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(54) **Method and apparatus for orthotic fabrication.**

(57) A technique is disclosed for fabricating a foot orthotic. The technique involves the determination of the arch volume of the foot and the subsequent formation of an orthotic blank including measurements of the neutral alignment position of the foot. The orthotic is then formed by removing a portion from the orthotic blank. The orthotic has an upwardly extending convex region which is arranged to engage the arch portion of the foot.

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The present invention relates to orthotic fabrication.

The human foot consists of numerous different bones. These bones, in conjunction with numerous muscles and ligaments, distribute the body's weight on the ground. For each foot, there is a neutral alignment position. In this position, the various bones are aligned properly, and the various muscles and ligaments are not unnecessarily tensioned. However, for some feet in the neutral alignment position, the bottom of the foot is not horizontal. Moreover, the toe and heel might not be coplanar. When moving about, as by running or walking, on an uneven surface, this is of little consequence. To accommodate the variations in the surface, each foot is randomly deflected by small amounts. As a consequence, the various muscles and tendons are more or less uniformly stretched.

However, for many people, most everyday movement is carried out on a substantially flat surface. Thus, for people living in an urban environment, nearly all surfaces on which they walk are horizontal with little unevenness. Also, for athletes, many playing or exercise surfaces are also horizontal. As a result, if a foot has a non-horizontal neutral alignment position, then when weight is placed on the foot it has to adopt a "compensated" position. In other words, the foot compensates, so that its bottom surface is horizontal. In the compensated position, ligaments can be stressed and imbalances set up in various muscles, the degree of stress and muscle imbalances being proportional to the degree of compensation. This can also affect the amount of flexibility.

It has also been realized that maintaining proper neutral alignment of the feet is important, since the various components of the human skeleton are related, and stress set up in one part of the skeleton can effect numerous other parts. Thus, the feet which continuously maintain compensated positions can lead to stress and problems in not only the feet themselves, but also in the legs, knees, lower and upper back and neck.

For athletes, a large number of injuries are caused by stress from over-use or due to a limited amount of flexibility. It is believed that by stabilizing the feet into neutral alignment positions and reconditioning the body to a balance of strength and flexibility, greater endurance can be achieved.

It is generally known to provide orthotic devices on the insole of a shoe, with the aim of correcting for muscle, ligament and bone imbalances. However, conventional orthotics are unsatisfactory in providing corrective adjustments to the orientation of the foot. Moreover, current devices available to fabricate the orthotics are elaborate and expensive, thereby requiring one such device

to service many clinics. This results in a prohibitive high cost for obtaining such orthotics.

It is therefore an object of the present invention to obviate or mitigate the above-mentioned disadvantages by providing a novel form of orthotic fabrication technique.

Briefly stated the invention comprises a foot support device comprising a blank defining a surface to contact a foot, a central region of said surface being complementary to and alignable with an arch region of a foot, said central region having oppositely disposed surface portions extending laterally outwardly and downwardly from a maximum in relation to said surface, so as to allow said arch portion to roll alternately on said surface portions in a manner to maintain the integrity of said arch region.

In another aspect of the present invention there is provided a method of forming a foot support device comprising the steps of:

providing a blank with a surface to contact a foot; forming on said surface a central region complementary to and alignable with an arch portion of said foot; and

providing said central region with oppositely disposed surface portions extending outwardly and downwardly from a maximum in relation to said surface so as to allow said arch portion to roll on said surface portions in a manner to maintain the integrity of said arch portion.

Further features, objects and advantages of the present invention will be evident following a detailed description of preferred embodiment given by way of example only and illustrated in the following drawings, in which:

Figure 1 is a perspective view of a measuring device to carry out one step in an orthotic fabrication procedure;

Figure 2 is a schematic view of another device to carry out another step in an orthotic fabrication procedure;

Figure 3 is a perspective assembly view of a portion of the device illustrated in Figure 2;

Figure 4 is a perspective view of another portion of the device illustrated in Figure 2;

Figure 5 is a perspective view of yet another device to carry out another step in the orthotic fabrication procedure;

Figure 6 is a sectional view taken on line 6-6 of Figure 5;

Figure 7 is a perspective view of an alternative embodiment of the device as shown in Figure 5; and

Figure 8 is a perspective sketch of an orthotic;

Figure 9 is a perspective view of an alternative to the portion illustrated in Figure 3;

Figure 10 is a sectional view taken on line 10-10 of Figure 9; and

Figure 11 is a sectional view taken on line 11-11 of Figure 9.

The present orthotic fabrication technique takes into account the neutral alignment position of the foot, as is determined with the device disclosed in the copending United States patent application, entitled "Measurement of the Neutral Alignment Position of the Foot", which was filed in October 2, 1986 under serial No. 914,270, the subject matter of which is incorporated herein by reference.

In addition, it is particularly important that the orthotic be made to fill substantially the entire area beneath the arch of the foot, (hereinafter referred to as the "arch volume"), to establish an even pressure distribution along the sole of the foot.

A device to measure the arch volume is identified at 10 in Figure 1 and includes a housing 12 which is formed of front, rear, side and bottom walls 22, 24, 26 and 28 respectively. Distributed evenly within the inner region of the housing is a bladder 14 including an upper section 15 which is filled with an appropriate liquid such as water. A platform 16 has a dimension to match the inner region of the housing and is positioned on the bladder 14 to receive the sole of the foot. A window 18 is provided on the platform 16 and has an area which is adjustable with respect to the arch portion of the foot as will be described. The window 18 permits a portion of the bladder 14 to emerge therethrough and engage the arch portion of the foot. A level mechanism is also provided to ensure that the platform is substantially horizontal and includes a bubble glass 32, positioned on the platform 16. An edge member 30 is disposed along each top edge of the front and rear walls 22, 24, each of which has a bore 30a. A pair of level screws 34 is threadably engaged with the respective bore 30a.

The lower end of each level screw 34 is rotatably coupled to a support member 36 which is disposed along the front and rear ends of the platform 16 adjacent to the front and rear walls 22, 24.

A displacement indicator is also provided to register the downward displacement of the platform. The displacement indicator 20 includes a gage 38, the needle of which is connected to a gear mechanism 40 (not shown). Registering of the displacement of the platform 16 is provided by a displacement rod 42 which is coupled to the gear mechanism and extends downwardly with the lower end engaging the top surface of the platform 16.

The arch volume measuring device also provides for adjusting the size of the window 18 and hence the portion of the bladder 14 extending therethrough, by way of a replaceable window plate

44 having a periphery which matches an aperture 46 on platform 16.

Thus any number of variations in the shape and size of window 18 is available simply by replacing the window plate 44. Moreover, the window plate may be replaced by a solid plate as shown at 60 in order to calibrate the arch volume measurement apparatus 10.

In order to ensure that measurements are made, it is important to make an initial calibration of the arch volume measuring device 10. This can be done a number of ways, one of which involves the replacement of window plate 44 with solid plate 60. By having no window, the plate 60 enables a user to align his foot on the platform 16 and exert a downward force on platform, which maintaining the bladder below the platform. The displacement mechanism is then set to zero, indicating the position where the upper surface of the bladder is equal with the platform 16. In this case, the final arch volume measurement must be adjusted by the thickness of solid plate 60. However, the effect of the thickness of solid plate 60 may be minimized by providing a minimal wall thickness in the region of the foot arch, while maintaining the structural integrity of the solid plate 60.

The above calibration technique provides for instances where the bladder may not be in complete contact with the platform 16 due to air pockets or folds in the bladder 14. However, if the bladder 14 is filled with no air pockets and a substantially complete contact is established between the bladder and the platform 16, the calibration may be performed by simply adjusting the displacement indicator 20 to indicate a load zero rest position of the platform 16. This position defines the configuration where the bladder is coplanar with the top surface of the platform 16, which has no weight exerted thereon.

Having been calibrated, the arch volume measurement device 10 is then prepared to receive the foot to be measured. The solid platform 50 is replaced an an appropriate window plate 44 which is selected depending on the characteristics of the foot being measured. When the window plate is in position the platform 16 is balanced by adjusting the level screws 34 until the balance is indicated by bubble glass 32.

The foot is then placed on the platform 16 with the arch portion aligned with the window 18. The subject is then instructed to stand on the platform with the normal proportion of weight being applied to the foot as in a normal stance. The subjects downward force causes the platform 16 to displace downwardly as the bladder 14 extends through the window 18. Downward displacement of the platform 16 continues until the pressure in the bladder 14 balances the downward force exerted by the user's

foot.

When displacement of the platform 16 is complete, the gauge 38 is read to obtain a measurement of the downward displacement. This measurement indicates the volume of the bladder 14 occupying the space between the sole of the foot and the top surface of the platform 16, corresponding to the above described arch volume of the foot.

Having described the arch volume measurement device, the technique of forming the orthotic will now be explained. As above-mentioned, the formation of the orthotic involves the measurement of the neutral alignment position of the foot, as well as the arch volume and involves two phases.

The first phase involves an orthotic blank which is prefabricated according to the particular dimensions of the subject's foot, for example the length and width of the arch portion of the foot. Such orthotic blanks may be made in advance in various sizes if desired. As will be described, each of the orthotic blanks has a cavity which is clinically filled with an appropriate foam material and according to the arch volume measurements.

The second phase involves the formation of the orthotic from the orthotic blank, while taking into account the precise measurements of the neutral alignment position.

The implementation of the first phase is carried out by way of a blank forming apparatus 100 illustrated in Figures 2, 3 and 4. The blank forming device 100 includes an element 102, hereinafter referred to as the orthotic blank, which is formed of three layers, namely a bottom, middle and top layer, 104, 106 and 108 respectively which are adhesively attached. The bottom layer 104 is moulded from a firm, non-collapsible material such as urethane elastomer, and includes a pair of passageways 110, 112 which receive inlet and outlet lines 114, 116 respectively. The bottom layer 104 also includes a pair of mounting flanges 113 for mounting on another portion of the device as will be later described.

The middle layer 106 is thin relative to the bottom layer and is formed from a resilient expandable plastics material such as urethane foam, while the top layer 108 is formed from an expandable cloth material and defines a foot sole engaging surface 108a.

In an alternative embodiment, an intermediate layer 107 is provided between the lower and middle layers 104, 106 of the orthotic blank 102. This intermediate layer is relatively rigid and formed from a material such as carbon or graphite reinforced resin, thermoplastic or the like. Extending downwardly from the lower surface of the intermediate layer 107 is a pair of tubular portions 107a, 107b which are aligned with the inlet and outlet passageways 110, 112.

The tubular portions may also be provided with fluted ends to ensure secure attachment within the respective passageways. The intermediate layer thus serves to alter the torsional and elongate rigidity of the orthotic blank so as to enhance the support offered by the finished orthotic. The dimensions and configuration of the intermediate layer will depend on the degree of support required for the foot, which will depend on the particular end use of the orthotic, for example, in skiing or running applications.

The passageways 110, 112 are located in the region corresponding to the arch region of the foot and are aligned with a raised section 106a formed in the middle layer 106. The raised portion 106 thus forms a cavity identified at 117 in Figure 2.

The inlet hose 114 leads to an injection reservoir 118 and is provided with a clamp 115. Similarly, the outlet hose 116 is joined to an exhaust reservoir 120 and has a clamp 121, with both the clamps 115 and 121 located an equal distance from the orthotic blank 102. Both the injection and exhaust reservoirs 118, 120 comprise a body 122, 123 to which is threadably engaged a cap 124, 125 respectively. Both caps 124, 125 are provided with a bore 124a, 125a to receive the respective hose therethrough, while cap 125 also has a passageway 126 to permit venting of the exhaust reservoir 120.

As an alternative, Figure 2 illustrates additional hoses 127, 128 emerging from the caps 124, 125 of the injection and exhaust reservoirs 118, 120 respectively which extend to another intermediate orthotic blank for the other foot of the subject. This provision enables the simultaneous formation of left and right orthotics if desired. In addition, the exhaust reservoir may be simply an open topped container or an expandable non-pressurized container, such as a plastic bag.

The orthotic blank 102 is secured on a forming vice mechanism 130 in order to orient the intermediate orthotic blank according to the neutral alignment position calculations.

The forming vice mechanism 130 includes heel and toe portion receiving plates 132, 134 respectively, each of which has a formation 136 to receive a respective mounting flange 113. The forming vice mechanism 130 includes heel and toe plate adjustment mechanisms 138, 140 which are located in the housing 142, formed from front, rear, side and bottom walls 144, 146, 148 and 150 respectively. Since the heel and toe adjustment mechanisms 138, 140 are substantially identical, a description of the heel mechanism 138 will be given.

The heel mechanism 138 comprises a front and a rear screw 152a, 152b respectively, located on each side of the heel plate 132. Each of screws 152a, 152b has a lower end rotatably positioned in a bushing 152. Anchor plates 154 are disposed on

the upper edge 148a and have a bore 154a which receives the screw 152 in a rotatable non-threaded engagement.

Each of the screws 152a, 152b is aligned with a slot 156 formed in the respective side wall 148 and extends through a complementary threaded bore 158a in a slide element 158. The side element 158 also extends into the slot and has an outer face 158c which is coplanar with the outer surface of the respective side wall 148. Joining each of the slide elements 158 is a spanner rod 160, each end of which is mounted in a bore 158b formed in the side of the slide element 158. The spanner rod 160 is aligned with a recess 162 which is formed adjacent the corresponding side of the heel plate 132.

Graduations 164 are provided along the longitudinal periphery of the slot 156 to correspond with an indicator line 166 defined on the slide element outer face 158c.

The housing 142 is also provided with an outlet hose passageway 168 which is formed in one of the side walls 148, as well as an intake hose passageway formed in the back wall 144.

A pair of heel elevation adjustment screws 167 are also provided on the back edge of the bottom wall 150 should a downward extending slope be required during the injection process.

A particular feature of the orthotic blank forming apparatus 100 is that the neutral alignment position of the foot, as well as the arch volume and the contour of the sole are accurately taken into account in forming the orthotic. Moreover, the orthotic is formed in direct contact with the foot in a load bearing condition in its neutral alignment position. This ensures that the orthotic, when placed in the shoe, will fully support the foot while orienting the foot in its neutral alignment position.

Before using the orthotic blank forming device 100, it is first necessary to fabricate the orthotic blank 102. To do this, measurements are first made of the length and width of the foot. The orthotic blank 102 is then formed according to those measurements by moulding bottom and middle layers 104, 106 respectively and assembling them together with top layer 108.

When completed the intermediate orthotic blank 102 is then mounted on the forming vice mechanism 130 as illustrated in Figure 4. The heel and toe adjustment mechanisms 138, 140 are adjusted to orient the sole engaging surface 108a in such a manner that the intermediate orthotic blank will cause the foot to adopt its neutral alignment position. The subject is then instructed to stand on the intermediate orthotic blank 102 with the arch portion of the foot being aligned with the raised section 106a. A mixture of plastics material such as urethane foam is then placed in the injection reservoir 118. This plastics material is of a type which,

upon mixing, expands and thus provides a supply of expanded plastics material through the inlet hose 114 to the cavity 117. Thus, by making the reservoir 118 air tight, a positive injection pressure is established by the inherent expansion pressure of the plastics material.

This causes the air in the cavity 117 to be displaced through the outlet hose and into the evacuated expansible reservoir 120.

It should be noted here that the amount of expanded plastics material contained in the cavity 117 is measured to equal the arch volume determined as previously described. The calibration is done by determining the flow rate of the expanded plastics material through the inlet line, which corresponds to the expansion rate of the mixture. With the flow rate known, the period of time during which the cavity 117 is filled may be precisely determined so that after the filling time is completed, the clamp 115 is immediately closed. In the meantime, the outlet line 116 is continually monitored until the outward flowing expanded plastics material passes the clamp 121, at which time the clamp 121 is immediately closed. Since the length of inlet and outlet hoses between the clamps 115, 121 respectively are equal, the volume of expanded plastics material in the outlet hose 114 cancels the volume in the inlet hose, thus enabling the injection period to be monitored by the flow of expanded plastics material past the inlet hose clamp 115.

After a period of time, for example 10 minutes, the subject is then instructed to remove his foot from the orthotic blank, which is then cured at room temperature for a given cure time. The curing time period will vary according to the type of plastic material used. However, for the urethane foam being used in the present example, a curing time of 5 to 10 minutes is appropriate.

The second stage of the orthotic fabrication technique involves a device illustrated in Figures 5 and 6.

Once cured, the orthotic blank is mounted on an orthotic finishing apparatus 200, comprises a heel portion vice mechanism 202 and a toe portion vice mechanism 204. The heel and toe portion vice mechanisms 202, 204 respectively receive the respective mounting flanges 113 of the orthotic blank 102, and are slidably mounted on a transfer plate identified at 206. The transfer plate 206 is in turn slidably mounted to a carrier 208, for movement in the direction of a transverse axis "T". The carrier 208 is in turn slidable in a direction of a longitudinal axis "L" along a base 209, relative to a saw blade 210.

Each of the heel and toe portion vice mechanisms 202, 204 are rotatable about respective axes parallel to axis "L" to enable the orthotic blank to

be oriented in the neutral alignment position. As illustrated in further detail for the toe portion vice mechanism 204, each of the vice mechanisms includes first and second vice members 212, 214. The first and second vice members 212, 214 are moveable relative to one another along guide members 216 extending outwarding from the first vice member 212 and slidably engaged with complementary bores 214a formed in the second vice member 214.

A fastener 217 is also provided between the first and second vice members 212, 214 and extends through bores 212b, 214b therein to draw the vice members together, in order to hold a respective mounting member 113 therebetween. The second vice member 214 is also pivotally mounted in its central region to a vice frame 220 by way of a first pair of flanges 218 and a fastener 219. This pivotal mounting enables the first and second vice members 212, 214 to be rotated collectively about an axis parallel to axis "L".

For the toe portion vice mechanism 204, a second pair of flanges 222 is provided on the vice frame 220 to engage matching guide members 224 disposed on the transfer plate and parallel to the axis "T". In this fashion, the first and second vice members 212, 214 are displaceable in the direction of axis "T". A positioning screw mechanism 223 extends through a threaded passage 220a formed in vice frame 220 to enable the toe portion vice mechanism 202 to be adjusted releasably relative to the transfer plate 206. The positioning screw mechanism includes a screw element 223a which is rotatably mounted on a screw base 223b which in turn is fixed to the transfer plate 206.

In a similar fashion, the vice frame 220 of the heel portion vice mechanism 204 is provided with a third pair of flanges identified at 225, which slidably engage with a second pair of guide members 226 oriented parallel with respect to axis "L" on transfer plate 206. A screw mechanism 227 is also provided for adjusting the heel portion vice member relative to the carrier 208, and includes a screw element 227a which is threadably engaged with a bore 220b in the heel portion vice frame 220. The screw element is in turn rotatably mounted to a screw base 227b fixed on transfer plate 206.

The transfer plate 206 has transversely oriented edges 206a, which slidably engage with a third pair of guide members 228 oriented in parallel with respect to axis "T". The transfer of plate 206 is positionable relative to the base 208, by way of a screw mechanism 229 which includes a screw element 229a threadably engaged with a block element 229b which in turn is fixed to transfer plate 206. The screw element is also rotatably mounted on a screw frame 229c fixed to the carrier 208.

The orthotic finishing apparatus 200 thus en-

ables the orthotic to be oriented in the neutral alignment position with specific measurements being taken by way of graduation identified at 236 on the first flange of each of the heel and toe portion vice mechanisms, to register collective rotation of the first and second members 212, 214. Gradation markings are also provided at 238, 240 and 242 on first, second and third guide members 224, 226, 228 respectively to register displacement of the heel and toe portion vice members 202, 204 and the transfer plate 206 in their respective directions.

When operating the orthotic finishing apparatus 200, the orthotic blank is first mounted on the heel and toe portion vice mechanisms with mounting flanges 13 respectively engaged between each of the first and second members 212, 214. The heel and toe portion vice members are then oriented to correspond precisely with the neutral alignment position of the foot.

The minimum thickness of the finished orthotic is then adjusted by displacing the transfer plate 206 relative to the carrier 208 thereby adjusting the position of the orthotic blank relative to the saw blade 210.

When all necessary adjustments are made, the carrier 208 is then displaced along axis "L" along base 209 to engage the orthotic blank with the saw blade 210, thereby removing the outward portion of the orthotic blank to form the finished orthotic illustrated at 250 in Figure 8.

The finished orthotic 250 may then be sanded, if desired, to smooth and round the cut edges thereof.

Several variations are contemplated in the fabrication of the orthotic 250. For example, in forming the orthotic blank 102, variations are considered for obtaining the desired characteristics of the finished orthotic. The materials selected for the bottom, middle and upper layers may be altered depending on the particular degree or flexibility, stiffness, rebound, insulation and wear resistance desired.

It is also to be understood that the arch volume measurement apparatus 10 can be used to determine the surface contour of other locations along the bottom surface of the foot, for example, the cavities between the toes. Moreover, the use of the arch volume measurement can be extended to the measurement of the degree of concavity for any object.

The orthotic may also be utilized to locate a magnet adjacent the sole of the foot for healing purposes. This would be done by locating a magnet between the layers of the orthotic blank 102, for example as shown at 252 in Figure 3. The magnetic field generated by the magnet 252 influences bone growth and aids in repairing damaged tissue, with the particular location of the magnet 252 also influencing the direction of the bone growth. More-

over the magnet 252 may be located in the desired region of the orthotic blank 102 either before or after the injection of the expanded plastics material.

Furthermore, a circuit as shown for example at 254 in Figure 3 may be formed in the orthotic blank 102, to provide a source of heat or distribute a current for healing purposes.

An alternative embodiment to the screw mechanism 223, 227 and 229 is illustrated in Figure 7 wherein fasteners 262, 264 are threadably engaged with each of toe and heel portion vice mechanisms 266, 268 respectively to position releasably the respective vice mechanism with the transfer plate 270. In addition, a fastener 272 is threadably engaged with the transfer plate 270 to position releasably the same relative to the carrier 274.

Several alternatives are contemplated for the fabrication of the foot orthotic from the blank illustrated in Figure 3, including the embodiment shown in Figures 9, 10 and 11, wherein a blank is identified at 302 having a bottom layer 304, a middle layer 306 and an upper layer 308 adhesively bonded together and using materials similar to those discussed previously. As will be described below, the middle layer has a cross-section which diminishes in thickness toward a region in the blank corresponding to the maximum height of the arch region of the user's foot. This diminishing cross-section thus defines a cavity 310 between the middle and bottom layers 306, 304 respectively. This cavity is joined in its central region with an inlet pipe 312 extending through a passage 304c defined in the lower blank while the rear and front peripheries of the cavity respectively are joined by outlet tubes 314, 316 extending through passages 304d, 304e respectively in the lower blank. The inlet tube is in turn attached to a piston cylinder arrangement 316 forming an injection ram.

As with the blank 102, the blank 302 has a pair of mounting flanges 304a, 304b extending beyond the exposed surface of the bottom layer 304 and enables the blank 302 to be mounted in a forming vice member of the type described previously.

With reference again to Figure 9, it can be seen that the cavity 310 extends along the length of the blank beneath that portion of the foot contacting the surface which is aligned with the arch portion of the user's foot. Moreover, the width of the cavity is selected so that it terminates a distance from the lateral edge of the blank. This ensures that the cavity, when filled, will assume the shape of a convex surface with a maximum being defined in both lateral and longitudinal cross-sections to ensure that a outwardly downward slope is provided along the sides of the blank in the arch region. This allows the finished orthotic to co-operate with the arch portion of the foot to assume a

ball and socket arrangement. This allows the region of the foot to roll about the raised section in the top surface 102 in a manner which enables the foot to maintain its arched configuration in whatever orientation it is placed.

An orthotic is formed from the blank 302 by initially depositing a urethane resin and the appropriate foaming agent. This sample may be premixed, but is more suitably handled if mixed within the injection device by reciprocating the piston.

The convex shape of the arch support region of the blank is achieved by tapering the cross-section of the middle layer toward the centre of the cavity and also by aligning the inlet tube 312 with that portion of the cavity defined in the apex of the arch support region. As material is pumped by the injection device 316 into the inlet tube 312, the filler material first contacts that portion of the middle layer having the minimum cross-section and spreads radially outwardly into the surrounding space of the cavity. Since the outlying thickness of the middle layer around the periphery of the cavity is substantially thicker than the cross-section of the middle layer in the central area of the cavity, the force exerted by the injection device 316 combined with the expansion of the filler material forces the central area of the cavity higher than the peripheral regions of the cavity. The filler material continues to fill the cavity in a symmetrical fashion until the material begins to exit through the exit tubes 314, 316. At that time, the inlet tube is clamped to cease the injection procedure. At this stage, the blank is then placed on the forming vice mechanism which is in turn oriented according to the neutral alignment position of the appropriate foot. The user is then instructed to stand on the mechanism. The weight of the user is directed through the foot and in particular, through the arch portion of the foot to cause the excess foam to be expelled through the outlet tubes 314, 316. However, this is done in a manner which ensures that the filler material being expelled is that portion located at the periphery of the cavity rather than in the central region. This ensures that the height of the arch-contacting portion of the upper surface 102 is maintained. The user remains standing on the vice mechanism for the required period of time to allow the filler material to cure. The inlet and outlet tubes may be removed and the foot orthotic formed in the conventional manner using the orthotic finishing apparatus 200.

It is to be understood that, while the preferred technique for forming an orthotic involves the use of a cavity in the manner described above, it is to be understood that the convex outer surface 102 may be attained by a number of other methods including a conventional injection moulding. In this case, the convex region can be formed in a num-

ber of sizes, for example high arch, mid arch and flat footed users, while these may also be provided for a various number of shoe sizes. In this case, while the user is not benefiting from the specific shape of the orthotic according to the neutral alignment position, the user will derive significant benefit by allowing the arch portion of the foot to roll on the convex arch portion of the orthotic to allow the foot to maintain a conventional arch configuration in all ranges of motion.

It is also to be noted that other materials may be used to fill the cavity 117, for example other suitable plastics, liquids or gases. In addition, the cavity 117 may be replaced by a porous region or may not initially have any measurable volume. For example, the cavity 112 may be a infinitely small separation or an unattached region between the bottom and middle layers of the orthotic blank which is expansible upon the injection of the filler material.

The orthotic 250 thus not only provides support to the foot, but also enables the foot to be oriented in a position to correct muscle, bone and ligament imbalances. Furthermore, the simplicity of the above described orthotic fabrication procedure enables such orthotics to be made in local clinics, which at the same time substantially reduces orthotic fabrication costs.

Although the discussion has focussed on the preparation of an orthotic per se, it is to be understood that the present technique may be applied to the manufacture of footwear in general, and in particular, to athletic shoes, ski boots and the like. In this case, the base and middle layers may be integrally formed with the shoe construction and thus allow the purchaser to have the shoes specially configured to the purchaser's feet. In this case, the forming vice mechanism would be modified to carry the shoe during the forming process if necessary.

A still further application of the present technique is simply to shape the arch contacting portion of the upper surface of the shoe in the manner above described thereby providing the ball and socket type interaction between the arch portion of the foot and the arch contacting portion of the surface.

Furthermore, the finished orthotic presents a new environment for the foot which enables the body to grow in such a manner as to transmit energy most effectively.

The features disclosed in the foregoing description, in the following claims and/or in the accompanying drawings may, both separately and in any combination thereof, be material for realising the invention in diverse forms thereof.

Claims

1. A foot support device comprising a blank defining a surface to contact a foot, a central region of said surface being complementary to and alignable with an arch region of a foot, said central region having oppositely disposed surface portions extending laterally outwardly and downwardly from a maximum in relation to said surface, so as to allow said arch portion to roll alternately on said surface portions in a manner to maintain the integrity of said arch region.

2. A foot support device as defined in claim 1 wherein said blank has a base layer and an upper layer defining said surface with a cavity defined therebetween, said cavity being expansible so as to define said surface portions.

3. A foot support device as defined in claim 2 further comprising an inlet passage to allow for the ingress of filler material into said cavity.

4. A foot support device as defined in claim 2 wherein said upper layer has a cross-section with a progressively reducing thickness to ward a central portion of said upper layer adjacent a central location in said cavity.

5. A foot support device as defined in claim 4 wherein said inlet passage is aligned with said central portion.

6. A foot support device as defined in claim 5 wherein said cavity is provided with an outlet passage allowing for the egress of filling material therefrom.

7. A method of forming a foot support device comprising the steps of:
providing a blank with a surface to contact a foot;
forming on said surface a central region complementary to and alignable with an arch portion of said foot; and
providing said central region with oppositely disposed surface portions extending outwardly and downwardly from a maximum in relation to said surface so as to allow said arch portion to roll on said surface portions in a manner to maintain the integrity of said arch portion.

8. A method as defined in claim 7 further comprising the steps of:
forming said blank from a base layer and an upper layer;
defining a cavity between said layers in said central region and;
expanding said cavity to define said surface portions.

9. A method as defined in claim 8 wherein said upper layer has a progressively diminishing thickness in the region of said cavity toward a location in said upper layer defining said maximum.

10. A method as defined in claim 9 further comprising the step of providing an inlet passage in the said cavity to allow the ingress filler material thereto and aligning said inlet passage with said maximum.

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11. A method as defined in claim 10 further comprising the step of providing an outlet passage in said blank to allow the egress of filling material from said cavity.

12. A method as defined in claim 11 wherein said outlet is disposed near a peripheral edge of said cavity.

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13. A method as defined in claim 11 further comprising the step of placing said blank in a predetermined configuration corresponding to a neutral alignment position of said foot.

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14. A method as defined in claim 13 further comprising the step of depositing into said cavity an amount of filler material, and thereafter allowing said filler material to escape said cavity by a force exerted by said foot under load.

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15. A method as defined in claim 14 further comprising the step of removing a slice adjacent said upper surface of said blank to form said foot support device.

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16. A method as defined in claim 15 wherein said step of removing said slice includes the steps of orienting said blank in a position corresponding to said neutral alignment position; swerving said blank while maintaining said position so that said slice assumes a shape dictated by said neutral alignment position.

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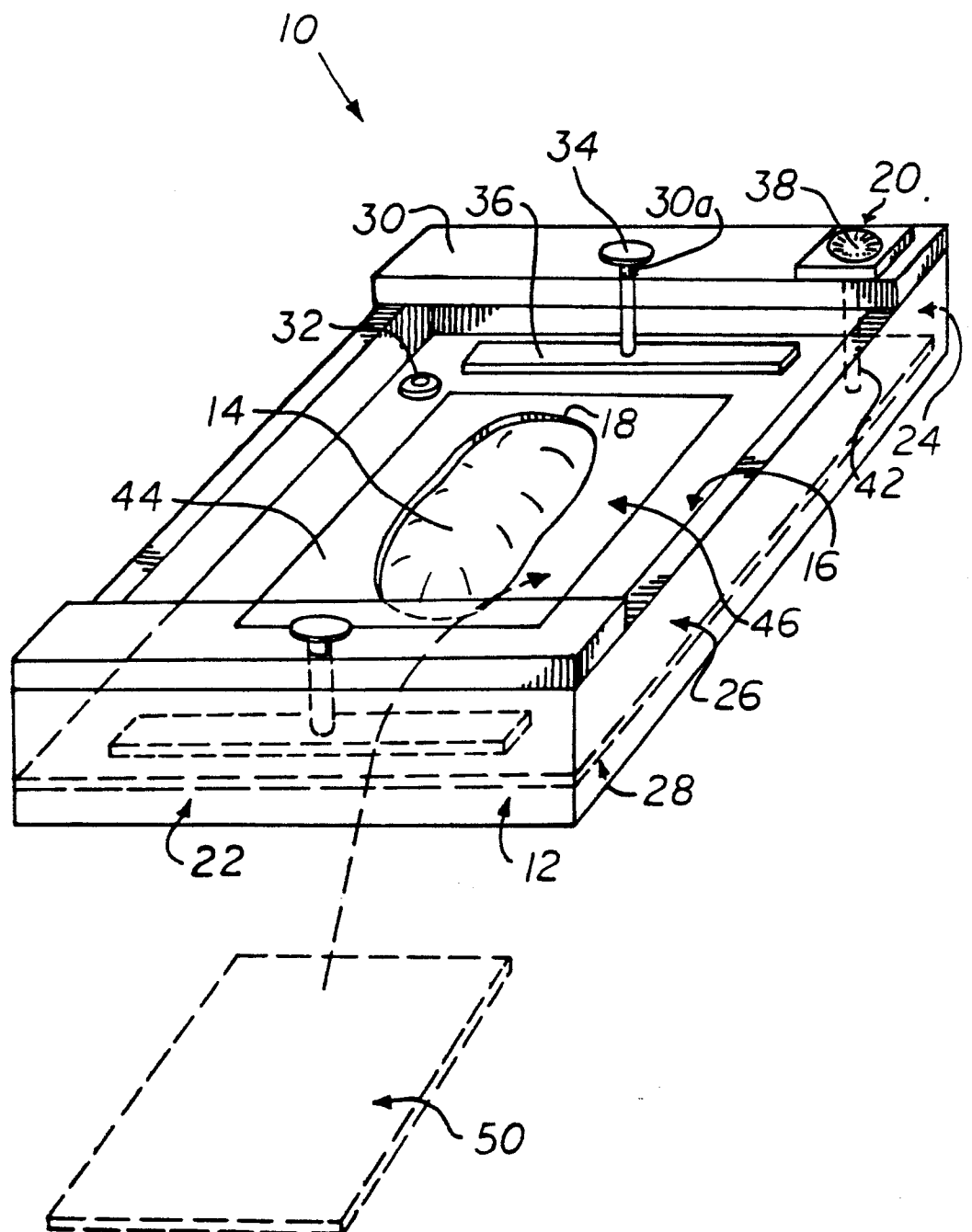


Figure 1

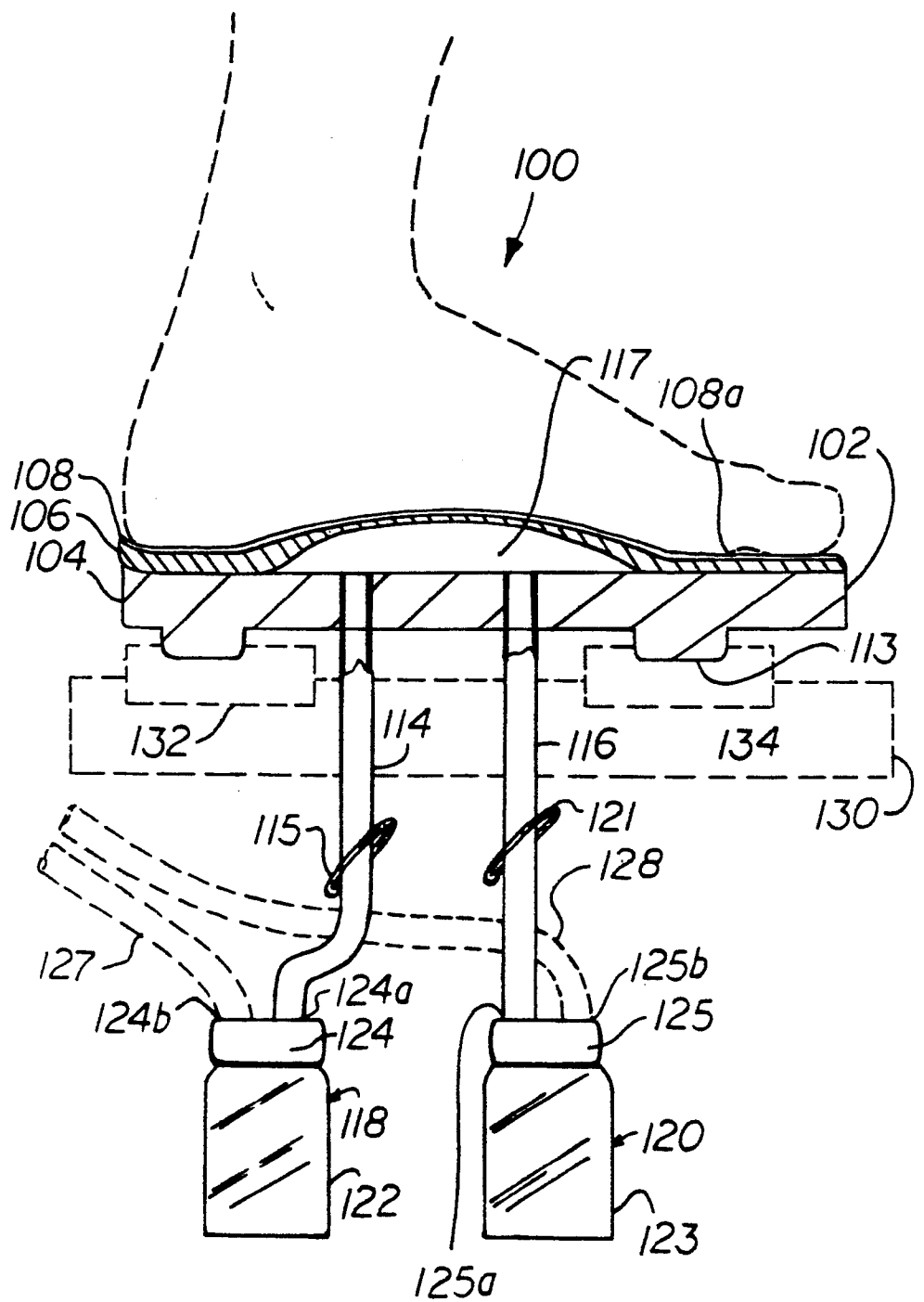


Figure 2

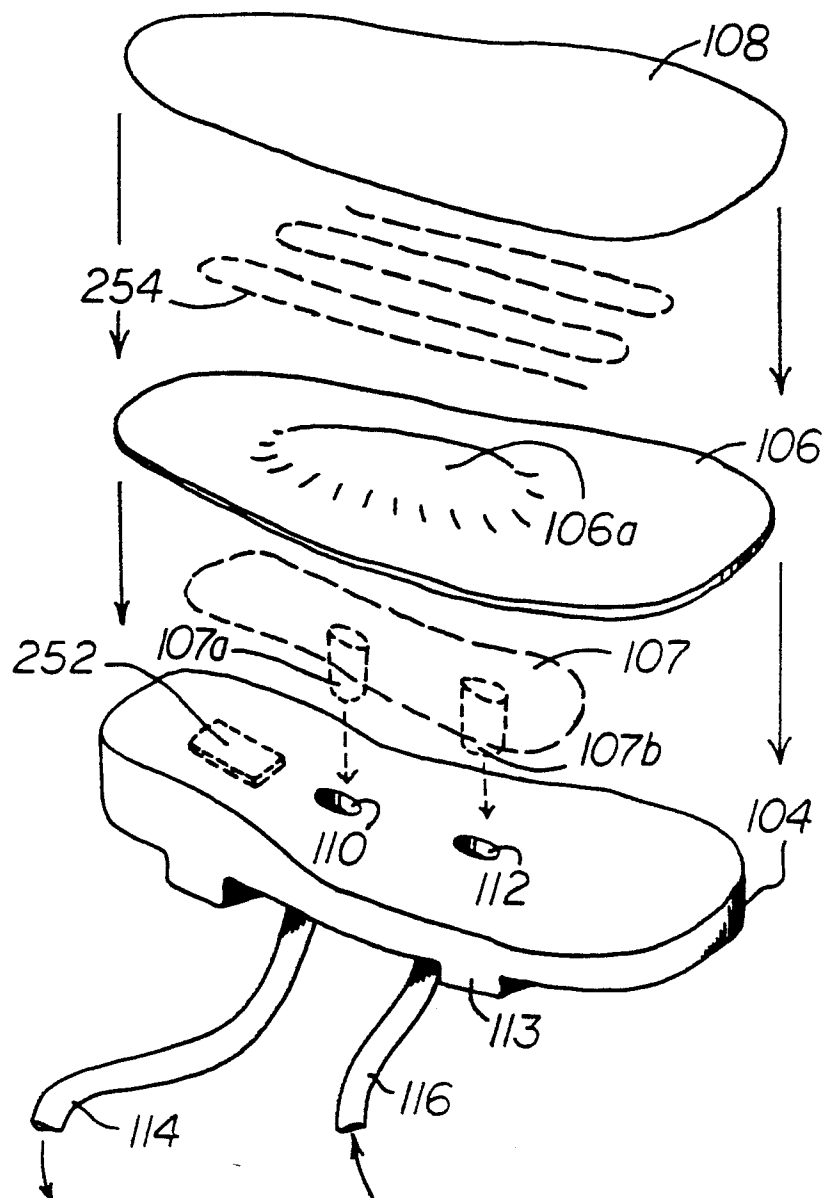


Figure 3

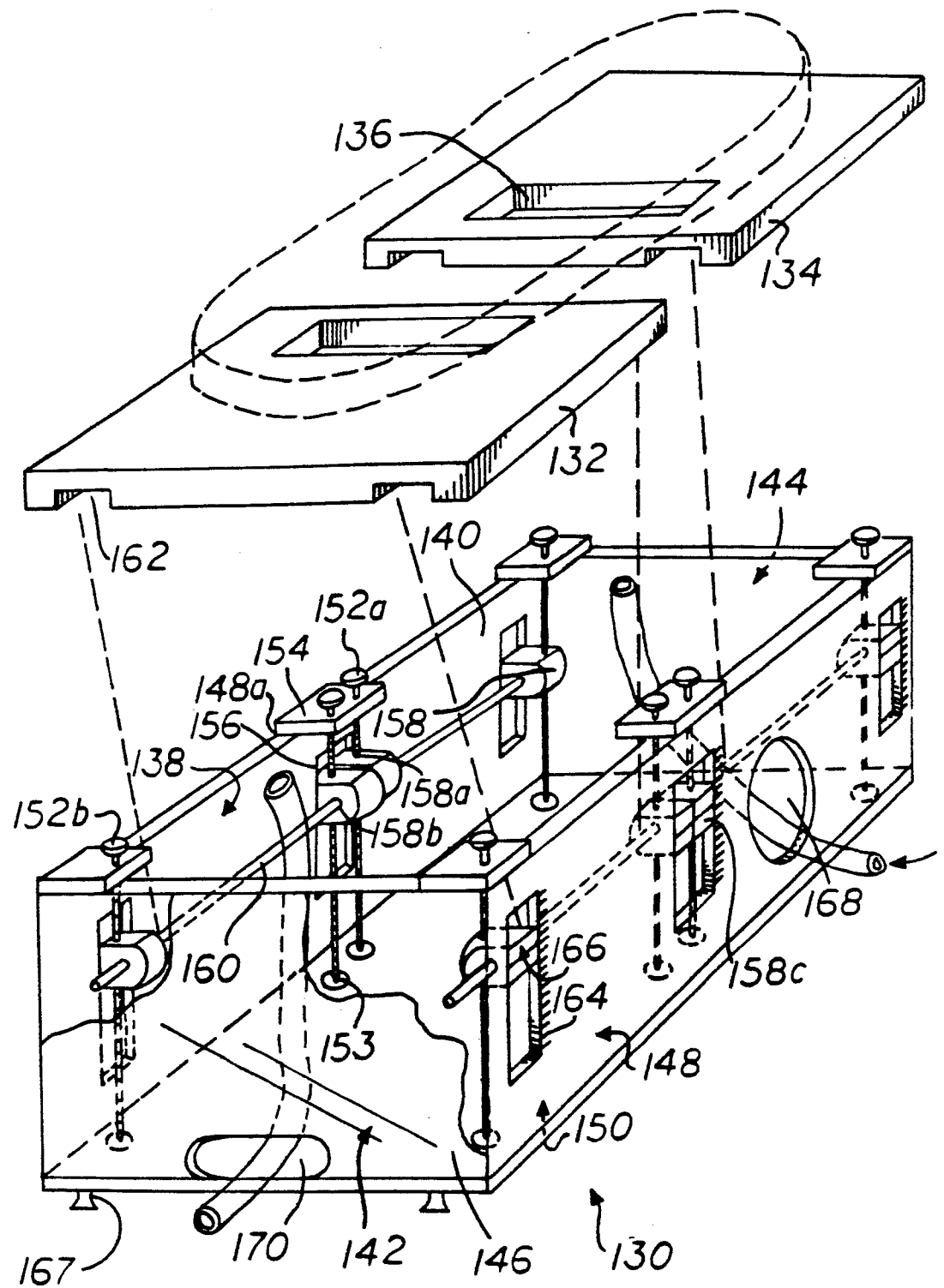
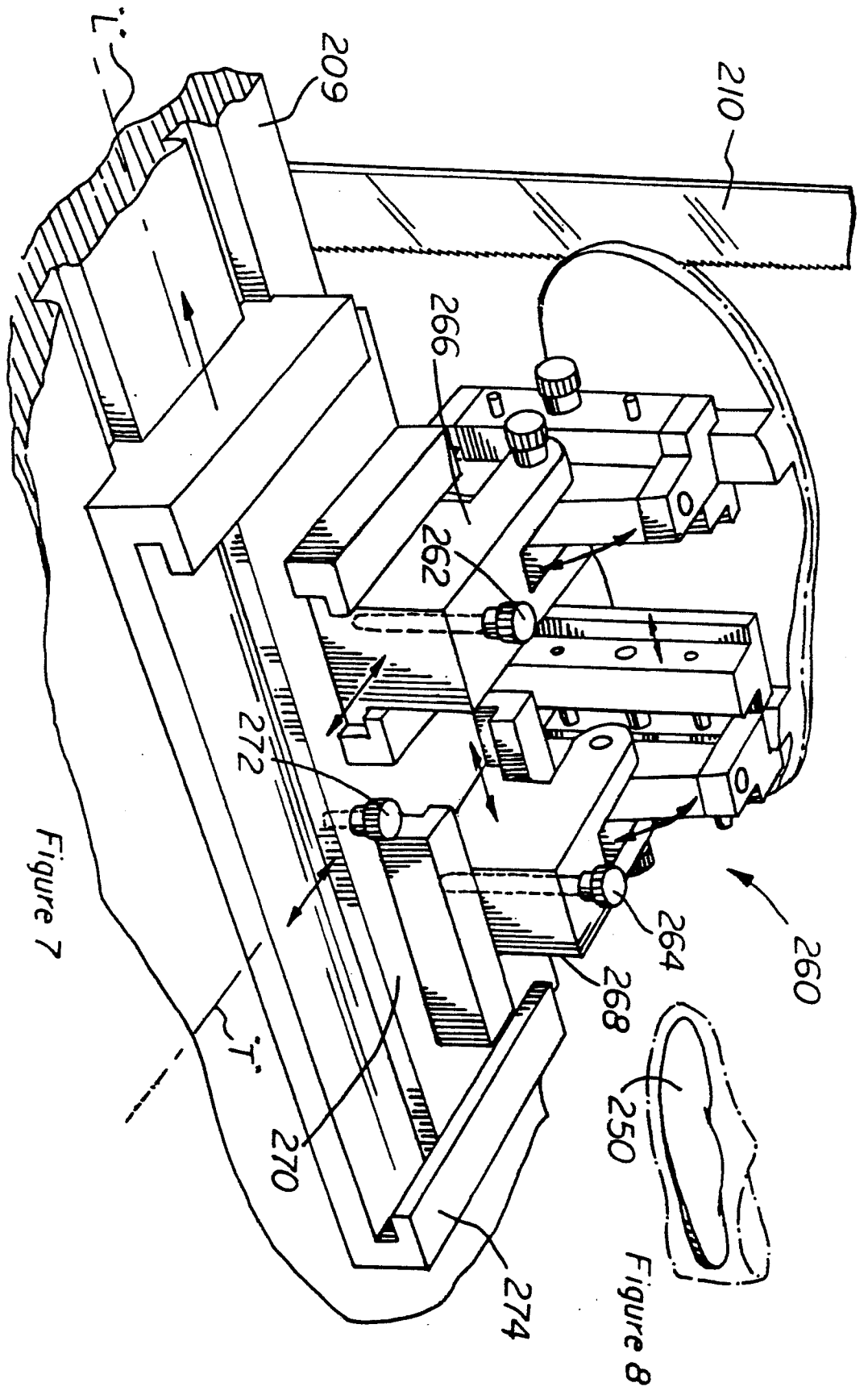


Figure 4



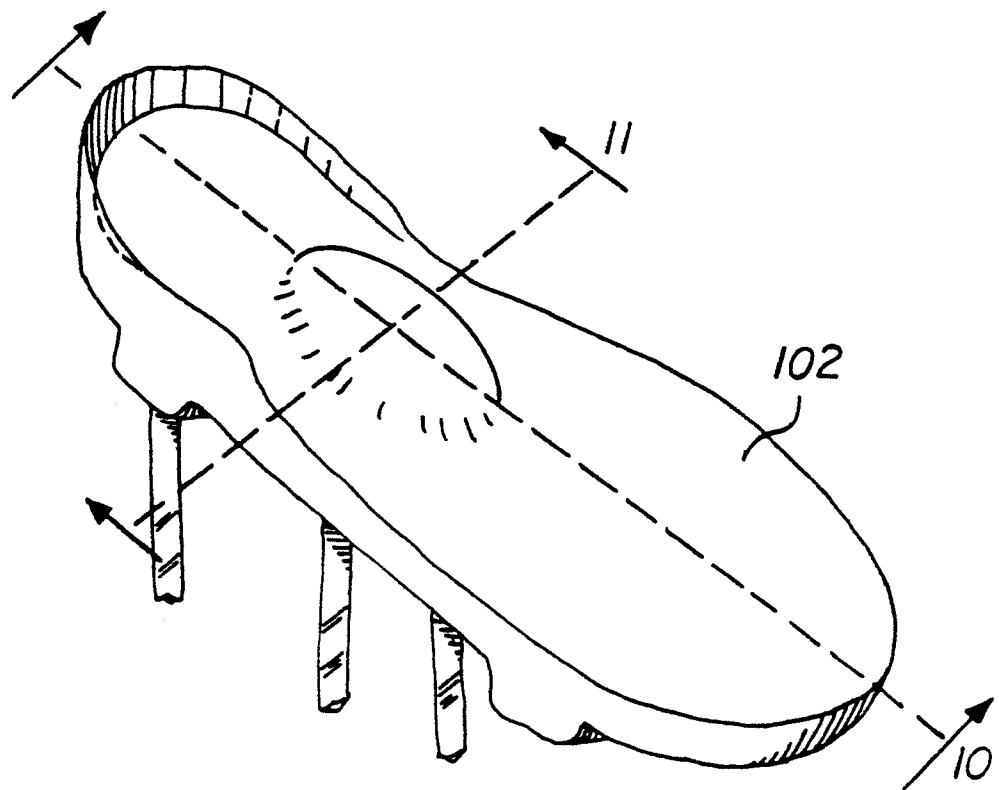
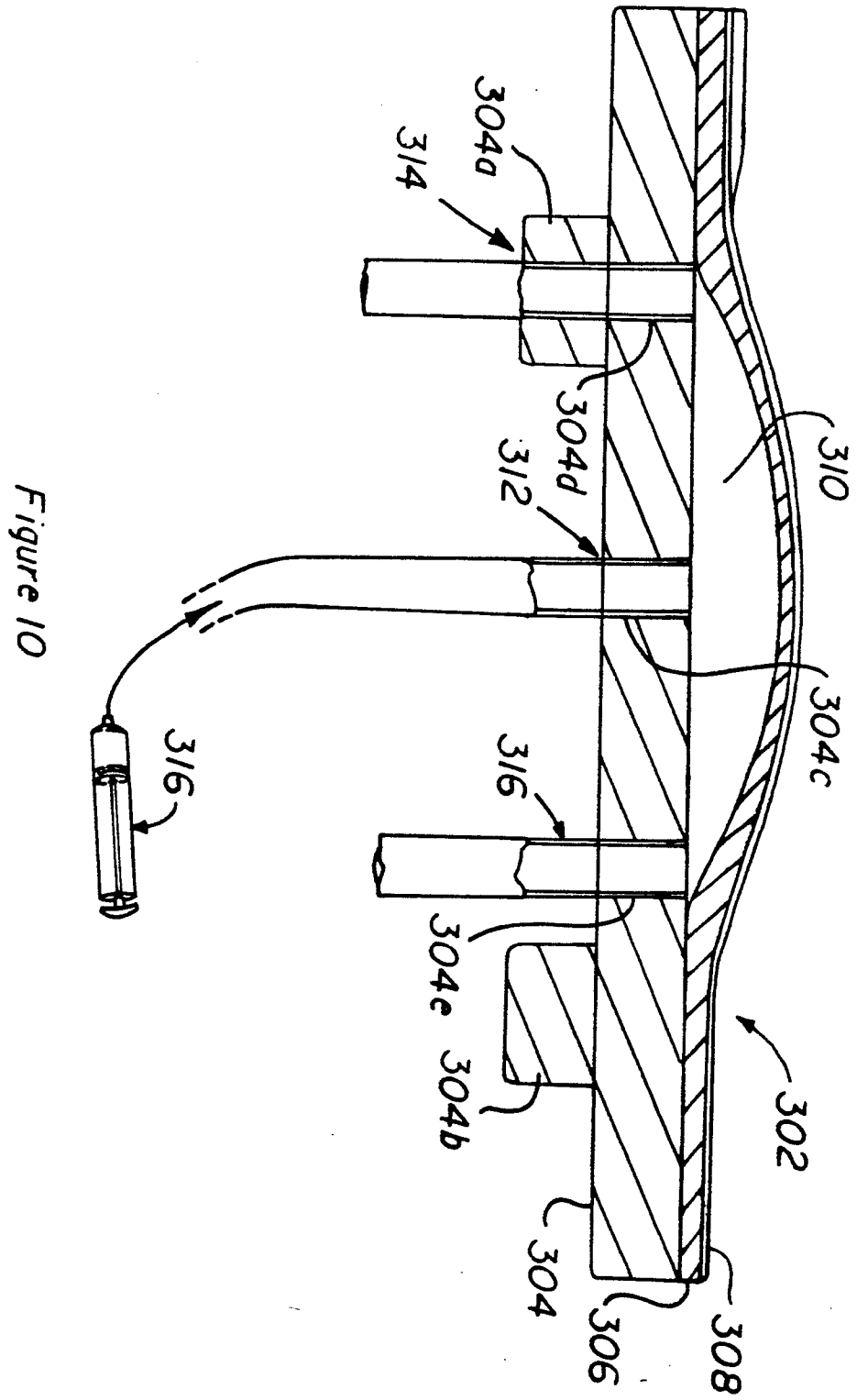


Figure 9



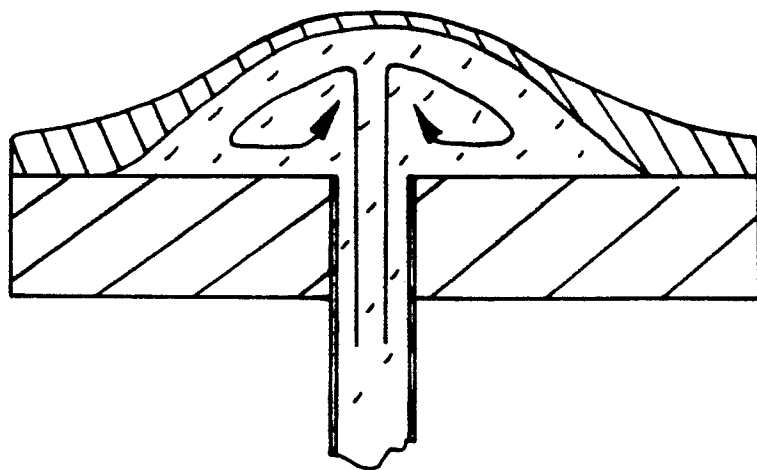


Figure 11