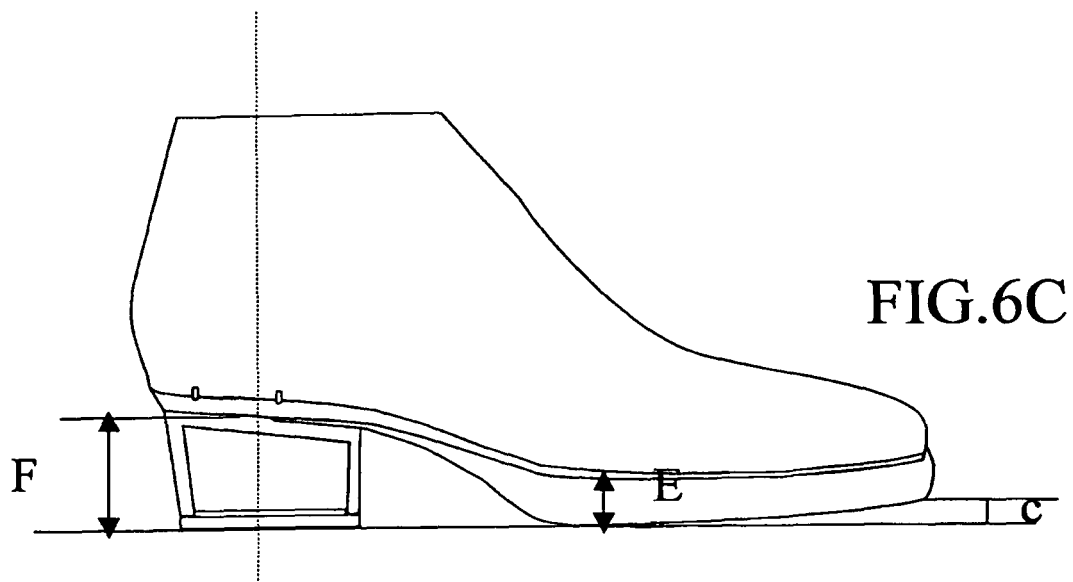
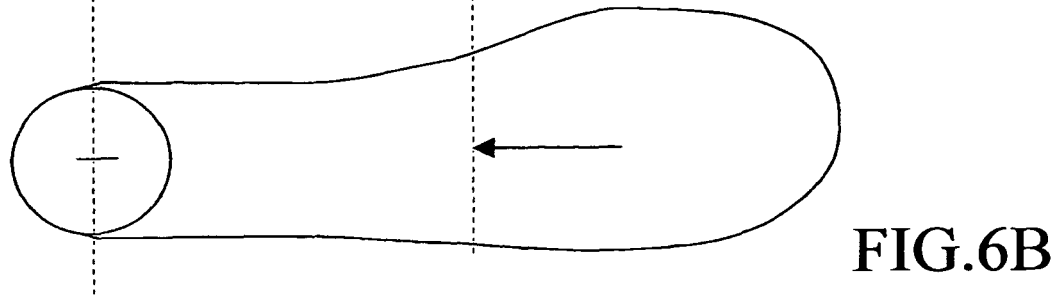
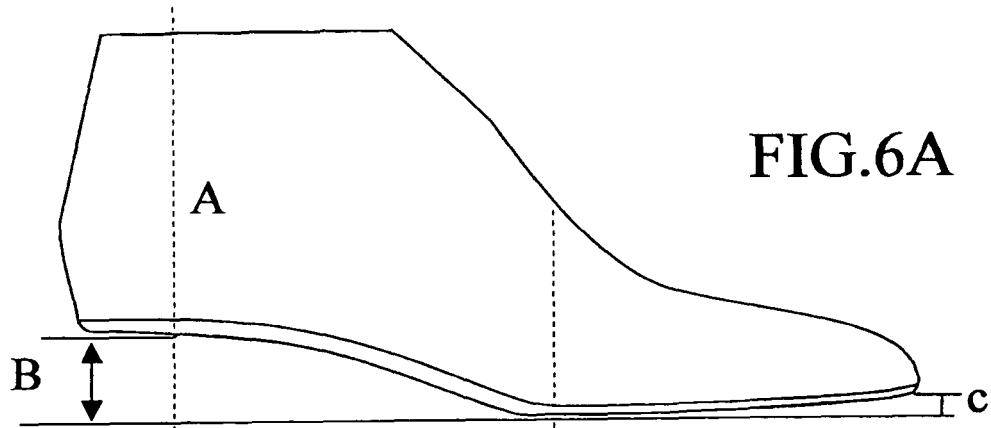


FIG. 4





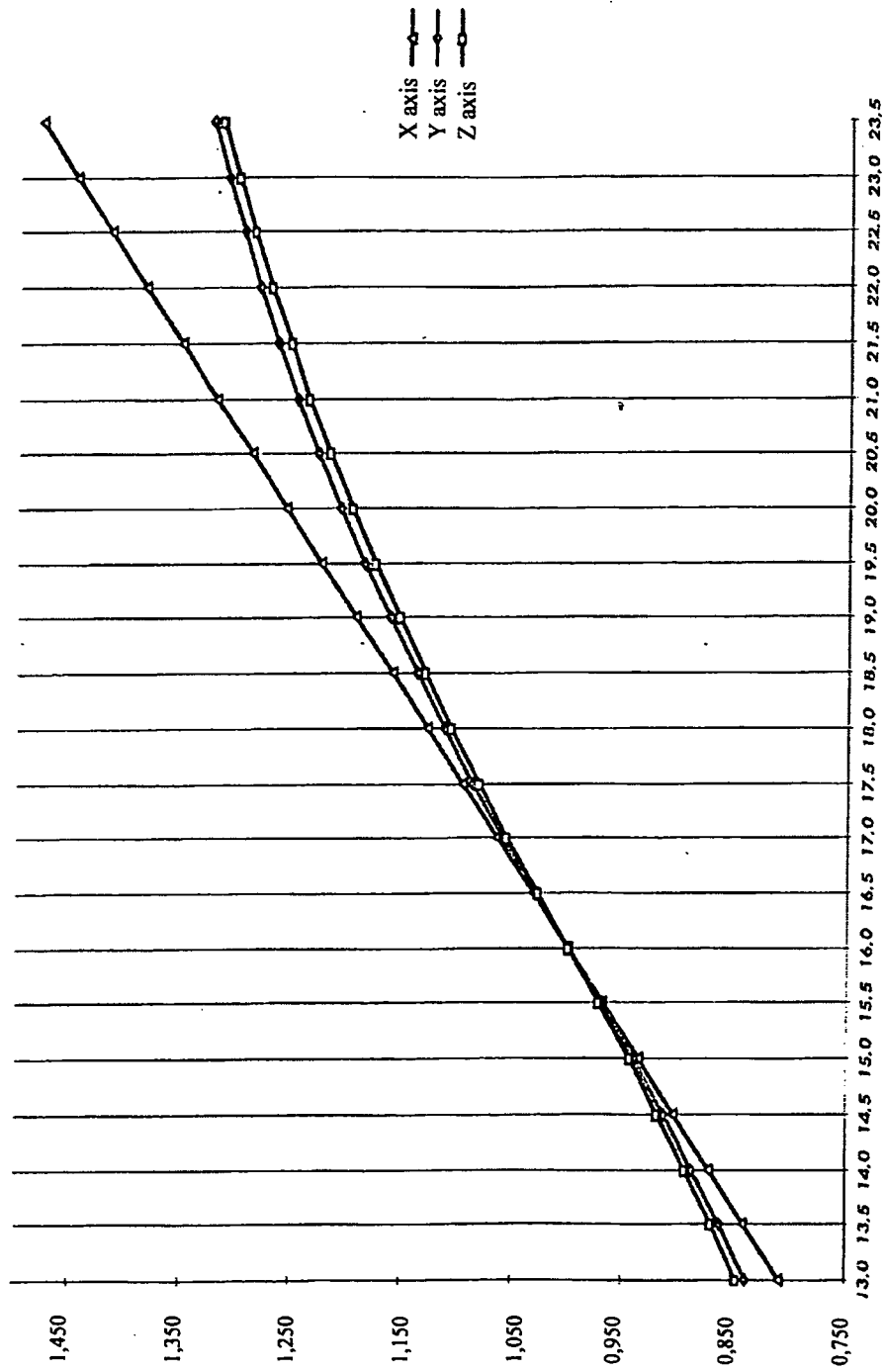


FIG.7

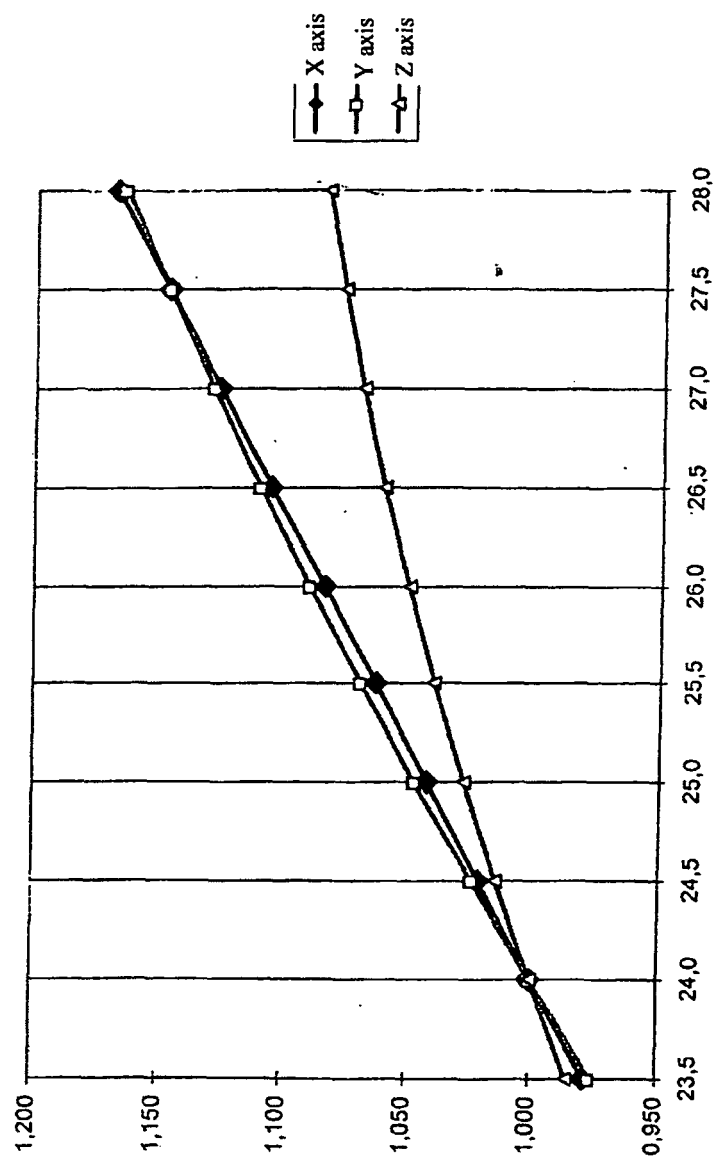


FIG.8

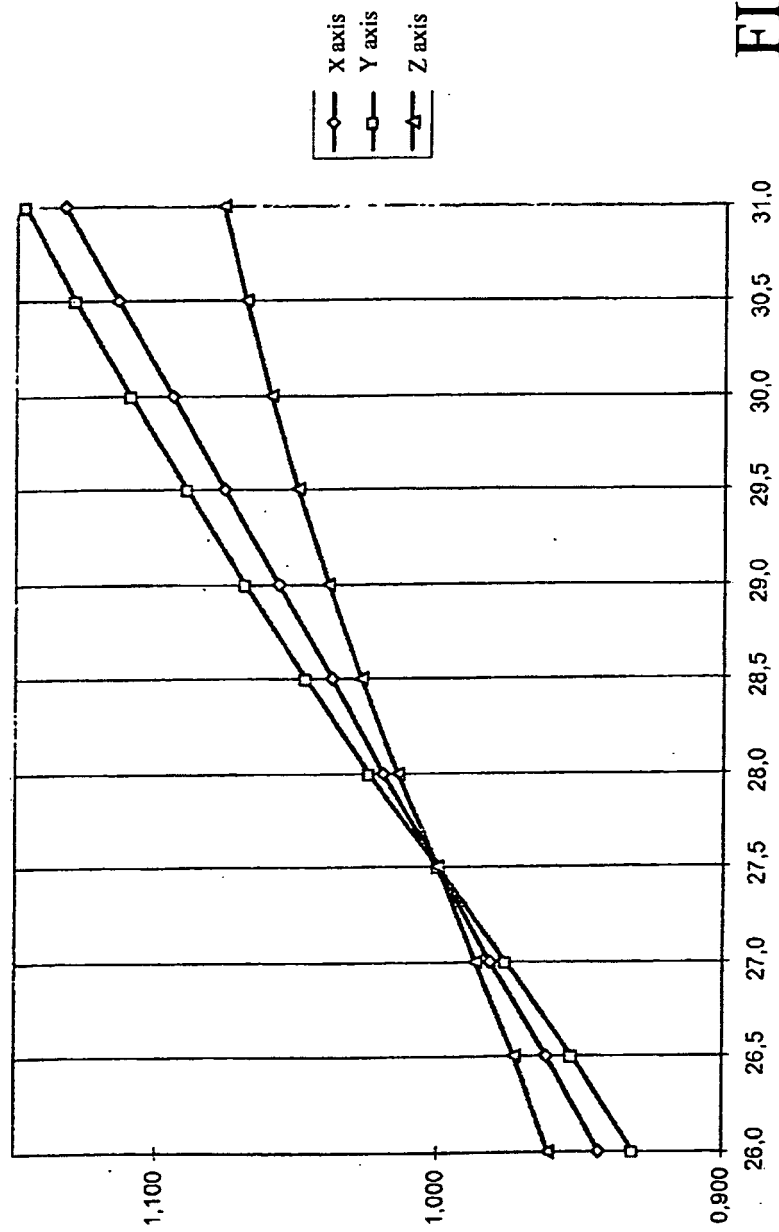


FIG.9