

[54] **SHOE MAKING**

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[51] Int. Cl. A43d 11/00

[58] Field of Search 12/146 R, 146 C, 54.1

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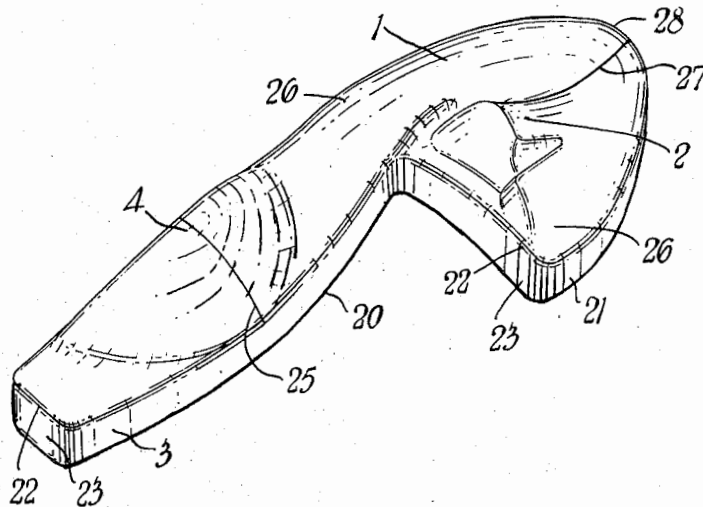
Primary Examiner—Patrick D. Lawson
Attorney—Lerner, David & Littenberg

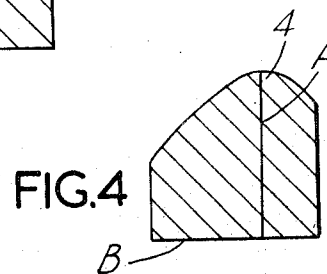
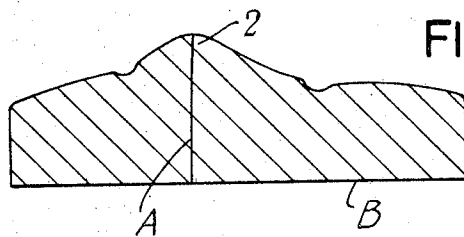
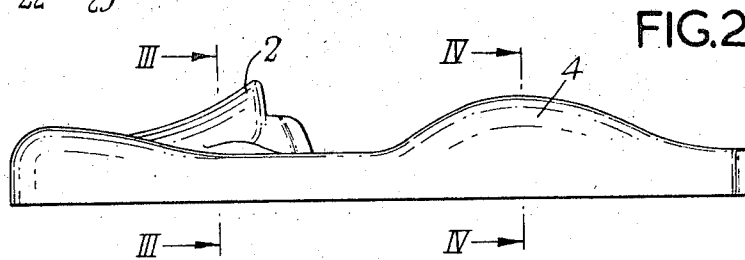
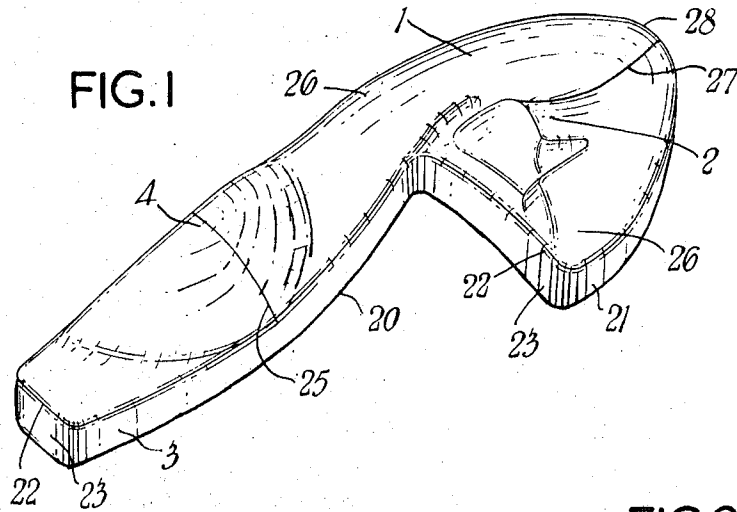
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ABSTRACT

Methods of preforming shoe uppers are provided using molds of a novel shape. The shape of the mold is such that the material is not stretched more than, in preferred embodiments, about 25 percent. The mold corresponds to the shape of the whole upper but is flatter than the last, is preferably unitary but can be in two or more parts. The methods involve heating the material and carrying out a pressure differential forming operation. Mechanical movement of the molds into the material, just prior to the vacuum forming is also described. When forming several uppers simultaneously, a template may be placed over the molds and subsequently used as a cutting guide. The difficulties of lasting in the normal way are avoided by the invention.

26 Claims, 37 Drawing Figures





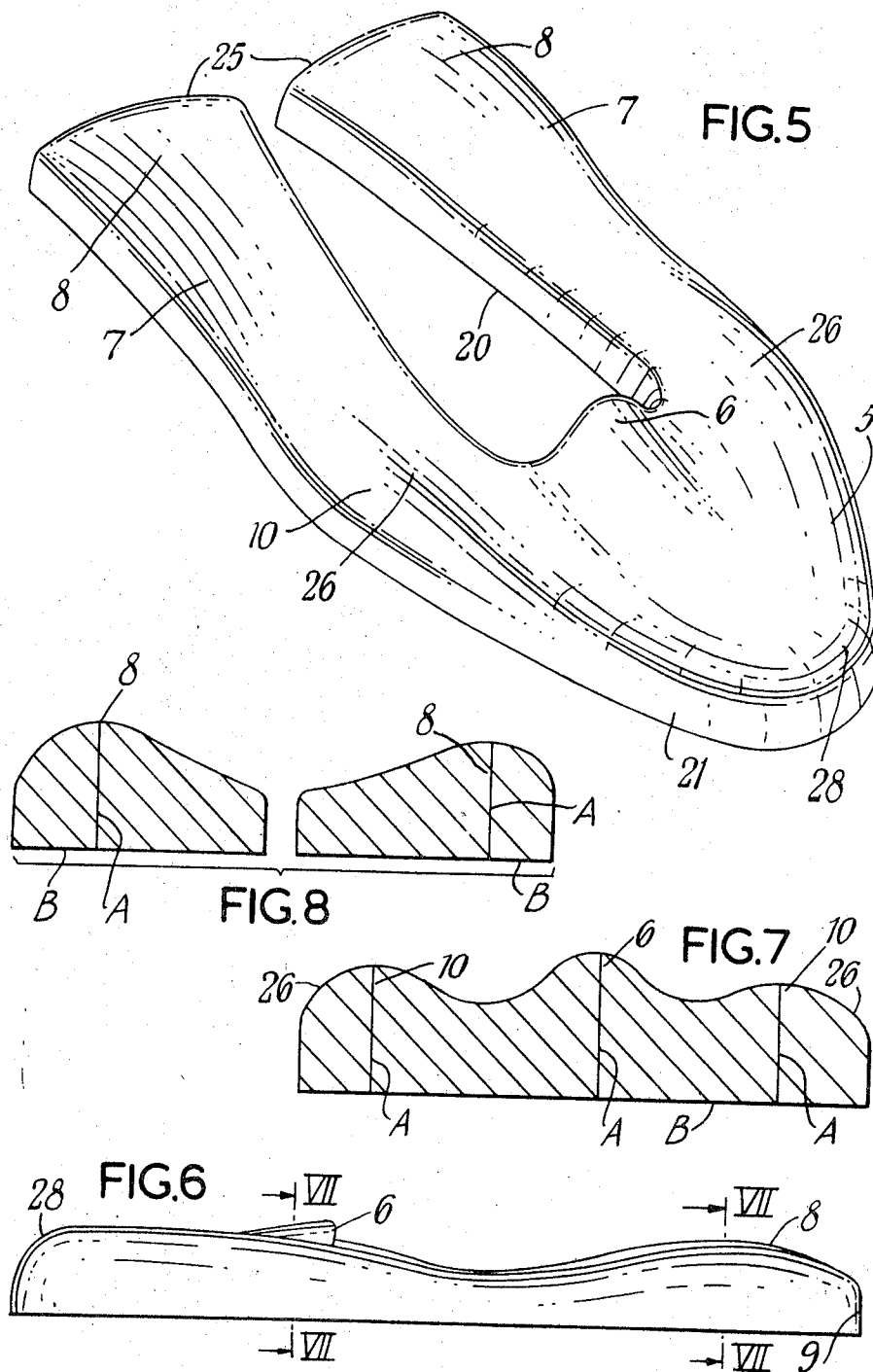


FIG.9

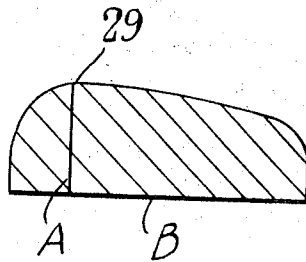
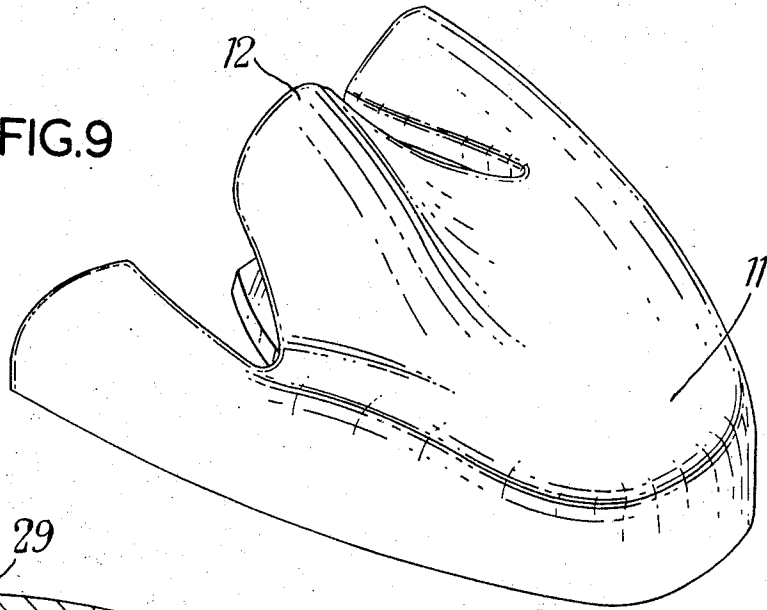


FIG.11

FIG.10

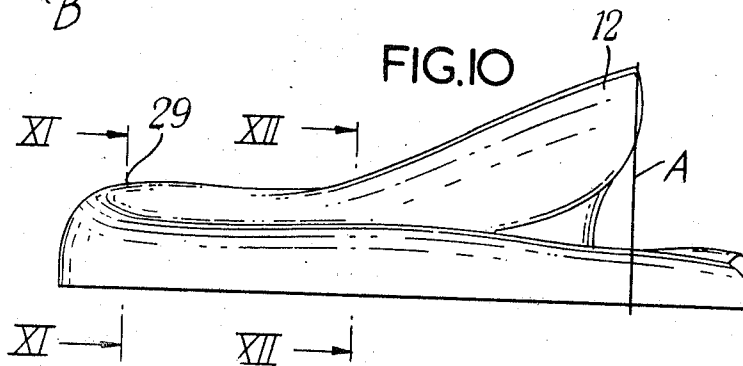
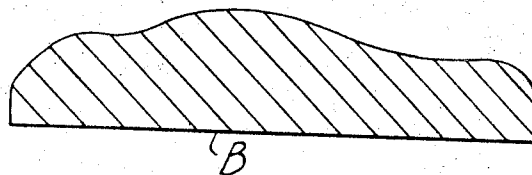
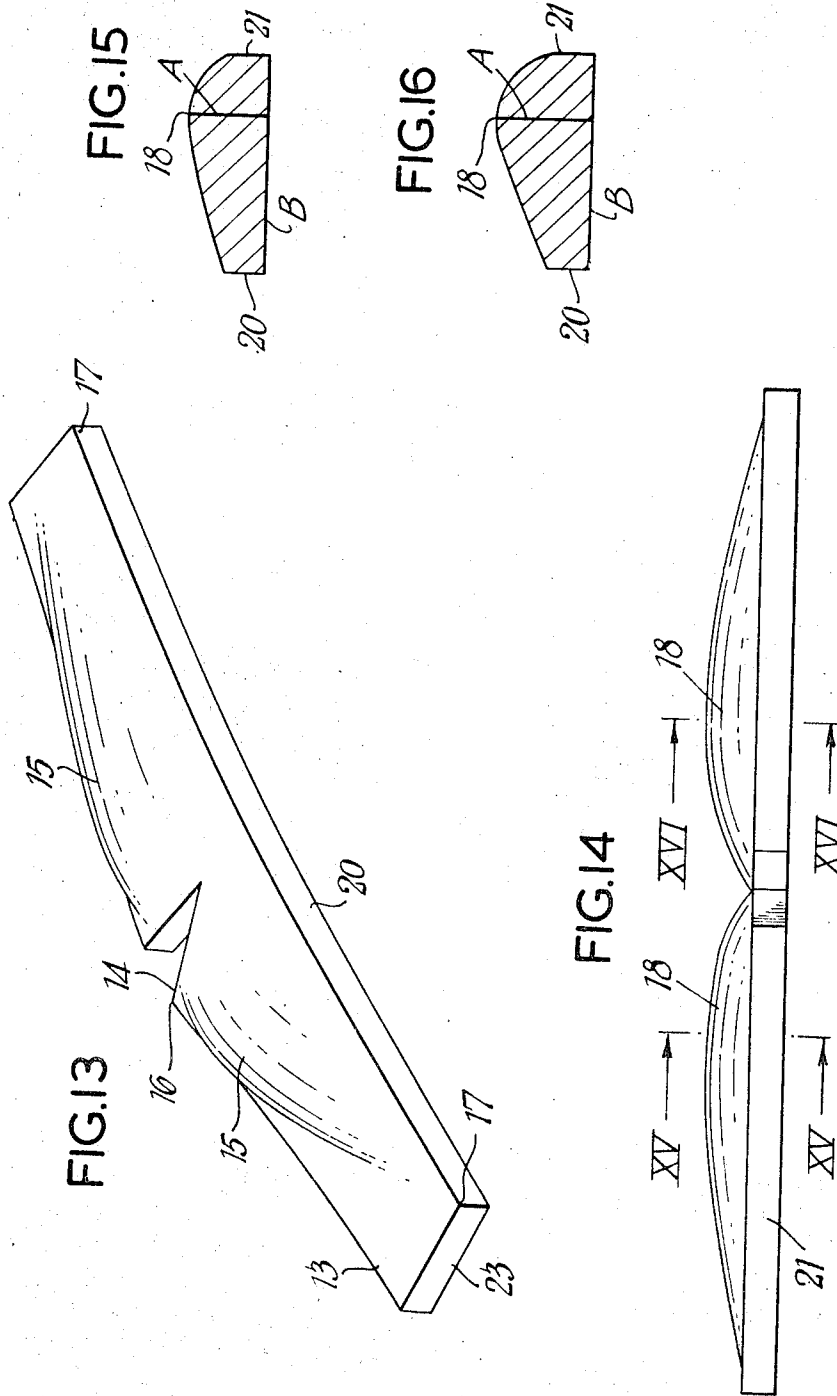


FIG.12





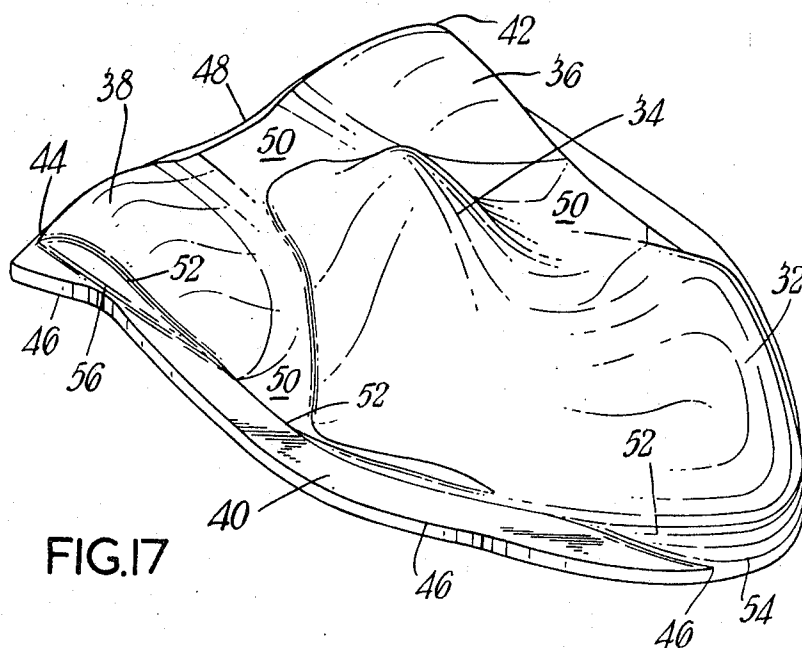


FIG. 17

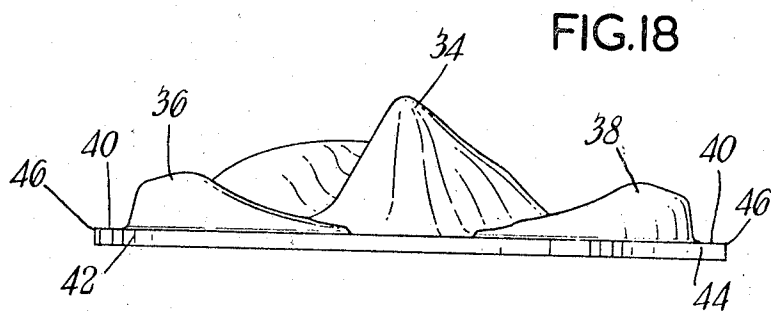
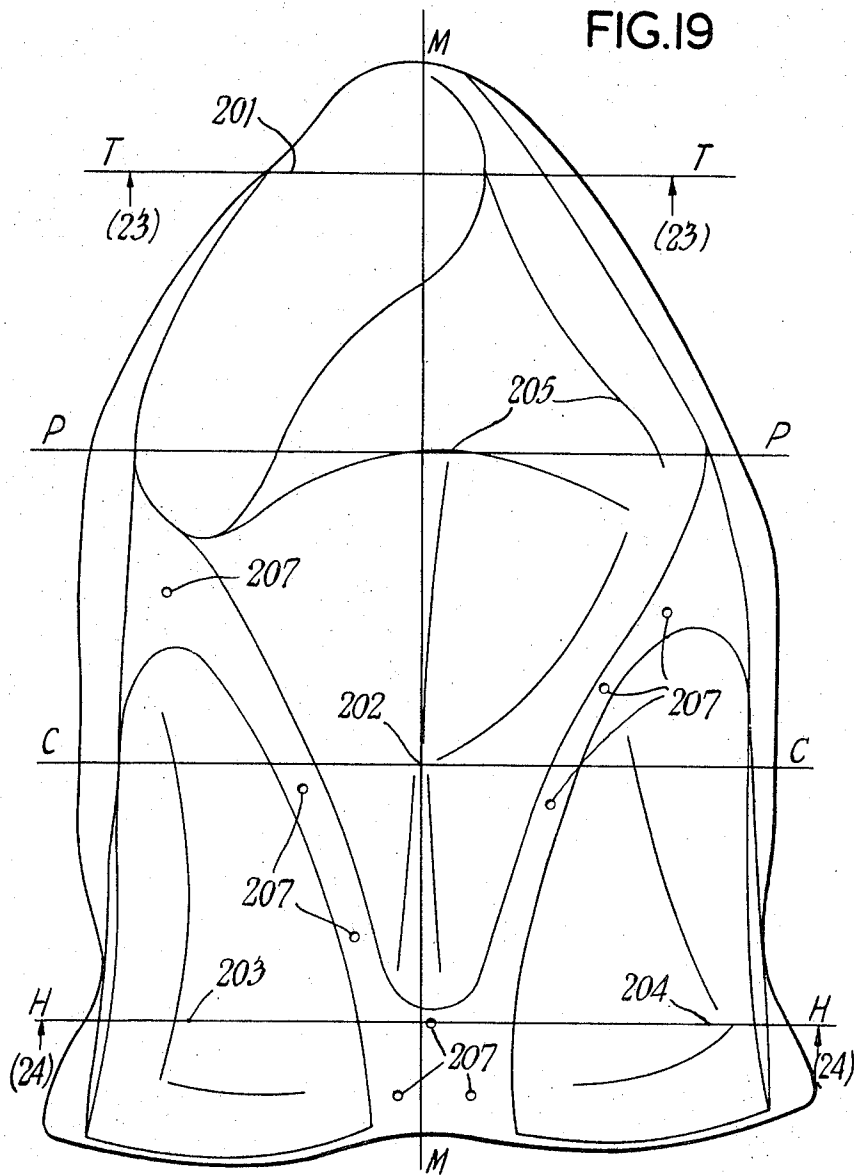


FIG. 18



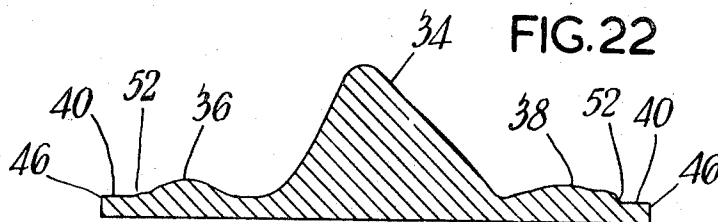
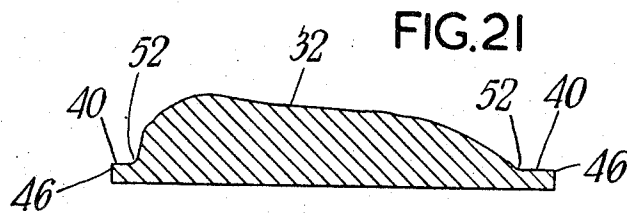
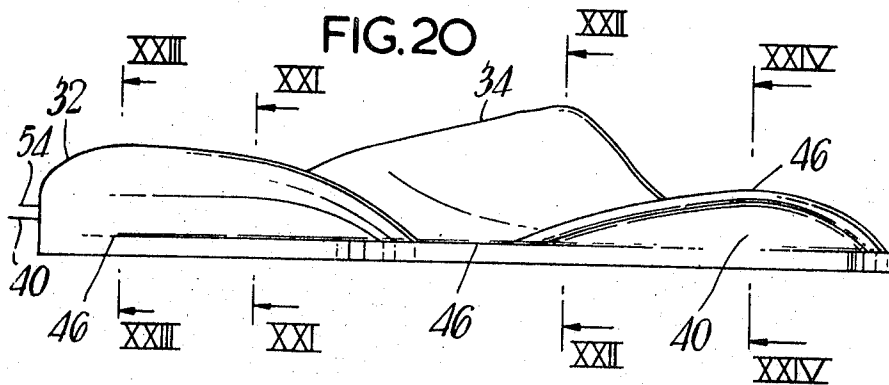


FIG. 23

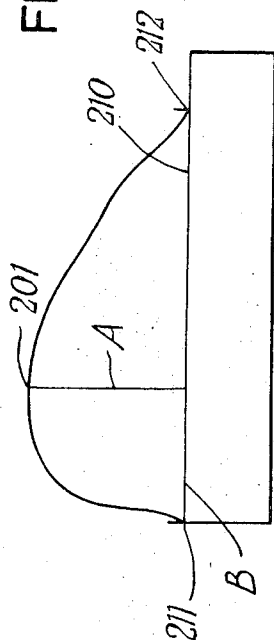


FIG. 24

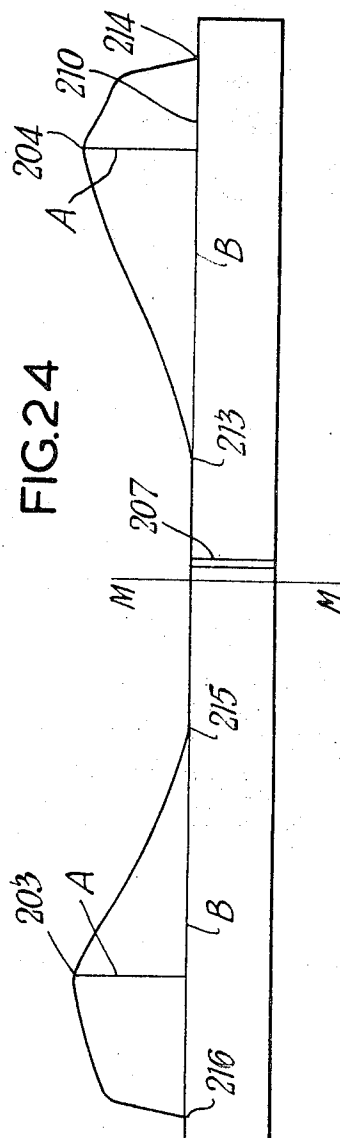


FIG.25

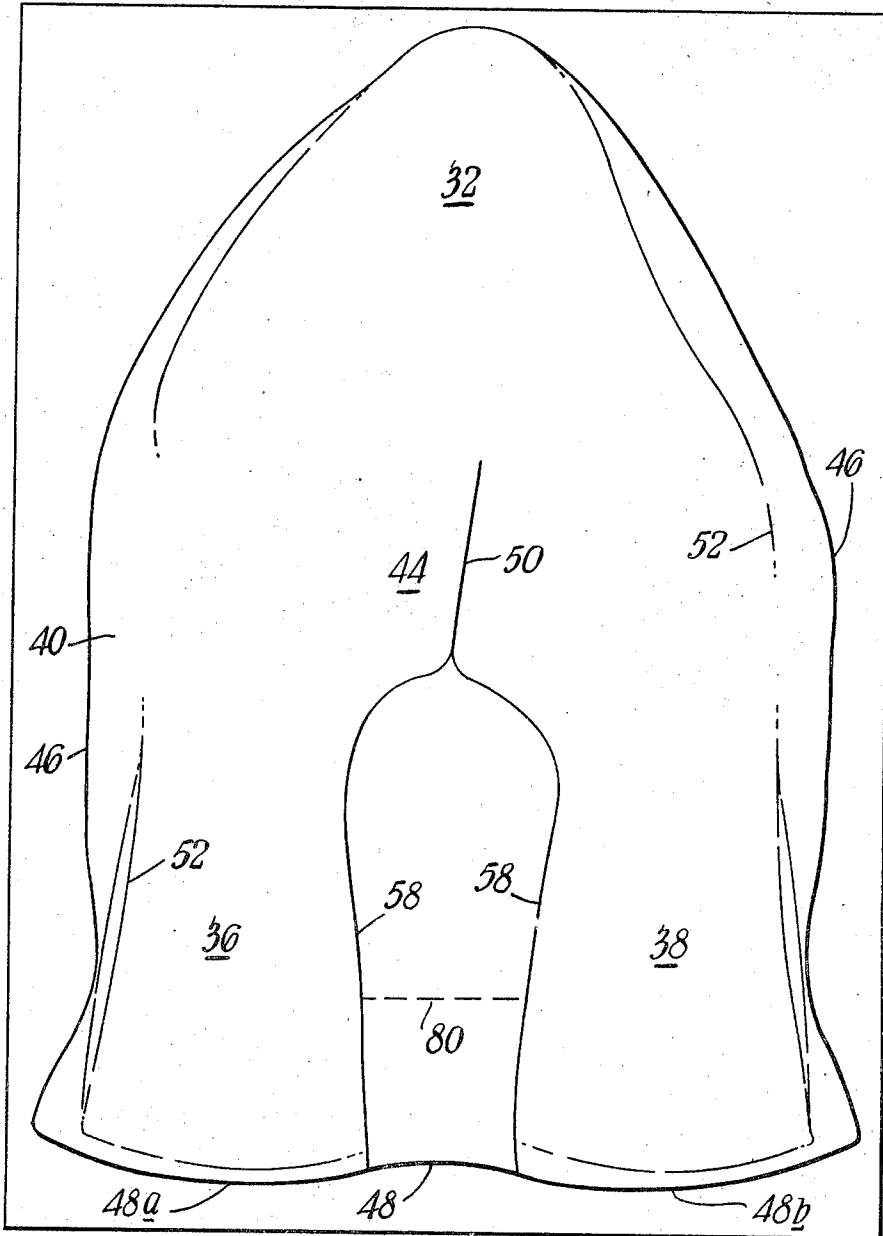


FIG.26

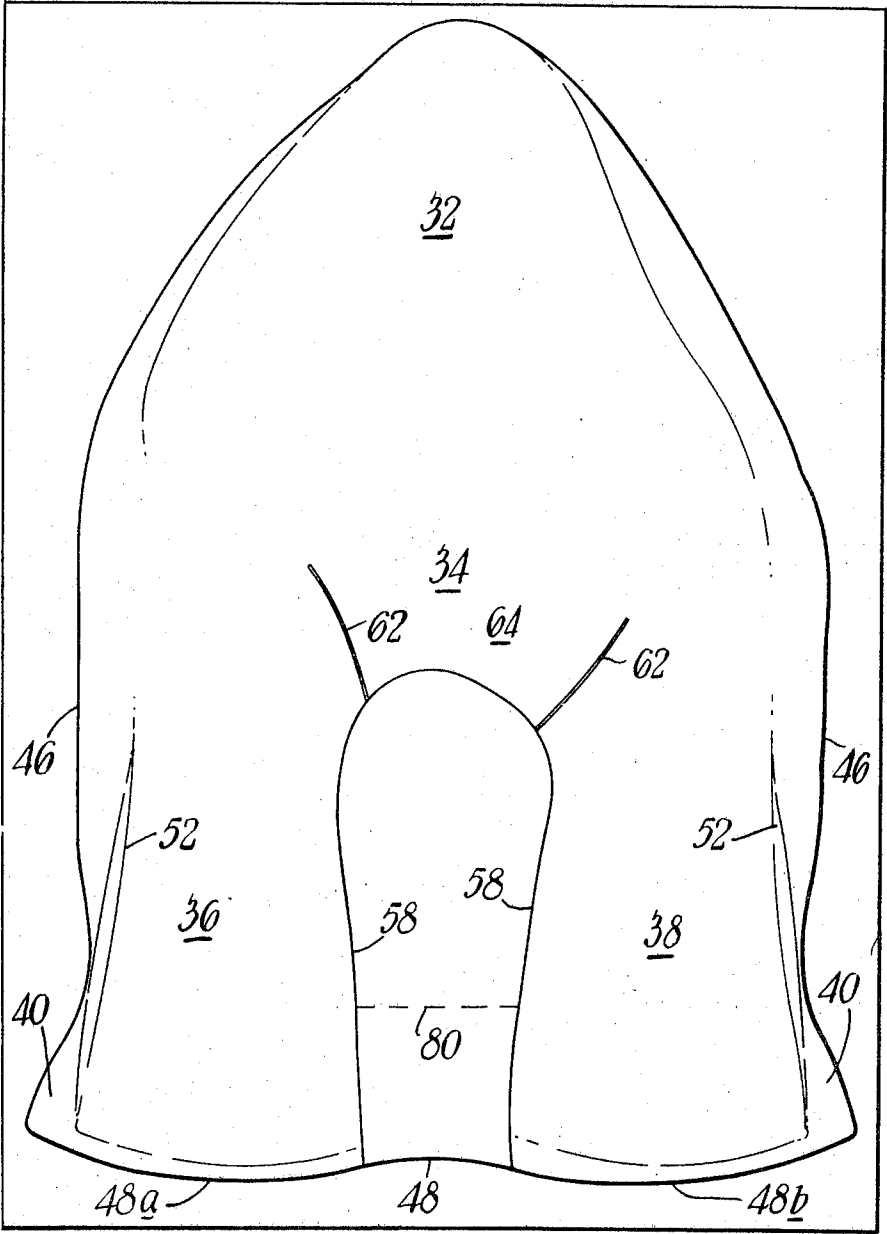
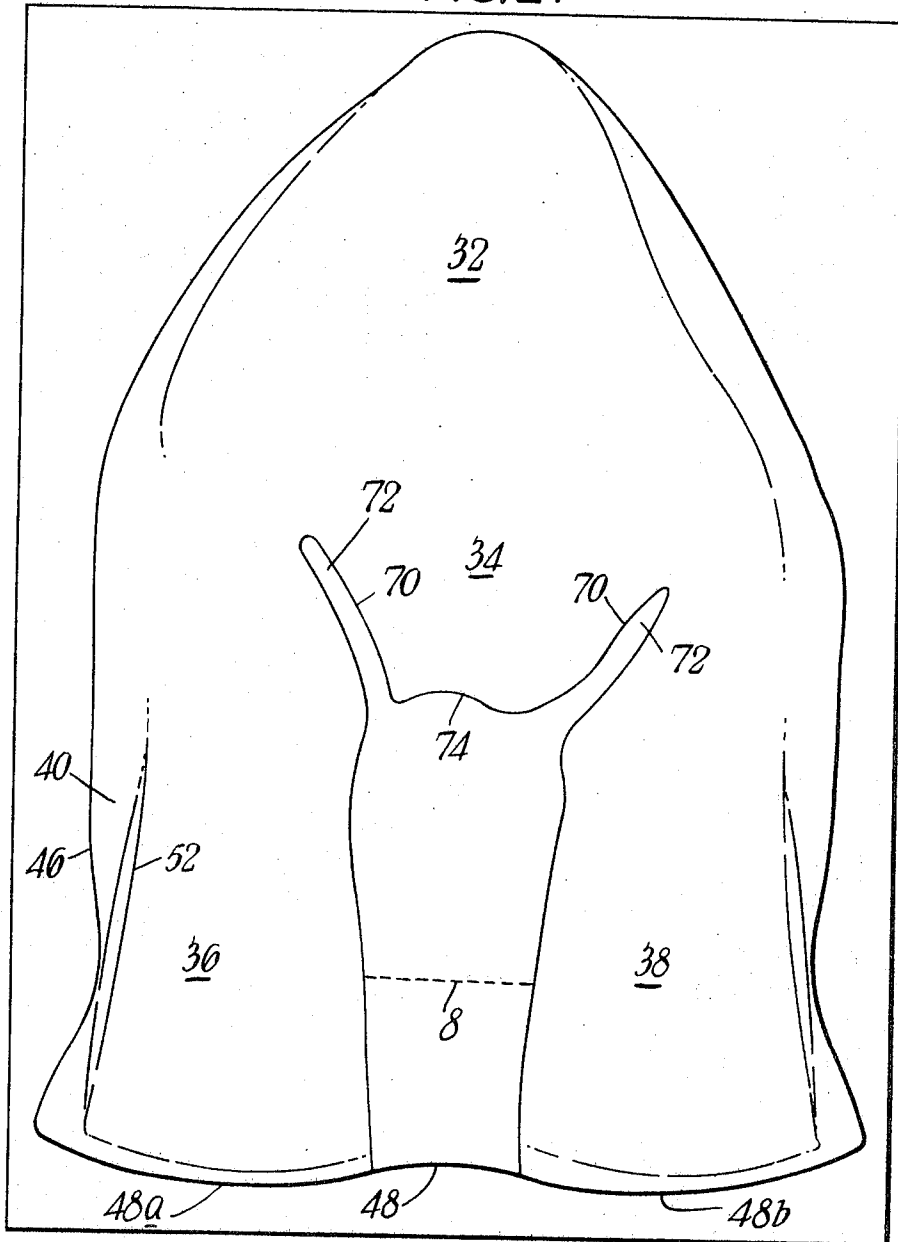
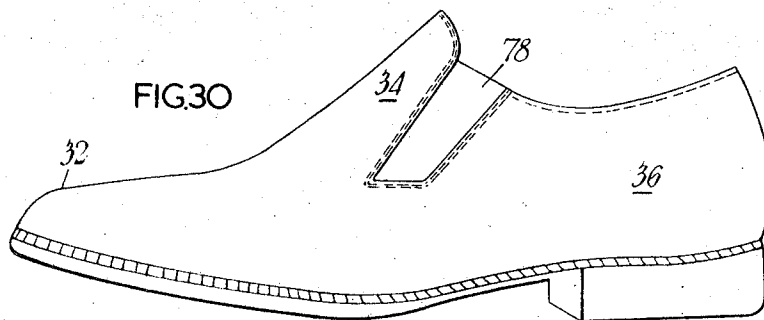
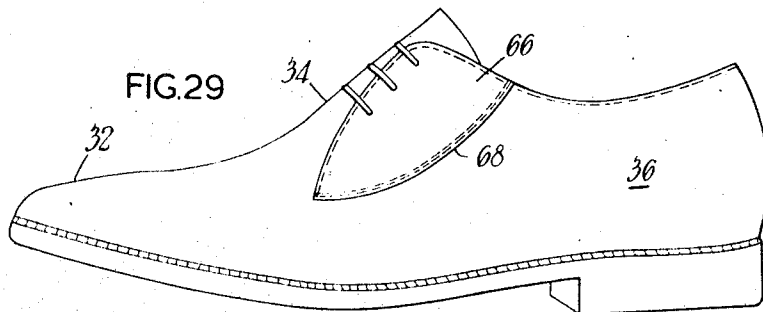
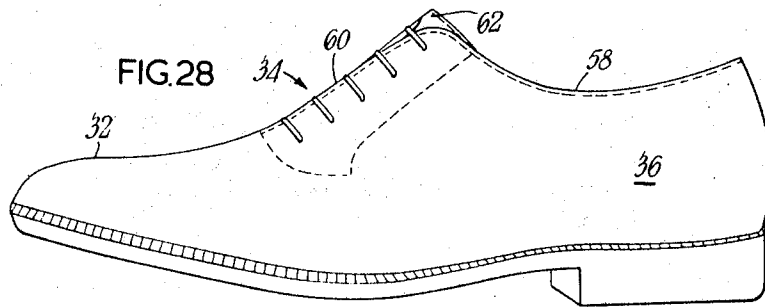
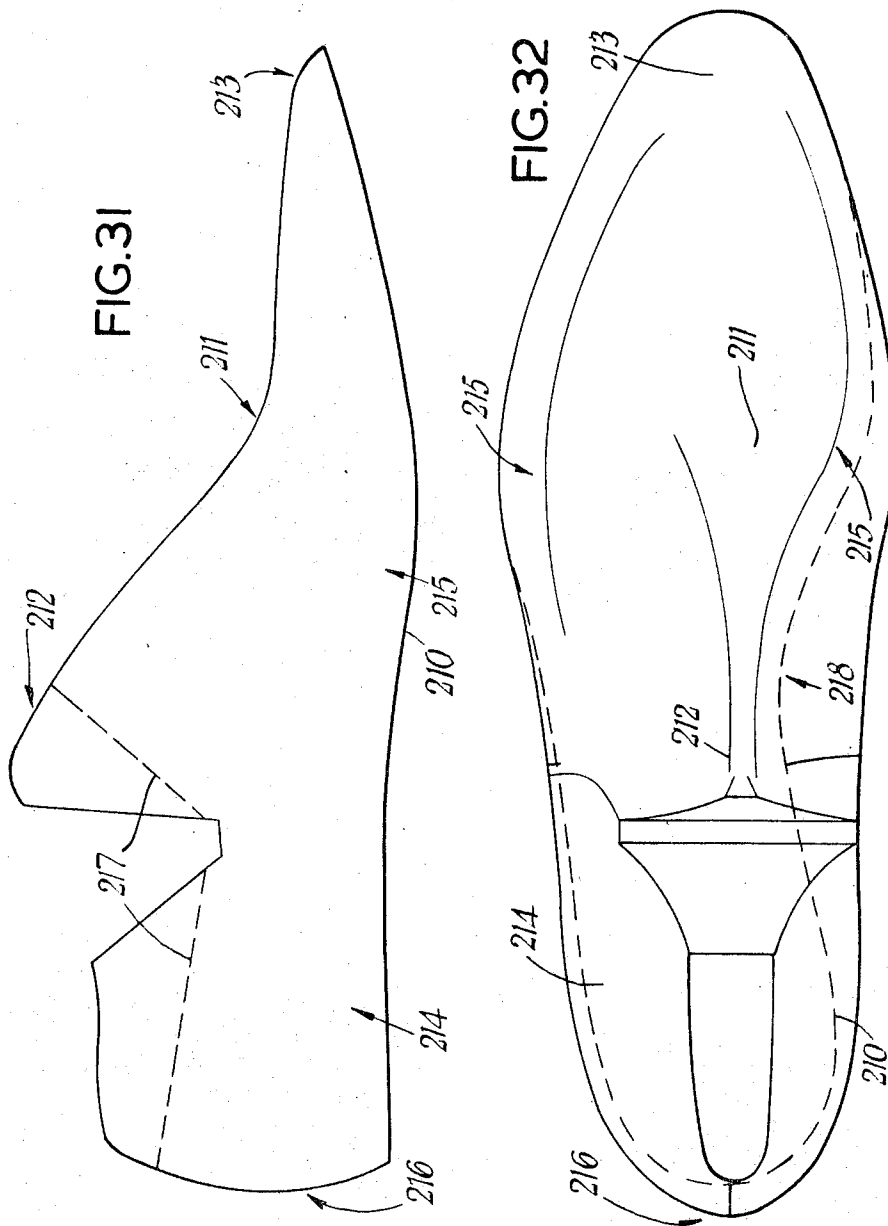


FIG. 27







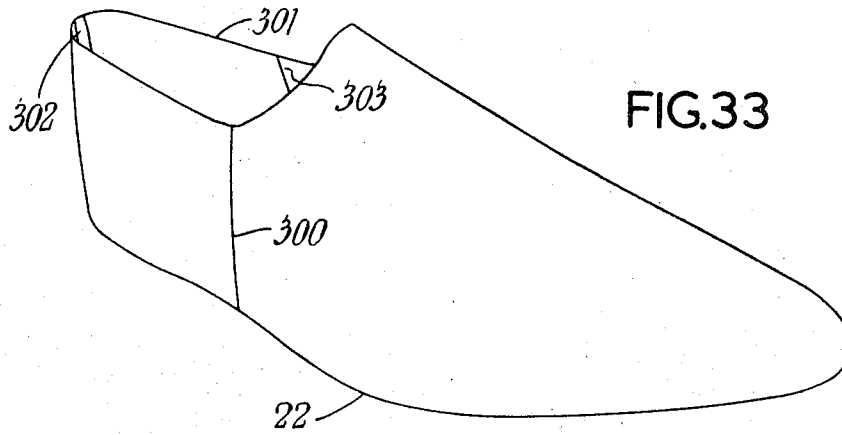


FIG. 33

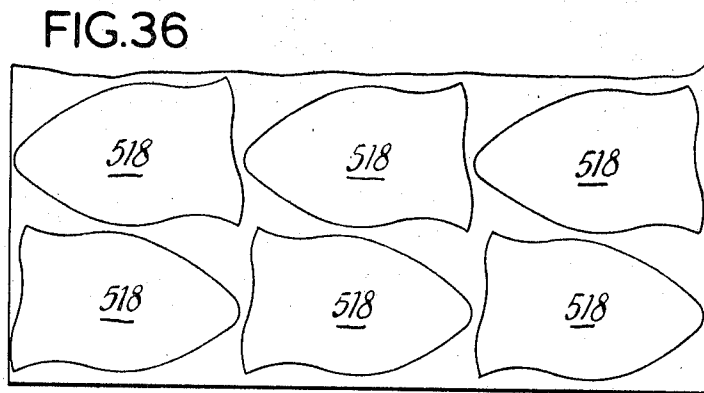


FIG. 36

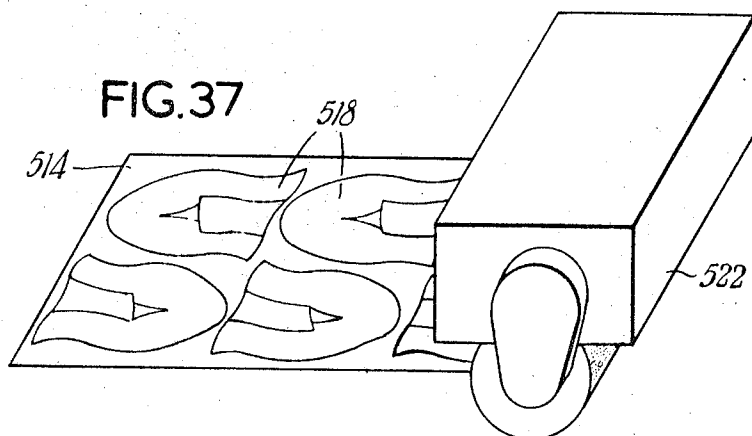
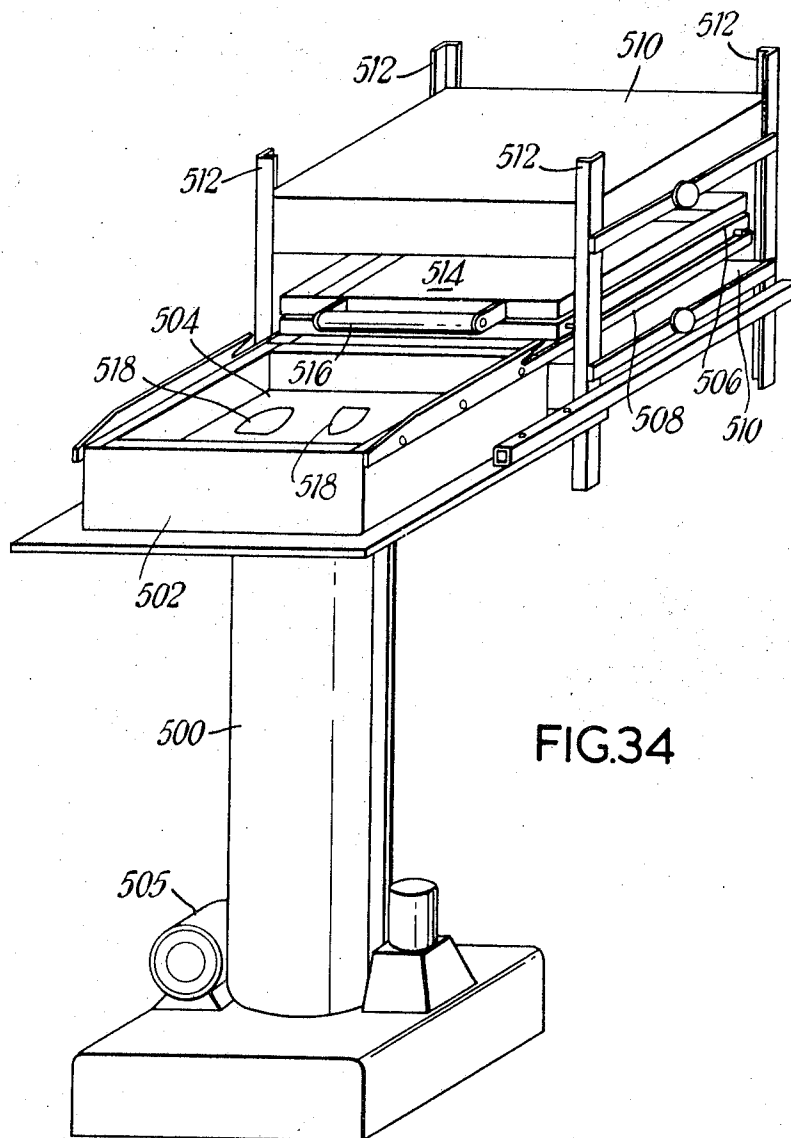


FIG. 37



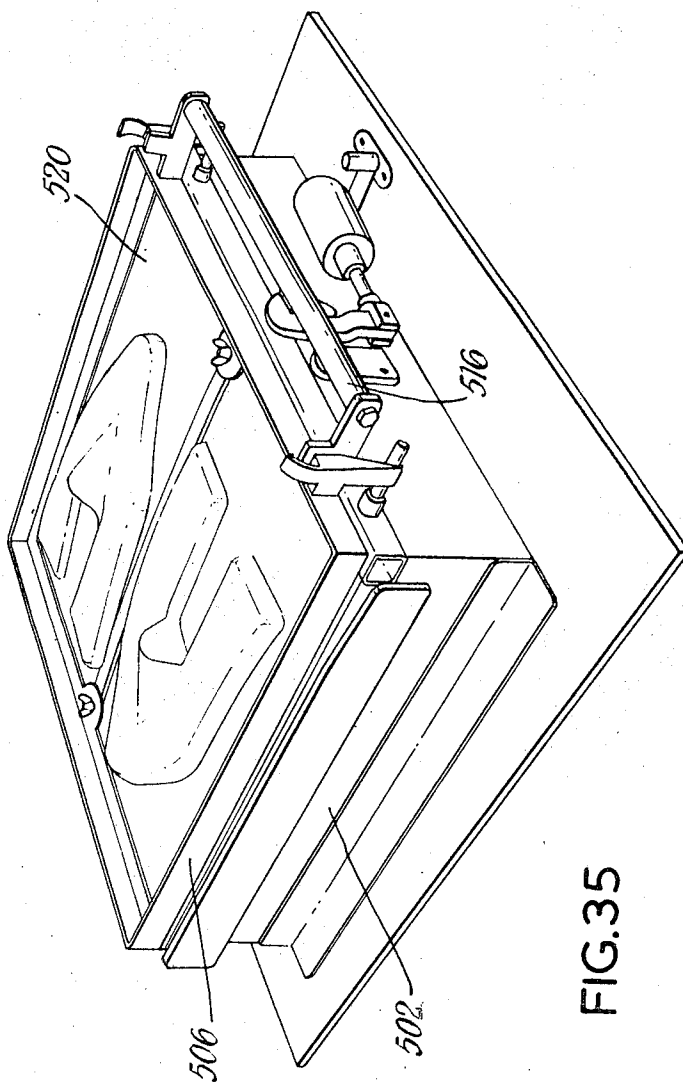


FIG. 35

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SHOE MAKING

The present invention relates to improved methods of shoe making, to improved shoes made thereby, to novel molds for use in the improved methods and to novel methods of making the molds. It is to be understood that the term shoe includes all forms of footwear having uppers consisting of substantial areas of material which have to be conformed to a surface which fits the wearer's foot and includes slippers and boots as well as shoes.

As an example of a conventional method of shoe making the upper of the shoe is made by cutting a vamp portion and a pair of quarters to go around the inside and outside of the waist of the foot and round the heel. Each of these flat pieces has a margin extending around its edge. The margin at what will be the lower edge in the shoe is the lasting allowance and that at the top edge is the folding in margin or topline margin. Margins are also provided to enable heel and waist seams to be formed. The upper is assembled and then slipped onto a last to the bottom or sole of which insole has temporarily been attached. (The upper may have had liners and stiffeners and toe puffs already attached inside it). The upper may have been pretreated to soften it making it more amenable to stretching and compression. It is then gripped around its lower edges and pulled down over the last and its lasting allowance bent and pushed under the last (this is call wiping) and the lasting allowance secured by adhesive or other means to the insole.

The lasting operation stretches and compresses the material so that it conforms tightly to the last. These strains are then set or given a reasonably permanent quality by a setting operation, which may involve moist and/or dry heat treatment, which relaxes the stresses in the material. With leather only a maximum of about 70 percent of these strains are normally set and the last is thus an exaggerated version of the required upper shape to allow for a certain loss of shape on removal from the last.

After setting an outsole is attached or formed in situ. The shoe is then removed from the last and the remaining finishing and dressing operations carried out.

Attempts have been made to simplify the lasting operation (which requires a very high degree of operator skill as well as complicated and expensive machinery) by molding thermoplastic settable materials to female cavity molds having the last shape or variations of it, by means of the application of a pressure differential across the sheet both by vacuum and fluid pressure techniques as well as mechanical techniques.

However these prior proposals require deep drawing of the sheet material which will result in unacceptable thinning of such materials as can be drawn to this depth and will not be effective to completely shape stronger and less extensible materials. Moreover such female molds, in that the exterior surface of the shoe conforms to the female mold surface, will be liable to result in damage to the exterior surface of the upper marring the appearance of the finished shoe. Such molds also provide little flexibility in the design of the upper, as the mold itself defines any ornamentation on the upper. Female molds are also liable to result in wrinkling of the sheet material during the shaping operation.

We have proposed methods and techniques for simplifying the assembly of uppers by a technique of preshaping the upper forepart component by carrying out the stretching and compression operation separately from the operation of bending or wrapping the material into a last shape.

British Pat. Nos. 1096001 and 1096002 describe methods for determining the amount of stretch required in the material, and for putting this stretch into the material by a mechanical gripping and pulling operation before conforming the material to the last.

British Pat. Ser. Nos. 110295 and 1102696 described in detail the theory involved and methods of making male molds for carrying out the preshaping operation on foreparts. These specifications can be summarized as being based on the discovery that successful preshaping of foreparts can be achieved mechanically if the lasting margin of the upper fore-

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part is maintained in a single plane and the necessary stretching of the sheet material is achieved by conforming it to a mold the shape of which is the same as the which would be arrived at by forming a sheet of resiliently bendable material such as unplasticized polyvinyl chloride to the last shape required and partially flattening out the shell by outwardly displacing the side portions.

The present invention is based on the discovery that it is possible to derive male molds using the same principles which define not only the forepart but the whole surface area of the upper. The shallow configuration and the fact that the molds are male in shape provides a solution of the above problems.

The invention is also based in a preferred aspect on the discovery that certain preferred elastomeric settable materials can take on very high degrees of set in the range of distortions involved e.g., of the order of 80 percent or more.

The present invention enables both a single-piece integral upper to be formed, and a vamp portion and a cooperating heel and quarter portion to be produced; these will all be referred to as upper components.

According to the present invention a mold adapted for use in the preforming of the upper of a shoe from deformable settable material, has a male molding surface the shape of which is substantially the same as that which would be arrived at by forming a shell of thin resiliently bendable material conforming to the last shape required and outwardly displacing the side portions and partially flattening out the shell, and molding surface corresponding to the whole upper. The displacement will be such as not to stretch or compress the material of the shell significantly.

It is to be understood that the above definition of the mold shape is merely a definition of its shape and it is not a limitation on the manner in which any particular mold is made.

It will be appreciated that the last on which the shell is formed may be larger than the last on which the upper is to be assembled or alternatively that the flattened out shell could have its protuberances enlarged, to allow for less than 100 percent set, i.e., shrinkage, after the preforming operation.

It should also be appreciated that desirably the molding surface will be such that any line on it will be of the same or substantially the same length as the same line or the inner surface of the finished shoe. Moreover to the rear of the toe area, the distance between two points on the feather edge measured along the surface in a direction transverse to the longitudinal median line of the mold will be of the order of up to 25 percent and not more than 35 percent greater than the distance between the two points as measured in a straight line.

Preferably the mold includes a lasting margin defining portion providing the lasting allowance, said portion having its extremity in a single edge defining plane.

The mold's surface preferably provides at least one of the following protuberances, a toe protuberance, a heel protuberance, a pair of heel protuberances, the protuberances having a draw ratio as hereafter defined in excess of one, and preferably in the range one to 10 for example one to four for heel protuberances, and one to two for toe protuberances.

Production of upper components for mens shoes having a vamp cone portion will involve the use of molds having a vamp cone protuberance positioned around the median line. Here the draw ratio, B/A is preferably in the range one to five especially about two to five.

Preferably the toe protuberance peak is located outside the median line i.e., on the left in a left foot mold considering a plan view of the mold from above. The toe protuberance generally extends from the peak along the mold edge to the outside joint region on the outside edge, where in some forms of the invention there may be a smaller joint protuberance. The toe protuberance may also extend along the inside edge of the mold preferably at a slightly lower height to the region of the inside joint where again in some forms of the invention there may be a smaller joint protuberance which may be smaller than the outside joint protuberance.

The heel protuberance may be formed across the median line or back seam area in the eventual shoe (in this case there will be no structural need for a back seam) and then the draw ratio B/A is preferably in the range one to two, or may be located in two parts one on each side of the median line in which case the draw ratio B/A is preferably in the range two to four. When the heel protuberance is in two parts the molding surface may be arranged so that a complete or partial back seam may be used.

Preference has been made to a lasting margin defining portion extending from the first upper component defining portion. The junction of these two portions defines what will be the feather edge in the eventual shoe. In one form of the invention the second portion extends down from the feather edge (which in this case lies in a single plane) and provides a generally vertical lasting allowance around the outside edge. Further portions provide a seam allowance and top line allowance around the remainder of the molding surface.

In another form of the invention the lasting margin defining portion is generally vertical around the toe portion spreads out into a diverging or generally horizontal plane along the sides of the vamp to the waist and then at the heel turns back to a vertical lane, the arrangement being such that the extremity of the margin defining portion is always in the same horizontal plane. Desirably this margin is of substantially constant width.

The draw ratio and further features and certain embodiments of the invention will be defined and will be described with reference to the accompanying drawings in which:

FIG. 1 is a perspective view of the whole of one form of mold for a left foot,

FIG. 2 is a side elevation of the mold shown in FIG. 1,

FIG. 3 is a cross section on the line III—III of FIG. 2,

FIG. 4 is a cross section on the line IV—IV of FIG. 2,

FIG. 5 is a perspective view of another form of mold for a left foot,

FIG. 6 is a side elevation of the mold shown in FIG. 5,

FIG. 7 is a cross section on the line VII—VII of FIG. 6,

FIG. 8 is a cross section on the line VIII—VIII of FIG. 6,

FIG. 9 is a perspective view of the forepart of a two part mold the heel part of which is shown in FIG. 13,

FIG. 10 is a side elevation of the forepart mold shown in FIG. 9,

FIG. 11 is a cross section on the line XI—XI of FIG. 10,

FIG. 12 is a cross section along the line XII—XII of FIG. 10,

FIG. 13 is a perspective view of the heel part of this part form of mold,

FIG. 14 is a side elevation of the heel part of the mold shown in FIG. 13

FIG. 15 is a cross section on the line XV—XV of FIG. 14,

FIG. 16 is a cross section on the line XVI—XVI of FIG. 14,

FIGS. 17 to 24 illustrate a further form of mold in accordance with the present invention and FIGS. 25 to 27 preshaped blanks made by use of this form of mold and FIGS. 28 to 30 shoes made from these preshaped blanks.

FIGS. 17, 18, 19 and 20 are respectively perspective rear, plan and side views of this form of mold according to the invention,

FIGS. 21, 22, 23 and 24 are respectively sections taken on the arrows XXI—XXI; XXII—XXII; XXIII—XXIII and XXIV—XXIV of FIG. 20,

FIGS. 25, 26 and 27 respectively show in plan view three blanks which have been formed by means of a mold according to FIGS. 17 to 24 and are therefore of the same shape, but also illustrate different cut lines whereby different styles of shoe can be made from the same preformed shape of blank; and

FIGS. 28, 29 and 30 illustrate the three different shoe styles formed from the blanks cut as shown respectively in FIGS. 25, 26 and 27,

FIG. 31 is a side elevation of a conventional last for a left foot,

FIG. 32 is a plan view of the last shown in FIG. 31,

FIG. 33 is a perspective view from in front of a polyvinyl chloride shell of last shape illustrating the shell from which the mold shapes of the present invention are derived,

FIG. 34 is a diagrammatic perspective view of a suitable vacuum forming machine for carrying out the process of the present invention,

FIG. 35 is an enlarged view of the vacuum box of the machine shown in FIG. 34,

FIG. 36 is a part plan view of one suitable nested or interlocked arrangement of molds to economize on material, and

FIG. 37 is a diagrammatic perspective part view showing one method of severing the preshaped uppers from the sheet, utilizing a template as a guide or stop means for a rotary grinder.

The draw ratio B/A is defined as follows. As seen in FIG. 19, the molding surface has a longitudinal median axis MM which is an axis about which it is generally symmetrical. For a molding surface defining a vamp portion or a complete upper it passes through the middle of the toe, and the peak of the vamp cone (and the back of the heel for the complete upper). For a molding surface defining a quarter component only the median axis MM passes along the length of the mold. A is the perpendicular distance of the remotest point of the protuberance, i.e., the peak, from the edge defining plane. B is the shortest transverse mold width of the protuberance across the edge defining plane and is measured perpendicular to the median axis MM for feather edge to feather edge. Thus for a toe protuberance B is measured on the line T—T (in FIG. 22) for vamp cone protuberance on the line C—C (in FIG. 23) and for a heel protuberance or protuberances on the line H—H (in FIG. 22). B is measured through the point at which the line A meets the edge defining plane.

The shapes of the mold of FIGS. 1 to 24 are derived from a typical last as shown in FIG. 31 in side elevation. The bottom line 210 in this view is called the feather edge. The point 211 is called the vamp point. The protuberance 212 is the vamp cone. The toe is 213. The quarter is 214 and extends from below the vamp cone to the heel 216. The joint area is at 215. The eventual top line of the shoe will be in the region of the dotted line 217. It will be observed that the back seam at the heel will be curved and that the feather edge 210 lies in at least three general planes whilst being gently curved.

FIG. 32 is a plan view from above of the last shown in FIG. 31. The feather edge is indicated by the dotted line 210.

It will have been observed that the last shown is for a left shoe.

The shell shown in FIG. 33 is of unplasticized PVC and has been vacuum formed over the desired last shape, the top trim removed and the shell cut along the feather edge. To derive the different mold shapes the shell is cut at different places from the feather edge 22 to the ankle hole 301. The sides of the open shell are then removed outwards to produce a flattened mold shape and the mold is derived from the inside surface of the shell as described in more detail below.

In the accompanying drawings, FIGS. 1 to 4 illustrate a mold of so-called "walking-stick" or "crook" shape intended particularly for the production of a complete preformed upper for women's court and casual shoes, FIGS. 5 to 8 illustrate an alternative form of mold intended for production of a complete preformed upper for children's shoes and men's and women's casual shoes, and FIGS. 9 to 16 illustrate a two-piece mold intended for the production of separate preformed upper forepart and heel part for almost every variety of men's, women's and children's shoes.

Referring firstly to FIGS. 1 to 4, the mold is formed as follows.

To form the shell, the desired last shape, for example, as shown in FIGS. 31 and 32 has a thin sheet (0.020 to 0.050 inches thick) of unplasticized polyvinyl chloride vacuum formed around and under it by conventional techniques and an even width lasting allowance 21 (FIG. 1) is left on the shell. The top of the rigid shell is then cut out leaving a folding allowance 20 (FIG. 1) around the top line. The shell is then cut, for example, vertically about halfway along one of the waist sides e.g., at 303 in FIG. 33 and each cut edge 22 has a seam allowance 23 of the same width attached to it. The shell is then taken off the last shape and unfolded around the back seam

region 25 to produce a heel protuberance 4. The vamp cone 2 is then pushed downwardly while the joint regions 26 are pulled outwardly so as to unfold the vamp around the median line 27 from the toe 28 to the vamp cone 2. The margins all round are brought into a vertical plane and the shell further flattened by unfolding until the extremities of all the margins lie in the same plane as shown in FIG. 2. It will be appreciated that this causes the rear or waist and heel portion 3 to rotate until it is lying flat rather than vertically. A molding surface is then cast from the shell, in this case a male mold is produced. The flattening operation is carried out in this case until the heel draw ratio B/A shown in FIG. 4 is 1:1.7.

Thus the developed mold is of "walking-stick" or "crook" shape, with a front or vamp portion 1 having a raised tongue or vamp cone 2 and a rear portion 3 extending backwardly from the side of the front portion opposite the arch, this rear portion having a raised zone 4 of low irregular pyramidal configuration in the region corresponding to that of the eventual heel.

In FIGS. 5 to 8 the developed mold is again for a complete preformed upper for an eventual shoe of overall configuration similar to that corresponding to the developed mold of FIGS. 1 to 4, and made in the same manner except that the cut is made at 302 in FIG. 33.

Thus the developed mould is of "tuning-fork" or U-shape with a front portion 5 having a raised tongue zone 6 and two rear portions 7 extending backwardly from opposite sides of the front portion. The tongue zone 6 is raised somewhat less than in the developed mold of FIGS. 1 to 4, and each rear portion 7 gradually rises to a rounded peak 8, nearer the external periphery than the internal periphery of the rear portion, before dipping down to rear edges 9. Since the tongue zone is flattened to a greater degree, the shell and hence the developed mold rises correspondingly at 10 about each side of the tongue, as shown clearly in FIG. 7, to give an overall bow-shaped profile at this point.

In this form of mold the round peak or heel protuberance peaks 8 have drawn ratios, B/A as shown in FIG. 8 of 2.1 and 2.2 for the left and right sides in FIG. 5 respectively.

In FIGS. 9 to 16 the mold is in two parts and is derived by cutting the rigid shell into two, transversely just behind the top of the tongue i.e., at 301 and 303 in FIG. 33. The front shell is flattened to a lesser degree than in the preceding figures and hence the developed mold for the upper forepart has a front portion 11 with relatively high tongue portion 12. It is made in the same general manner as described for FIGS. 1 to 4.

The toe protuberance 29 has a draw ratio B/A of 4.0 and the vamp cone protuberance 4.5.

The rear shell as cutoff is cut vertically downwards at the extreme heel end, to a point about halfway down the depth of the heel. The developed rear mold derived from the flattened shell is shown in FIGS. 13 to 16.

The rear mold is of approximately "gull-wing" shape, each wing 13 diverging slightly backwards from V-shaped reentrant 14, corresponding to the heel cut in the original shell. The wings are of substantially similar configuration, with a relatively shallow ridge 15 extending from the V-corners 16 to the diagonally opposite corners 17 of the wings. Ridges 15 rise to rounded peaks 18 about two-thirds along their length, descending gradually to corners 17 and more sharply to V-corners 16.

The left and right heel protuberances 18 have draw ratios B/A of 2.8 and 2.6 respectively.

Referring to FIG. 17 to 24, the mold illustrated has a shape which is arrived at in the following way. A shell of resiliently flexible material such as rigid PVC, is formed onto a last with its break filled in, for example with modeling clay, as by vacuum forming, and the material is allowed to set. The shell is cut to the exact feather line of the last and also the portion of the shell which drapes over the top trim of the last is removed. A vertical cut is then made in the back portion of the shell and the shell is thereafter removed from the last and flattened out partially by spreading out the side edge portions,

as described with reference to FIGS. 1 to 4. To arrive at the mold shape illustrated in FIG. 31 which again complies with the restriction as to the draw ratio B/A extra material is added to the rear of the vamp cone to provide a smooth continuous cone extending down to the plane of the margin edge. This enables a plurality of top lines to be formed by cutting at the desired top line or allowing a suitable folding margin. The mold is then made to conform to this shape of shell. The portions of the mold corresponding to the margin parts of the upper which in the finished shoe are secured between the insole and the outer sole of the shoe for securing the upper to the sole are added when the mold is made.

Thus, the mold illustrated in FIGS. 17 to 24 comprises a toe portion 32, a central raised or vamp cone portion 34 which corresponds to the tongue area of the shoe, left and right side portions 36 and 38 corresponding respectively to the left and right sidewalls and the rear wall of the shoe, and a margin portion 40 providing a lasting allowance extending from the left rear corner all the way around the toe portion to the right rear corner 44. The aforesaid flattening out of the shell was carried to such an extent that the outer or free edge 46 of the margin portion 40 lies in a single plane, and the rear edge 48 of the mold corresponding to the vertical cut made in the shell lies in the same plane. Furthermore, an area 50 intermediate the raised portions 34, 36 and 38 and extending from the rear edge 48 to the margin 40 at either side lies in this plane.

A line 52, corresponding to the feather edge portion of the shoe to be formed, can also be seen in FIGS. 17 to 24. The shape of this line is such that it is equidistant from the edge 46 of the margin 40 all the way around the mold. It will thus be seen that the margin 40 largely lies in the horizontal plane, but in certain areas, particularly in the area 54 at the toe and in the areas 56 at opposite sides near the rear, the margin portion lies in a substantially vertical plane. This results from ensuring that the edge 46 lies in a single plane. (For an alternative embodiment the margin may lie entirely in the vertical plane and this facilitates some methods of cutting.)

Since the edge of the mold lies in a single plane and corresponds precisely to the edge of the shoe upper to be formed, the cutting out of the shoe upper from the sheet material from which it has been formed is facilitated. Several different shoe styles can be formed from it, simply by varying the cut line in interior portions of the preformed blank.

In forming a shoe upper with the mold, various techniques can be employed, such as vacuum forming, pressure forming, or a combination of vacuum and pressure forming. Reference is made to "modern Plastics Encyclopedia" for a description of conventional techniques.

Blanks preformed to the same shape by means of the mold illustrated in FIGS. 17 to 24 are shown in plan view in FIGS. 25, 26 and 27. Each blank was initially a plane rectangular piece of sheet material, but a central portion has been deformed by the mold. The edges 46 and 48 are shown and it is along these edges that the preformed upper forepart will be severed from the rectangular sheet material. This can be done very simply by means of a knife of the special required shape to cut along the desired lines for example a strip of spring steel with a sharpened edge bent to conform to the edge shape. This method of cutting is facilitated by the fact that these desired lines lie in the same plane. In FIG. 25 further cut lines 58 and 60 are illustrated. The lines 58 correspond to the upper edge of the shoe to be formed, which is as shown in FIG. 28. This show is known as the "Oxford" style. The cut 60 corresponds to the slit at the front of the shoe, which is to be laced up. After the blank has been cut along the lines 48, 46, 58 and 60, the forepart so formed can be assembled, as by means of a last, with the remaining parts of the shoe to form the finished shoe shown in FIG. 28. In assembling the shoe a tongue 62 is added and is secured inside the upper. The portions 48a and 48b of the rear edge 48 are secured together and form the rear vertical seam of the shoe. Also, of course, the upper is formed with holes at either side of the slit 60 to receive the laces.

The blank shown in FIG. 26 is cut differently to form, instead of the "Oxford" style shoe, the style known as the "Gibson" style. In place of the single slit 60 at the center, two outwardly inclined slits 62 are formed at positions spaced outwardly of the center region. The slits 62 can be rather wider than that shown. Thus, a tongue 64 is defined between the slits 62. Otherwise, the cut lines are the same as in FIG. 25. In assembling the "Gibson" style shoe from the blank shown in FIG. 26, two side flaps 66 are stitched at 68 onto the preformed blank and have holes for laces formed in them.

A third style which can be made from the same preformed shape of blank is the "Gusset Casual" style. The cut lines are illustrated in FIG. 27 and the finished shoe in FIG. 30. In FIG. 27, cut lines 70 replace the lines 62 of FIG. 26 and are so formed as to provide a pair of gaps 72. Thus a center tongue region 74 is formed and this is connected to the side portions (indicated as 38 to conform with the numbering on FIG. 17) by a resilient or elastic gusset 78. The gaps in the finished shoe are shown as rather wider than those in the blank.

Hence, it can be seen that the present invention provides a mold and a method of shoe making and preforming uppers for shoes, in which the uppers can be easily cut from a sheet of material after preforming and in which different style shoes can easily be formed from the same shape. It may be noted that the formation of different style shoes by simply providing different cut lines as the lines 60, 62 and 70 is facilitated if the central raised portions 34 of the mold is smoothly curved.

It may further be noted that as the area 50 lies in the same plane as the lines 46 and 48, the portion of this area at the rear of blank can be cut out easily at the same time as cutting out the preformed blank along lines 46 and 48 by use of an appropriately shaped knife. The cut lines which would be made are that indicated at 80 in FIGS. 25, 26 and 27, the portion of lines 58 extending between line 80 and line 48 and of course lines 48a, 48b and 46.

Reference is also made to FIG. 19 which is a diagrammatic plan view of a mold in accordance with this form of the present invention and also to FIGS. 23 and 24 which are cross-sectional elevations on the lines T—T and H—H of FIG. 19 and the lines XXIII—XXIII and XXIV—XXIV of FIG. 20 looking towards the toe.

The mold is for a left foot and is derived as described for FIGS. 1 to 4 and FIGS. 17 to 24 from a last, that shown in FIGS. 31 and 32. The peak of the toe protuberance is indicated by the reference 201, the vamp point by the reference 205, the peak of the vamp cone by the reference 202 and the peaks of the left and right heel protuberances by the references 203 and 204. Holes 207 pass through the mold to assist in the application of a vacuum to the regions between the heel protuberances and the vamp cone.

M—M is the median axis of the mold and it will be seen that the vamp point 205 is displaced to the right of it and the peak 201 of the toe protuberance to the left of it.

In FIGS. 23 and 24 the line 210 is in the edge defining plane and the draw ratio is measured for this form of the invention with reference to the line 210. In FIG. 23 it will be appreciated that the length B is from point 211 to point 212. The draw ratio for the toe protuberance 201 is 2.0, that for the vamp cone is 4.2, that for the heel protuberances 203 and 204 is 3.6 and at the vamp point it is 6.7.

It will be appreciated that the draw ratio for the heel protuberances 203 and 204 is measured from the points 213 to 214 and 215 to 216.

Conventional vacuum forming techniques may be used but preferred sequences of operation and conditions for one particular preferred material are described below.

EXAMPLE I

A piece of porous polymeric the preferred artificial upper leather material described below was heated in a high-frequency field of 27 megacycles/second at a power input rating of approximately 20 watts/square inch for 10 seconds. It

was then transferred to a conventional-type vacuum forming machine and formed over a mold in accordance with the invention for example, those disclosed with reference to any of the Figures except 20 and 21. After being allowed to cool, the preformed upper component was then removed from the mold cut to shape assembled into an upper and placed in position over a last for example, as illustrated in FIG. 31. The lasted preformed upper was then heated in an oven at 90° C. for 10 minutes, a post setting operation, during which time the upper material sets to the shape of the last by virtue, it is thought, of its viscoelectric properties of recovery and the preformed strains were set in a substantial permanent form so that when the assembly was then removed from the oven, and allowed to cool the shaped upper on being taken off the former retained its shape to a satisfactory extent. An outsole was attached and the usual finishing operations carried out.

EXAMPLE II

In a further experiment using the same material as Example I, 5 percent moisture was initially introduced into the material and 5 seconds dielectric heating time was employed prior to preforming.

In the second stage of the process the last with the preformed upper material positioned thereon was placed in a steam oven at 90° C. and setting was effected in 6 minutes. The post setting used in Examples 1 and 2 is not essential but some post setting treatment e.g., of only short duration may assist in fully conforming the preshaped upper to the last to get the exactly desired appearance in the shoe for example by eliminating minor distortions which may occur during the bending of the preshaped upper around the last.

The invention can be used for forming shoe uppers from water vapor permeable porous and especially microporous polymeric plastics sheet materials, especially but not exclusively those which do not have their extensibility constrained by fibrous reinforcement, e.g., woven, nonwoven or knitted textile fabrics such that their elongations at break are below 20 percent. Especially suitable materials have extensibilities i.e., elongations at break which are in excess of 100 percent or 150 percent.

These materials to make them useful for shoe uppers purposes also desirably have ultimate tensile strengths of at least 20 lbs./in. width/mm. thickness and preferably 25 lbs./in. width and preferably at least multiples of tens of lbs./in. width/mm. thickness.

The materials are preferably water vapor permeable at least to the extent of having a water vapor permeability of at least 100 preferably at least 500 e.g., 900–1,500 or even 2,000 g./m.²/d HRS)

The extensible material is preferably at least 0.5 mm. thick. For use in the production of footwear the material preferably has a thickness in the range 0.5 mm. to 5 mm. and for women's shoes in the range 0.8 to 1.5 mm. preferably 0.8 to 1.1. For men's shoes the range is preferably 1.1 to 2.5 mm. especially 1.5 to 1.8 mm.

It has also been mentioned that the material is extensible preferably having an elongation at break of at least 20 percent.

The fact that in contrast to last shapes the molds of the present invention have draw ratios, B/A of at least one enables materials of such low extensibility to be satisfactorily preshaped.

Thus the extensible material may include fibrous reinforcement for example in the form of a woven, knitted or nonwoven sheet adhered to or embedded in the water vapor permeable thermoplastic material, especially elastomeric polyurethanes, or in the form of a nonwoven felt desirably consolidated as by punching with barbed needles and impregnated with water vapor permeable thermoplastic polymer. Such materials may be provided with adhered woven fabric reinforcements or elongated cell sponge or honeycomb like masking layers or microporous wear resistant surface layers again especially of

elastomeric polyurethanes or any combination of these four possibilities. Desirably these materials are free of materials which degrade significantly under the conditions used.

In addition the material need not necessarily be microporous or breathable thus it could be an impermeable synthetic plastics material for example polyvinyl chloride or a fabric backed polyvinyl chloride or other polymer film.

However, as mentioned above, the preferred material is one which does not have its extensibility constrained by the presence of fibrous reinforcement.

The preferred polymers however are elastomeric polyurethanes having recovery properties intermediate between pure rubbers and pure thermoplastic materials at room temperature.

The article by Schollenberger Scott and Moore in "Rubber Chemistry and Technology" Vol. XXXV, No. 3, 1962 pages 742 to 752 at page 743 and in FIG. 3 indicates the long so-called half lives of the polyester urethanes made from adipic acid, 1,4 butane diol and diphenyl methane-p,p'-diisocyanate. This disclosure is incorporated herein by reference.

For use in making shoe upper materials the preferred polyurethanes have melting points of at least 100° C. preferably about 150° C. (e.g., about 170° to 200° C. as measured by differential thermal analysis or differential scanning calorimetry). When formed into a smooth void-free thin film 0.2-0.4 mm. in thickness (by carefully casting a degassed solution in dimethylformamide and then carefully evaporating off the solvent in a dry atmosphere) they have the properties described below: a tensile strength of at least 210 kilograms per square centimeter (preferably at least 350, e.g., about 420 to 560), a percent elongation at break of at least 300 percent (preferably at least 400 percent, e.g., about 500 to 700 percent), an elastic modulus of at least 105 kilograms per square centimeter (preferably at least 350 e.g., about 560 to 770), a 100 percent modulus (stress divided by strain at 100 percent elongation) of at least 28 kilograms per square centimeter (preferably at least 84, e.g., about 110 at 134). These mechanical properties are measured by ASTM D882-67.

The preferred polyurethane (again, tested as a thin film made as described above) recovers completely from a 5 percent elongation at room temperature (23° C.) but preferably does take on a permanent set (one measured for example as in an ASTM D412-66) after 100 percent elongation. This set is usually within the range of about 5 to 20 percent, as in the range of about 10 to 20 percent, e.g., about 15 percent. The "permanent set" is usually measured an hour after the release of stress; for example, a material which shows a tension set of some 24-26 percent immediately on release of the clamps after being held at the 100 percent elongation for 10 minutes will have a tension set of 14 percent measured 1 hour after the release of the clamps. (In the measurement a film specimen 1 cm. wide with a gauge length of 5 cm. is strained to the 100 percent elongation at a rate of 254 percent per minute). Preferably the material has a Shore hardness of at least 75 A (more preferably about 90 A to 60 D), measured by ASTM D1706-67.

The preferred technique for making the preferred microporous shoe upper sheet material for use in accordance with the present invention is by casting a thick layer of a suspension of microscopic salt particles in a dimethylformamide (DMF) solution of the polyurethane, coagulating the solution and leaching out the salt. The thickness of the coagulated sheet, after leaching and drying is desirably at least 25 mils (0.63 mm.), e.g., about 30 to 100 mils (about 0.75 to 2.5 mm.) and preferably about 30 to 70 mils (about 0.75 to 1.8 mm.).

Other techniques however may be employed.

The particle size of the microscopic particulate material for example sodium chloride is below 100 microns, preferably less than 50 microns and greater than about 1 micron, more preferably in the range of about 3 to 20 microns. The ratio of the total volume of the microscopic particulate void forming material and the total volume of polyurethane in solution may

be, for instance, in the range of about 0.5:1 to 5:1, preferably in the range of about 1:1 to 3:1, thus 178 grams of the sodium chloride particles may be mixed with 333 grams of a 30 percent solution of the polyurethane in dimethylformamide, giving a volumetric salt; polymer ratio of 1:1.

The microporous sheet preferably has an apparent density in the range of about 0.25 to 0.7 g./cm.³ more preferably in the range of about 0.35 to 0.5 g./cm.³. Typically the density of the polyurethane itself is about 1.2; it will therefore be apparent that in the neighborhood of one-half to three-fourths of the volume of the microporous material is air. The sheet preferably has a percent elongation at break of above 50 percent (e.g., in the range of about 300 to 400 percent or more); a tensile strength above 35 kg./cm.² (e.g., in the range of about 60 to 100); an elastic modulus above 2 kg./cm.² (e.g., in the range of about four to nine, and a notch tear strength above two (e.g., in the range of three to five) kg. per mm. of thickness. It should permit the passage of water vapor; thus its water vapor transmission should be at least 200 g./m.²/24 hrs. (measured as in ASTM E 96-66, procedure B). Also, it is desirable that at least the upper surface of the sheet, after suitable finishing, be resistant to the passage of liquid water, e.g., the finished sheet should have a hydrostatic head (British Standard 2823) of above 100 mm. Hg. While the polyurethane itself usually shows a tension set below 100 percent, as previously discussed, the preferred microporous polyurethane sheets generally recover completely with substantially no permanent set (under standard dry conditions at room temperature) after being stretched 100 percent.

All measurements referred to herein are made at room temperature (e.g., 23° C.) unless the test method specifies otherwise.

As mentioned above certain elastomeric settable materials have the ability to take on high degrees of set. This enables them to achieve very adequate significantly permanent sets during the preshaping operation of the present invention without needing a further setting stage on the last. This enables adhesives to be used during lasting which are liable to be reactivated by heat or solvent and which are thus likely to result in lifting of the lasting margin of the upper with certain convenient lasting techniques unless complicated measures are taken to prevent this occurring.

In addition preembossed upper materials might have the embossing destroyed by relaxation of the surface caused by post setting after lasting.

The additional heat cycle involved in post setting also increases the risk of surface degradation of the material.

The polyurethane materials described above and especially the preferred materials free from fibrous reinforcement have these high degrees of set. Seven days after forming the set may still be as high as 80 percent or more.

Referring to FIG. 34, the vacuum forming machine comprises a container 500 on top of which is mounted a vacuum box 502 which contains a vertically reciprocable air permeable support member 504. The support member 504 can be reciprocated by a mechanism (not shown) located within the container 500, e.g., an air pressure or fluid pressure actuator. A vacuum pump 505 is connected to the container 500 to evacuate air therefrom as well as from the vacuum box 502.

A rectangular clamp 506 is horizontally reciprocable on rails 508 between a position between radiant heaters 510 which is supported, to one side of the vacuum box 502, on legs 512, and a position in register with the vacuum box 502. The clamp is for supporting a piece of shoe upper material 514 during the steps of heating the material and conforming it to molds as hereinbefore described. The reciprocation of the clamp 506 is carried out manually, for which purpose a handle 516 is attached to the clamp. Latching means (not shown) is provided for securing the clamp 506 in airtight relationship with the vacuum box 502 when the clamp is in register with the vacuum box, whereby vacuum can be developed within the vacuum box. As seen in FIG. 34, the vacuum box contains two molds 518 which are similar to that illustrated in FIGS. 17

to 22, but obviously these molds can be of any of the described shapes.

In operation, the vacuum pump 504 is operated to develop vacuum in the container 500, from which communication into the vacuum box 502 is normally interrupted by a suitable valve arrangement. The heater 510 is energized. A piece of material is fixed in the clamp 508 and the clamp located beneath the heater so that the material 514 is heated and softened preparatory to the forming operation. Thereafter, the clamp 506 is moved to its position in register with the vacuum box 502 and secured in that position by the aforesaid latching means. The mechanism for reciprocating the support 504 is then operated to raise the support and force the molds 518 into the material 514. At the same time, the aforesaid valve is opened to place the vacuum box in communication with the container 500 whereby a vacuum is formed in the box 502. Also a template 520 (FIG. 35), which is rectangular to fit within the clamp 506 and contains openings shaped to fit around the molds 518 with the material thereon, is placed over these molds as shown in FIG. 35. This template assists in ensuring that the material 514 is pulled down snugly over the molds. The template can then be used as a guide for a knife when cutting out the preformed uppers from the sheet 514. To carry out the cutting operation, the molds together with the template and sheet material can be removed from the vacuum forming machine and transferred to a suitable support surface. If desired, as is illustrated in FIG. 37 (showing six uppers being formed rather than two) a grinding operation can be used to sever the preformed blanks from the sheet material, the assembly of the template, molds and material being inverted and passed under a grinding device 522.

The use of the template is particularly advantageous where a number of uppers are to be formed simultaneously over molds disposed in a closely spaced arrangement in the vacuum forming machine. A suitable arrangement, which is only one of many possibilities, is shown in FIG. 36 in which six of the molds 518 are arranged. The template assists the vacuum forming operation in this case because it presses down the material in the narrow spaces between adjacent molds.

The apparatus shown in FIG. 34 heats the material from both sides, it may in several cases be found advantageous to heat from only one side. Likewise, other forms of heating such as HF heating instead of radiant heating could be used.

It has been assumed in describing FIG. 34 that the material is synthetic such as a poromeric or a PVC. The process can also be applied to forming leather uppers. In this case, the leather would normally be covered by a sheet of impermeable material, preferably rubber which would assist in the forming of the vacuum, leather being usually relatively porous. With some leathers it may be desirable to use a pressure forming operation, or a combination of high pressure on one side of the leather with vacuum on the other. Also where forming leather uppers it is desirable, instead of preheating the material, to precondition the leather usually by heat and moisture and to utilize heated molds for the heating of the material so that the heating takes place simultaneously with the forming operation.

The following is a report on tests carried out on the preferred microporous polyurethane material referred to above using the molds of FIGS. 5 to 8.

The tests were carried out on a sheet of material 1.7 mm. thick comprising a microporous base layer 1.2 mm. thick over an integrally more porous but microporous top layer 0.5 mm. thick which had a glossy partially fused surface and was pigmented with carbon black.

Temperature measurements were made during vacuum forming experiments using copper-constantan thermocouples buried just below the surface of the material, and also using Tempelstiks of known melting point.

A subsidiary experiment verified that the Tempelstik readings agreed with those obtained using Thermocouples.

It was found that the "flesh" side was slightly blackened at 160° C., and the "grain" side glazed at about 170° C. The

material also thinned, presumably due to collapse of the pores, when the "grain" surface reached 170° C.

Heating from one side only (the grain side) the material was not softened enough to pull down against the sides of the mold when the vacuum was applied, when heated to 149° C. (grain surface temperature). At 150° C. grain temperature, formings were satisfactory.

EXAMPLE III

Sandwich heating, i.e., heating both surfaces, makes the heating conditions much less critical. We have found that subsidiary heating from below, at a lower level than the top heating, gives quite satisfactory formings with the "grain" temperature 150° C. The "flesh" side temperature has not been measured under these conditions, but will be below 150° C. and therefore well below the danger level of 160° C.

To sum up, using the criteria of satisfactory formings without visible damage to the material, the "grain" temperature should be between 150° C. and 160° C. and the flesh side not over 155° C. and preferably below 150° C. The material was found 7 days after vacuum forming to have an excellent degree of set, about 80 percent, and to need no further setting during making up into a shoe. Thus conventional shoe-making techniques were used to form a shoe from the preshaped upper of this example. These techniques included tack lasting of the seat and pressure sensitive adhesive lasting of the toe followed by injection molding of a PVC outer sole. The properties of the upper material were not significantly affected by the vacuum forming and the shoe had excellent flex and appearance and comfort characteristics.

What we claim is:

1. A mold adapted for use in the preforming of the upper of a shoe from deformable settable material, having a male molding surface the shape of which is substantially that which would be arrived at by forming a shell of thin resiliently bendable material to the last shape required and partially flattening out the shell by outwardly displacing the side portions, said molding surface corresponding to the whole of the upper.

2. A mold adapted for use in the preforming of the upper of a shoe from deformable settable material, having a male molding surface or surfaces corresponding to the whole of the upper, the said surface or surfaces providing at least one of the following protuberances, a toe protuberance, a heel protuberance, a pair of heel protuberances, the said protuberances having a draw ratio, B/A, as herein defined in excess of 1.

3. A mold adapted for use in the preforming of the upper of a shoe from deformable settable material, having a male molding surface or surfaces corresponding to the whole of the upper, in which to the rear of the toe area the length or distance between two points on the feather edge measured along the surface in a direction transverse to the longitudinal median line of the mold from edge to edge is greater than but not in excess of 35 percent greater than the distance between the two points as measured in a straight line.

4. A mold according to claim 1, which includes a margin defining portion providing the lasting allowance, said portion having its extremity in a single-edge defining plane.

5. A mold as claimed in claim 4, wherein the margin is substantially perpendicular to the said edge defining plane at least adjacent the toe and heel portions of the mold.

6. A mold as claimed in claim 4, wherein the margin is substantially perpendicular throughout its length to the edge defining plane.

7. A mold according to claim 1, whose shape is that which would be arrived at by cutting said shell along a line corresponding to the back seam whereby portions corresponding to the quarters extend rearwardly from the forepart portion at either side thereof.

8. A mold according to claim 7, wherein said molding surface extends between said rear quarter portions whereby the top line of the upper formed on the mold, or a folded margin therefor.

9. A mold according to claim 7, wherein said molding surface extends between said rear quarter portions whereby the top line of the upper formed on the mold, or the extremity of a folded margin therefor can be varied.

10. A mold according to claim 1, whose shape is that which is arrived at by forming a cut in said shell at a position removed from the heel portion extending from the top trim area to the edge.

11. A mold as claimed in claim 10 in which the cut is made in a quarter or at the junction of the quarter with the forepart and the rear portion of the shell is unfolded so as to bring the heel seam region from a vertical orientation into a general horizontal orientation.

12. A mold as claimed in claim 11, in which the cut is formed in both quarters or at the junction of each quarter with the forepart whereby the rear part of the shell is severed from the forepart.

13. A mold according to claim 1, whose molding surface is smooth and free from ornamentation.

14. A mold according to claim 1, in which protuberances in the molding surface correspond to areas wherein the upper material will be stretched by being conformed to the said mold are enlarged to such an extent as to compensate for the loss of shape in the material being stretched anticipated to occur when the said stretched material is removed from the molding surface.

15. A mold according to claim 1, wherein the shape of the mold corresponds to the inside surface of the shell.

16. A method of preforming a shoe upper or upper component preparatory to assembly of a shoe which comprises conforming a sheet or blank of stretchable and settable shoe upper material to a mold whose shape is substantially that which would be arrived at by forming a shell of thin resiliently bendable material to the last shape required and partially flattening out the shell by outwardly displacing the side portions, said molding surface corresponding to the whole or a part of the upper, said conforming being achieved by applying a fluid pressure differential to said material whereby it is conformed to the said molding surface and setting the resultant distortions into the sheet material at least temporarily.

17. A method according to claim 16, wherein the material is

conformed to the mold by establishing a fluid pressure differential across said material.

18. A method according to claim 17, wherein the mold is mechanically displaced into the material prior to establishing the fluid pressure differential.

19. A method according to claim 16, wherein the material is preheated before conforming the material to the molding surface.

20. A method as claimed in claim 16, wherein the material is a microporous polyurethane free from fibrous reinforcement.

21. A method according to claim 16, wherein the material is highly permeable and is covered by a flexible sheet of impermeable material to support the pressure differential.

22. A method according to claim 18, wherein the material is leather and is covered by a flexible sheet of impermeable material to support the pressure differential and the molds are heated.

23. A method according to claim 16, wherein a plurality of shoe uppers or shoe upper components are formed simultaneously by deforming a sheet of material over a plurality of said molds disposed in a closely spaced arrangement to minimize waste material.

24. A method according to claim 23, wherein a template having a plurality of openings corresponding to said plurality of molds is placed over said plurality of molds on top of the sheet material.

25. A method according to claim 24, wherein the template is maintained in position subsequent to the conforming operation and is used as a guide for a severing tool used to sever the preformed uppers or upper components from the sheet material.

26. A method of making an article of footwear which comprises attaching a shoe upper or shoe upper components made by a method as claimed in claim 16 to any other required upper components securing an outer sole to the said upper, the preforming of the said first shoe upper components having been such as to achieve substantially permanent setting of the desired percentage of the stretches imparted in its preforming whereby the need for a postsetting operation of its stretches is obviated.

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