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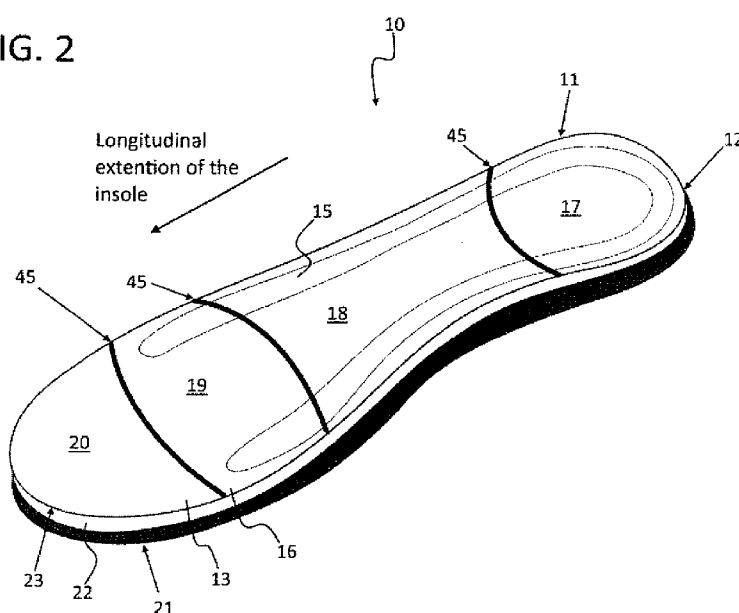
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FIG. 2



(57) Abstract: Multilayer insole (10) usable inside footwear of various kind, said multilayer insole (10) having a peripheral profile (11) of the standard type and comprising at least a first lower layer (21) and at least a second layer (22) made open-cell foamed polyurethane, and extended for the entire area of the same multilayer insole (10) and bonded overlapped to each other and thermoformed, and comprising at least an additional third upper layer (23) constituted by a three-dimensional fabric realized in filaments made of polyester, said first lower layer (21) having a density equal to a percentage comprised approximately between 104% and 222% with respect of the density of the second layer (22), said insole (10) being subdivided in the longitudinal extension thereof in four areas by thickness and density, a first area (17) corresponding to the heel of the user's foot, a second area (18) corresponding to the arch of the

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user's foot and comprising said convex part (14), a third area (19) corresponding to the metatarsus of the user's foot and a fourth area (20) corresponding to the phalanges of the user's foot. The invention provides also at least to a manufacturing process of the above-said multilayer insole (10) and a thennoforming mould usable in such a manufacturing process.

MULTILAYER INSOLE USABLE WITHIN VARIOUS TYPES OF
FOOTWEAR, THE PROCESS OF MAKING SUCH A MULTILAYER
INSOLE AND THE MOLD USED IN THAT PROCESS

The present invention concerns a multilayer insole usable inside footwear of various kind, intended
5 for the large-scale retailers, and adapted to support the user of such an insole, both during the static
phase and during the walk, particularly during the phase of walk and/or run by producing an
adequate support for all the joints of the foot and the tibiotarsic joint, an adequate cushioning, an
adequate upward thrust and an adequate comfortable accommodation of the user's foot, having also
characteristics of long life and greater breathability with respect to the insoles known now, which
10 are intended for the large-scale retailers.

The invention also concerns a manufacturing process of such a multilayer insole and a mould used
in such a process.

At present there are known footwear of various kind made of various natural or synthetic materials
and constituted substantially by a lower part, adapted to support the user's foot with its upper
15 surface and to leant on the ground with its lower surface, commonly named sole, and by an upper
part, possibly provided with laces, adapted to contain an to protect the user's foot, commonly
named vamp, and such footwear being known as for example as sport shoes, everyday shoes for
men and women, boots, high-heeled shoes, sandals, clogs, and the like.

On the upper part of the sole it is usually arranged a removable inside insole, on which the user's
20 foot actually find support.

Such an insole is generally manufactured with soft materials, and possibly covered with a layer of
leather, synthetic and/or natural material, a fabric, in such a way that the foot is accommodated in a
more or less comfortable way.

For the larger retailers, there are used insole for several aims, as for example for accommodating
25 different shapes of foot soles, therefore, for being used for long time without causing pain and

weariness, as for jobs in sites, in restaurants, and the like, or as for example for deadening blows and/or for helping the propulsion phase, so for being used particularly in the sport activities, as volleyball, hiking, and the like.

For achieving the above said results, namely accommodation of various shapes of foot soles or a
5 shock absorbing effect and/or a propulsive effect, the insoles are realized substantially with one or more layers of polymeric materials, overlapped and coupled to each other by means of gluing and shaped in such a way to have an upper part shaped for following generally the contour of the foot sole, that is leant on it.

At present there are not known insole usable inside footwear for supporting the user, intended for
10 the larger retailers, that search an adequate comfort of foot sole, cushioning and upward thrust, but only insoles that possess two of the above said characteristics at most.

In particular, for the comfortable accommodation of the foot sole there are used insoles that on the upper part thereof are provided with a layer of memory foam, applied preferably to a lower layer made of closed-cell polyethylene or of rubber, which memory foam, with a pressure applied by the
15 user, is crushed and is deformed according to the shape of the same foot sole, and maintaining such a shape as long as possible, sometime also without returning to the original shape thereof.

It's obviously that there is an initial accommodating effect, and at most a cushioning effect caused by the possible lower layer made of polyethylene, but it is not possible to achieve a propulsive effect because the memory foam maintains its deformed shape too long.

20 For the same aim, there are used insoles realized with one or more layers made of polymeric gels, which have moderate cushioning characteristics, but when the user's foot applies a pressure on the gel, this latter doesn't flatten down according to the shape of the foot sole, but it moves to side with respect to the pressure point creating a concave area, therefore it creates an imbalance under the same sole foot, and therefore it causes an incorrect postural attitude during the walk of the user.

25 Additional insoles are realized in one or more layers made of closed-cell polyethylene, that initially

has moderate accommodating and shock absorbing characteristics of the foot, but in short time the closed cells will break, so they will open, becoming ineffective, because the cells flatten down without being able to return to the original shape, as a punctured ball.

It may be possible to reduce the possibility of damage of such closed cells by increasing a lot the density of the polyethylene layers, but at expense of the accommodating and shock absorbing characteristics of the foot.

Finally, there are realized insoles with one or more layers made of ethylene-vinyl acetate (EVA) coupled preferably with one or more layers of closed-cell polyurethane, that have the same problems of the insoles made of polyethylene.

Therefore, at the state of art there are no insoles intended for the larger retailers that have at the same time characteristics of accommodation of any foot sole shape, characteristics of cushioning of the impact that helps the walk during the impact phase and characteristics of upward thrust that help the walk during the propulsion phase.

There are also sport insoles with inserts made of very elastic material, as for example carbon fibers or particular polymers, that have characteristics of high upward thrust, but are devoided or almost devoided of accommodating and shock absorbing characteristics.

Such insoles have additional disadvantages, listed below.

The foot needs an air circulation inside the footwear, and for obtaining such effect the above said type of multilayer insoles are provided with several vertical through or blind holes.

Such holes, is they are provided only in the lower material layer of the insole, during the flattening phase are closed by the upper material layer of the insole, being so ineffective.

In the case that the holes are of the through type, these modify the mechanical properties of the used materials, so that the above said characteristics of accommodation, cushioning and upward thrust are modified, and such insoles provided with through holes are so inadequate or ineffective.

Furthermore, said through holes may be filled by filth, as for example powder, making unhygienic

the inside of the footwear.

Finally, there are insoles made of polyurethane provided with shock absorbing inserts, namely anti-shock, which are usually arranged in the heel and metatarsal area, such inserts are bonded externally to the insoles by means of gluing, consequently, in addition to have to design a die adapted to
5 mould such inserts, these inserts easily detach from the insole after an intensive use, also for short duration.

The object of the present invention is to realize a multilayer insole usable inside footwear of various kind, intended for the large-scale retailers, and adapted to support the user of such insoles, both during the static phase and during the walking phase, with a structural conformation different and
10 most efficient with respect to the one of the inside multilayer insoles for footwear currently marketed and intended for the large-scale retailers, furthermore deleting the problems and limits of the above described current internal multilayer insoles for footwear, and additional aims and advantages will be described below and in the continuation of the description.

Main aim is to realize a multilayer insole suable inside footwear that has at the same time
15 characteristics of accommodation of any shape of foot sole, of cushioning of the impacts that helps during the walk and/or the run during the impact phase and of upward thrust that helps during the walk and/or the run during the propulsion phase, and with a good breathability for the foot.

Additional aim is to create an internal insole that allows to the foot, that leant on it, to center automatically and constantly.

20 Additional aim is to carry out a massage to the foot sole during the walk, in such a way to increase further the blood flow.

Additional aim is to realize an insole that has a prolonged fatigue strength, to avoid losing of its original mechanical properties.

The present invention also relates to a manufacturing process of such multilayer insoles, intended
25 for the large-scale retailers, and a mould used in such a manufacturing process.

Below, at first there are described the structural characteristics of the multilayer insole, object of the present invention, and after the phases of the manufacturing process of such an insole and the structural characteristics of the mould used in such a process.

The invention will be understood by the following description, by way of a not-limitative example

5 only and with reference to the accompanying drawings, in which :

- Fig. 1 shows the graphic of the loading phase of the gait of a foot during the walk, according to the analysis of the known doctor Jacquelin Perry (1918-2013) ;

- Fig. 2 shows a top perspective view of an example of the multilayer insole, according to the invention ;

10 - Fig. 3 shows a top view of the insole of Fig. 2, in a first embodiment thereof ;

- Fig. 3a shows a top view of the insole of Fig. 2, in a second embodiment thereof;

- Fig. 4 shows a longitudinal section view of the insole of Fig. 2 ;

- Figs. 5a and 5b show a side view of a layer of the insole, according to the present invention, in a first rest position thereof and in a second operative position thereof, respectively ;

15 - Fig. 6 shows the results of a test carried out by a person with normal insoles, already marketed ;

- Fig. 7 shows the results of the same test used in Fig. 6 and carried out always by the same person using an insole according to the present invention ;

- Fig. 8 shows a perspective view of the layered elements, spaced away to each other, used for obtaining such a insole, according to the present invention ;

20 - Fig. 9 shows a perspective view of the layered elements of Fig. 8 bonded to each other in a first way ;

- Figs. 10a-10b show a perspective view of the layered elements of Fig. 8, bonded to each other in a partial way ;

- Fig. 11 shows a perspective top view of a first example of embodiment of a first half-mould

25 (male) ;

- Fig. 12 shows a top view of the half-mould of Fig. 11 ;
- Fig. 13a shows a plurality of transversal cross-sections of the half-mould of Fig. 11 ;
- Fig. 13b shows a longitudinal cross-section of the half-mould of Fig. 11 ;
- Fig. 14 shows a top view of a second example of embodiment of a first half-mould (male) ;
- 5 - Fig. 15 shows a perspective top view of a second half-mould (female) ;
- Fig. 16 shows a top view of the half-mould of Fig. 15 ;
- Fig. 17a shows a plurality of transversal cross-sections of the half-mould of Fig. 15 ;
- Fig. 17b shows a longitudinal cross-section of the half-mould of Fig. 15 .

The present invention concerns a multilayer insole usable inside footwear of various kind, intended
10 for the large-scale retailers, and adapted to support the user of such an insole, both during the static
phase and during the walk, particularly during the phase of walk and/or run by producing an
adequate support for all the joints of the foot and the tibiotarsic joint, an adequate cushioning, an
adequate upward thrust and an adequate comfortable accommodation of the user's foot, in relation
to the weight of the user and the activity to be carried out, having also characteristics of long life
15 and greater breathability with respect to the insoles known now, which are intended for the large-
scale retailers.

For accommodation is meant the capability of at least one layer of the multilayer insole, object of
the present invention, to deform partially or for its entirety where the foot, or a part of it, applies a
pressure in a downward direction, preferably of the continuative type, by acquiring consequently
20 the shape of the part in contact to, thereby resulting devoid of unwanted pressure points.

The invention concerns also a manufacturing process of such a multilayer insole and a mould used
in such a process.

Referring to Fig. 1, in which there is shown the graph with the typical evolution of the vertical
ground reaction forces (Perry 1992) of a foot during a gait, it is noted that the curve of such
25 evolution is characterized by two humps (namely also camel's humps), in which the first left

convex part A indicates the force of impact of the heel with the ground, the central concave part B indicates the cushioning vertical upon force of the oscillating phase of the foot that brings forward the load, namely with the foot sole leant completely on the ground in the lower point of the same curve B, and the second right convex part C indicates the thrust of the foot for detaching from the ground. Such phases during the advancement of the user, as for example when he walks, when he runs, repeats cyclically with an unloading phases interposed between the end of the curve C and the start of a new curve A.

Therefore, at any peak of the above said gait phases, it corresponds a certain pressure of the foot on the ground in terms of force and of interested area.

The insole object of the present invention is structurally conformed, as it will be described, in a such a way that, relating to the weight of the user, it is obtained in particular :

- A determined cushioning during the phase determined by the above said curve A and by the first part of the curve B ;
- A determined accommodation of any foot sole shape during the phase determined by the curves A and B, that is that the insole compresses following exactly the shape of said foot sole ;
- A determined upward thrust during the phase determined by the second part of curve B and by the curve C ;
- A return to the original shape of the insole during the above said unloading phase, that is when the foot is raised up from the ground between the phase determined by the curve C and the new cushioning phase, in such a way to be efficient again for the new gait cycle.

other obtained aims will be described below.

As visible in Figs 2-4, that show various views of the multilayer insole 10, object of the present invention, it is noted that the same insole 10 is constituted by at least a plurality of layers made of

polymeric material bonded overlapped to each other for obtaining a single body shaped as an inside

insole for footwear.

Such a multilayer insole 10 is shaped outside with a profile 11 of the standard type and variable sizes depending on the size and on the type of footwear inside which it is inserted to, that is the available internal volume, and housed in an extended way.

- 5 If the multilayer insole 10 proves too long with respect to the length of the internal space of the footwear, in which it has to be inserted to, it is possible to trim the tip by means of a cutting instrument , as for example a scissor, therefore it may be reduced of the correct size for being arranged in an extended position inside said footwear, without leaving empty side spaces. Such an insole 10 has, on the lower part thereof, a lower surface 9 tendentially flat, possible inclined upward
10 on the front and back parts thereof, that leant on the upper inside part of the footwear in which it is inserted to, and that is jointed in a curved way with the upper edge 12 of the same insole 10.

Such a multilayer insole 10 presents superiorly an upper surface 13, delimited by said external upper edge 12, slightly concaved on its upper back part, flat on its front part, and convex on its upper part almost at its central part 14.

- 15 Said upper surface 13 comprises a lengthened raised rib 15, preferably with a upwardly convex semi-cylindrical section and with a reduced width, and with an extent such to follow inside and in a spaced way the perimeter 11 of the insole 10 delimited by the edge 12 for interrupting in the front part 16 of such an upper surface 13, in such a way to not interfere with the metatarsal heads and with the phalanges of the user's foot.

- 20 The insole 10 is subdivided, in the longitudinal extension thereof, in four areas by thickness and density, a first area 17 corresponding to the heel of the user's foot; a second area 18 corresponding to the arch of the user's foot and comprising said convex part 14, a third area 19 corresponding to the metatarsus of the user's foot and a fourth area 20 corresponding to the phalanges of the user's foot, therefore it may be obtained for each of said four areas a predetermined accommodation,
25 cushioning and upward thrust, namely that , when the foot, or at least a part thereof, pushes in a

downward direction the insole 10, the part of this latter pushed in such a downward direction has a cushioning effect, for then deforming by flatten down under the pressure of such a foot's push, or its part, thereby following its shape, so having an accommodating effect, for then thrusting upward the foot, of its portion, when such a pressure in a downward direction is decreased, the insole 10
5 returning then at its original shape in short time, for restoring its cushioning effect for a new possible pressure of the foot, also immediately followed.

The insole 10, by acting in the above said way, assures also a massage of the foot's arch, that reduces the effort of the user's foot, also after many hours of use.

Such four areas 17, 18, 19, 20 may be easily identifiable thanks to respective demarcation lines 45,
10 rectilinear or curved and arranged transversally with respect to the longitudinal extension of the insole 10 and preferably in low-relief, in such a way that who must choose the suitable insole for his foot, may easily associate said four areas 17, 18, 19, 20 to the relative areas heel, arch, metatarsus, phalanges of his foot, just by checking the position of the lines 45. This is necessary in particular because the phalanges usually has different length in various persons, consequently, if a person has
15 fingers shorter its standard size, so said four areas 17, 18, 19, 20 don't coincide with the real area of his foot, he just may choose a insole with a greater size, and then trim the insole's tip, by shortening such an insole

by a needed length for accommodating his foot in the correct way.

Advantageously, the convex part 14 of the upper surface 13, in addition to the above described
20 benefits, doesn't allow to the foot to slide forward, by preventing to the arch longitudinal movements, in such a way to prevent fingers injuries, caused by impacts with the internal front part of the footwear.

Said insole 10 is constituted nu at least a first lower base layer 21, by at least a second intermediate layer 22, by at least a third upper layer 23 and by a possible fourth upper coating layer
25 24, this latter being made of fabric and/or leather or equivalent material, all the above said layers

being extended for the entire area of the same insole 10.

As visible in Fig. 4, the second layer 22 follows both at its lower part and its upper part the contour of the four said areas 17, 18, 19, 20, as also the third layer 23 and the possible fourth layer 24, whereas the first lower layer 21 has on its lower part the lower surface 9, and on its upper part it follows the lower contour of the second layer 22.

The above said four layers 21, 22, 23, 24, in a respective initial parallelepiped shape thereof 40, 41, 42, 43 (See Figs. 8-10a), may be bonded in succession to each other by means of a flame coupling means and/or by means of adhesive material, preferably of the polyurethane type, for being then thermoformed inside specific moulds and then shaped peripherally by means of a diking die tool, or the first two layers 40, 41 are bonded in succession to each other by means a flame coupling means or by means of adhesive material, preferably of the polyurethane type, thermoformed inside specific moulds, bonded to the other third layer 42 and fourth layer 43 by means of adhesive material, preferably of the polyurethane type, and then shaped peripherally by means of a diking die tool, thereby obtaining the final shape and dimensions of the layers 21, 22, 23, 24.

By means of the diking die tool it is obtained the contour of the insole 10 with dimensions equal to the desired size.

Said first lower base layer 21 is realized by an initial layer 40 made of open-cell foamed polyurethane with an initial pre-thermoforming density comprises between 120 and 200 Kg/m³.

Said first layer 21 is adapted to provide support to all the other upper layers 22, 23, which are overlapped to it, in such a way to prevent the dispersion of the elastic properties and to consolidate in particular the technical characteristics of the material of the intermediate layer 22 and to provide a cushioning effect, or more simply a cushioning, when the user's foot, or a part of it, applies a pressure in a downward direction.

Said second intermediate layer 22 is realized by initial layer 41 made of open-cell foamed polyurethane with an initial pre-thermoforming density comprises between 90 and 115 Kg/m³,

preferably of 115 Kg/m³.

Therefore, said first lower layer 21 has a density equal to a percentage comprised approximately between 104% and 222% with respect of the density of the second layer 22, depending on the increasing weight of the user, that is the first layer 21 has a density higher than the one of the second layer 22.

Said second layer 22 is adapted to provide an accommodation and cushioning effect of the user's foot, or its part, when this latter applies a pressure in a downward direction, namely the insole deforms in the pressure points following the shape of the foot, or of its part, with a clear effect of comfort, and is also adapted to provide a upward thrust effect when the pressure applies in a downward direction decreases, namely when the foot is raised up.

As visible particularly in Figs. 5a and 5b, said third upper layer 23 is constituted by a three-dimensional fabric realized in filaments made of polyester, which are spun to each other and bonded to each other by means of thermo fixing at 180°C, creating a structure constituted by two external flat layers, upper one 26 and lower one 27, joined to each other by a plurality of pairs of filaments 28, made of polyester, arranged angled to each other, preferably in an orthogonal way and at 45° with respect to the two external layers 26, 27 and with longitudinal or transversal direction with respect to the longitudinal development of the insole 10.

Such filaments 28 intersected to each other, in the rest position thereof (Fig. 5a), are arranged extended in a rectilinear, or slightly curved, way, maintaining spaced away the two external layers 26, 27 to each other.

Such a fabric 23 in the rest position thereof has a thickness about 1,5mm.

Such a third layer 23 is adapted in particular to increase the cushioning effect of the insole 10 and to create a continuous and various air flow inside the footwear that keeps dry and fresh the foot, without that said third layer 23 risks to include inside itself foreign material, as for example powder, because it has only side openings and not vertical ones, in order to maintains its characteristics.

The average central thicknesses of the second 18, third 19 and fourth 20 areas are each comprised in the following percentage with respect to the thickness of the first area 17, which is considered the thickness 100%, and that has an average central thicknesses comprised between approximately 8,00 mm and 14,00 mm :

- 5 - The average central thickness of the second area 18 is equal to a percentage comprised between approximately 105% and 107% with respect to the thickness of the first area 17, so comprised between approximately 8,40 mm and 15,00 mm ;
- The average central thickness of the third area 19 is equal to a percentage comprised between approximately 92% and 93% with respect to the thickness of the first area 17, so
10 comprised between approximately 7,40 mm and 13,00 mm ;
- The average central thickness of the fourth area 18 is equal to a percentage comprised between approximately 63% and 73% with respect to the thickness of the first area 17, so comprised between approximately 5,00 mm and 10,20 mm .

The peripheral rib 15, with an upward convex semi-spherical section, has a central thickness
15 comprised between approximately 0,30 mm and 1,00 mm. In particular, it is proportional in an increasing way with respect the values of the thickness of the first area 17.

The above said thicknesses vary depending on the available internal volume of the footwear in which the insole 10 must be inserted to.

By combining the initial pre-thermoforming density of two layers 40, 41, made of open-cell foamed
20 polyurethane with their final thicknesses of the layers 21, 22 resulting in the multilayer insole 10, it is possible to choose also the cushioning, the accommodation and the upward thrust that are most adequate for the user's weight and to his personal needs, namely the type of footwear in which the internal insole must be inserted to and a determined activity for which it will be used.

For a determined and efficacious cushioning effect to be achieved with the present multilayer insole
25 10, for user with a body weight comprised between 40 and 65 Kg, it is used a first lower layer 40

with an initial density (pre-thermoforming) comprised between 120 and 140 Kg/m³, for user with a body weight comprised between 65 and 85 Kg, it is used a first lower layer 40 with an initial density (pre-thermoforming) comprised between 140 and 160 Kg/m³, for user with a body weight comprised between 85 and 105 Kg, it is used a first lower layer 40 with an initial density (pre-thermoforming) comprised between 160 and 180 Kg/m³, for user with a body weight comprised between 105 and 120 Kg, it is used a first lower layer 40 with an initial density (pre-thermoforming) comprised between 180 and 200 Kg/m³.

There are not considered users' weights less than 40 Kg or greater than 120 Kg, because don't be part of standard average weight of an adult, ma it may be possible to realize a specific insole also for these users with weight slots very low and very high.

If a user searches a cushioning effect different to the one achieved by means of above said description, he may use alternatively an insole intended for user that don't be part of its weight slot, in particular if such an user has a marginal weight with respect to the above said values ranges.

Furthermore, depending on the propulsive effect that it is desired and the activity that will be carried out with the insole 10, chosen the initial pre-thermoforming density of the first lower layer 21, and the final thicknesses of the various areas 17, 18, 19, 20 to be obtained, depending on the internal volume of the footwear in which the insole 10 will be inserted to, it be chosen the initial pre-thermoforming thickness of two layers 21, 22, namely greater is their initial pre-thermoforming thickness, greater the obtained propulsive effect will be.

As already described, this partition in areas 17, 18, 19, 20 is present in relation to the graph of the evolution of the forces of Fig. 1, therefore the insole 10 absorbs the force given by the area of the user's foot that pushes toward the ground, and that after helps the user to thrust upward the area of foot that must detach from the ground.

In particular, as visible in Fig. 5b, in the third layer 23 made of polyester, the filaments 28 are sized in such a way that under the pressure of one or more portions of the foot, or the entire user's foot, in

the area in which such a pressure is applied to, move in an operative position thereof by rotating around the intermediate joint point 29 between two filaments 28 crossed to each other, thereby moving closer their specular end portions and decreasing their angulation, and consequently moving closer two external layers 26, 27, thereby obtaining a cushioning effect even before that the lower layers 21, 22 being involved by the foot crushing, therefore by stressing these latter in a reduced way and by increasing the force absorbing effect of the foot, when it is moving. Furthermore, when the foot detaches from the ground, the filaments 28 from the operative position thereof returns automatically and immediately in the rest position thereof, contributing to increase the upward propulsive effect of the first polyurethane layer 21, and particularly giving time to the second polyurethane layer 22 to restoring its initial shape after have been flattened by the foot, before that the foot will act again with a pressure with a downward direction.

The above said rib 15 is extended along the perimeter delimiting the area of the metatarsus 19, the arch of foot 18 and the heel 17, remaining opened in front and made of piece by the thermoforming of two layers 21, 22 or three layers 21, 22, 23 and has the aim to create a slightly suspension of the central area of the arch of the foot, therefore, during the walk, it is decreased the pressure applied by the user's body weight, and thereby increasing the cushioning in the impact phase and helping the propulsive phase in the initial swing phase, limiting significantly arising of plantar fasciitis, that are consequence of continuous stress, pressure and frictions, furthermore such raised rib 15 helps the user's foot to be centred on the insole 10, in such a way that the foot tends to leant correctly, without inward or outward inclinations, and compressing the same insole 10 in the correct areas, therefore, the insole may always operate in an efficient way, as above described.

Such a rib 15 is opened in the metatarsus area, therefore it doesn't continue to delimit peripherally the area of the metatarsal heads and the phalanges, because the foot fingers must assure the physiological mobility of the metatarsal heads, which must be free to move also in the transversal direction for a proper functioning.

As visible in Fig. 3a, that shows an example of a second embodiment of the upper surface 13 of the insole 10, it is possible to shape this latter with top convex semi-cylindrical portions 13', having transversal or longitudinal lengthened extension on the horizontal plane with respect to the extension of the same insole 10, or having cylindrical or oval extension on the horizontal plane, such portions 13' being divide by grooves 13''. Such type of extensions of portions 13'' may be present on the insole 10 both in a repeated single shape and in combination between at least two types of such extensions.

Such conformations of portions 13' divided by the grooves 13'' assure a increasing of the cushioning effect because the air is compressed between the grooves 13'' during the loading response phase, and during the swing phase the air returns insinuating inside the single same grooves 13''.

So it is achieved a double effect, a greater cushioning, as already described, and a massage of the foot arch, but not so important to stimulate the mechanoreceptors, that may cause physical imbalances.

Referring to Fig. 6 and Fig. 7, there are now described the results of a test carried out by a person using an insole already purchased and an insole 10 according to the present invention.

The test has been carried out in a laboratory located in Udine by means of a system of the German company Moticon ReGo AG based in Munich (www.moticon.de), which system involves the use for each foot of 13 pressure sensors with a frequency of Hz, which equals to a measurement every 0,02 seconds, coupled to the insole of which it is wanted to obtain the relative data.

Which such a system, by making the person who performs the test walk, it is obtained the graph of the evolution of the vertical ground reaction force of each person's foot during each gait, that is brought back to the graph shown in Fig. 1, and that changes depending on the type of used internal insole.

The test has been performed by making the person walk with a regular frequency using uniform

insoles for the feet, on a stiff plane ground that is not slippery and in an indoor environment.

Particularly, in the attached graphs, the x-axis represents the gait of the foot divided in percentage (%), whereas the y-axis represents vertical force in Newton (N) that is exerted on the ground in a determined percentage of the gait.

- 5 The person who has performed the above said tests, of which the graph of the results thereof are shown in Figs. 6 and 7, is an adult male with a weight about 100 Kg and with a severe lameness on the right leg.

Fig. 6 shows two graphs 30, 31 that show the values of the temporal evolution of the vertical ground reaction force in Newton, with the relative temporal deviations, of a gait represented in
10 percentage of completion of its cycle, during the walk of the person who has performed the test using a pair of standard insoles (not shown) inside a pair of everyday shoes (not shown), of which the left graph 30 refers to the left foot, whereas the right graph 31 refers to the right foot.

It may be noted that the person applies a greater force with the left foot with respect to the right foot, in any phase of the gait, that is the impact force of the heel with the ground (curved part 32),
15 the vertical cushioning force of the swing phase (curved part 33), and the upward thrust of the foot for detaching from the ground (curved part 34).

Fig. 7 shows two graphs 35, 36 that show the values of the temporal evolution of the vertical ground reaction force in Newton, with the relative temporal deviations, of a gait represented in percentage of completion of its cycle, during the walk of the person who has performed the test using a pair of
20 insoles 10 according to the present invention inside the same shoes used for the test represented in Fig. 6, of which the left graph 35 refers to the left foot, whereas the right graph 36 refers to the right foot.

In particular, the pair of used insoles 10 are each constituted by a lower layer 21, with a density pre-thermoforming of 200 Kg/m^3 , by an intermediate layer 22, with a density pre-thermoforming of
25 115 kg/m^3 , by the upper third layer 23, and by a coating fabric 24, each used insole 10 having also

the following final thicknesses, subdivided as described below, the first area 17 with a maximum thickness of 9,8 mm, the second area 18 with a maximum thickness of 10,2 mm, the third area 19 with a maximum thickness of 9,3 mm, the fourth area 20 with a maximum thickness of 8,00 mm, and the peripheral rib with a maximum thickness of 0,4 mm, such maximum thicknesses being
5 measured along the longitudinal center line of the insole 10 and in the central point of the longitudinal section of the said rib 15.

It may be noted how the person applies almost the same force with both the feet in all the gait cycle, that is the impact force of the heel with the ground (curved part 37), the vertical cushioning force of the swing phase (curved part 38), and the upward thrust of the foot for detaching from the ground
10 (curved part 39).

It is evident that it is advantageous the use of the insole 10 according the invention because it has a balancing effect between the forces applied by the two feet, even if one of them has trouble walking caused by the lameness of the respective leg.

In the tests it is noted that, during the gait cycle, in the first impact phase and subsequent cushioning
15 the resultant force using the insole 10 (Fig. 7) is lower about 35% with respect to the resultant force using the standard insole (Fig. 6), whereas by using the insole 10 (Fig. 7), besides the fact that the forces during the thrusting phase are balanced between the feet, it is note particularly that the right foot during the thrust phase the force values using the same insole 10 (Fig. 7) are greater about 25% than the force exerted using the standard insole (Fig. 6), and that demonstrates that there is a great
20 cushioning effect and a substantial help during the propulsive phase given by the use of the insole 10, object of the present invention.

By using the layer made of open-cell polyurethane and the three-dimensional fabric, which contain air therein, when they are flattened by the pressure applied by the foot during the gait or when the user stands on the ground, they ejects laterally said air which rises and wraps around the foot,
25 whereas when the foot doesn't apply pressure anymore, the air returns inside the same layers and

the fabric, in this way it is created a continuous and various air flow inside the footwear that keeps dry and fresh the foot.

Furthermore, by using a first lower layer 21 made of open-cell polyurethane having a determined density, a second upper layer 22 made of open-cell polyurethane having a lower density than the one of the first layer 22, and the three-dimensional fabric 23, it is obtained a cushioning subdivided in three steps, because of the flattening in succession of the three above said elements, that may be modulated depending of the pressure applied by the user.

Finally, by using the layers made of open-cell polyurethane, there is not the risk that such cells burst, as it occurs using closed-cell polyethylene, therefore maintaining for a long time their mechanical properties.

With particular reference to Figs. 8-10b and 2, there are now described some example of manufacturing processes of such a multilayer insole 10.

For manufacturing the multilayer insole 10, above described, there are used the following component elements:

- A first lower layer 40 with rectangular base and made of open-cell foamed polyurethane, having a length and width such to result greater than the desired size, with a thickness comprised between 2 mm and 6 mm, and a density comprised between 120 and 200 Kg/m³.
For example, a lower layer 40 with a density of 180 Kg/m³ has a compression strength of 150-240 kPa, a tensile strength of 170 kPa, and elongation at break of 30% ;
- A second intermediate layer 41 with rectangular base and made of open-cell foamed polyurethane, having a length and width identical to the ones of the first layer 40, and with a thickness comprised between 2 mm and 10 mm, and a density comprised between 90 and 115 Kg/m³. For example, an intermediate layer 41 with a density of 115 Kg/m³ has a compression strength of 19 kPa, a tensile strength of 320 kPa, and elongation at break of 220% ;

- A third upper layer 42 with rectangular base constituted by a three-dimensional fabric realized with filaments made of polyester, which filaments are spun to each other creating a structure constituted by two external flat layers, upper one 26 and lower one 27, joined to each other by a plurality of pairs of filaments 28, made of polyester, arranged angled to each other, preferably in an orthogonal way and at 45° with respect to the two external layers 26, 27, such filaments 28 intersected to each other, in the rest position thereof, are arranged extended in a rectilinear, or slightly curved, way, maintaining spaced away the two external layers 26, 27 to each other. Such a three-dimensional fabric, in the rest position thereof, has a thickness about 1,5mm, and is structured in order not to lose its shape and mechanical characteristics up to temperature of 160°C-165°C ;
- A fourth layer 43 with a rectangular base made of fabric or microfiber or in alternative of processed animal leather, having a shape with a length and width identical to the ones of the first three layers 40, 41, 42.

And there are used the following equipment and the following external elements:

- A flame coupling means for thermoplastic polymers of the per se known type and/or adhesive material, preferably polyurethane glue ;
- A thermoforming mould constituted by a first stationary half-mould and by a second movable half-mould, which may be coupled to each other and heated in an independent way to each other, and shaped for obtaining a semi-finished insole with desired shape and dimensions, wherein the second half-mould is use for thermoforming the lower part of the semi-finished insole, whereas the first half-mould is used for thermoforming the upper part of a semi-finished insole ;
- A diking die means, as for example a diking die with a smooth blade made of steel or a diking die with a serrated blade made of steel (known as Tex or Micro-tex) ;
- At least a layer made of nonwoven fabric with a thickness comprised between 0,5 mm and 2

mm.

Generally, the manufacturing process of such a multilayer insole 10 provides the following phases:

- a) Bonding at least of said first two layers with rectangular base 40, 41 having different density;
- 5 b) Thermoforming of such layers with rectangular base bonded inside said thermoforming mould by maintaining a different temperature between the first half-mould and the second half-mould, which are able to be heated in an independent way to each other, such that the lower temperature be applied to the layer with rectangular base with the lower density or to the three-dimensional fabric, in such a way to be able to thermoform all the layer with
10 rectangular base with damaging them and thereby obtaining the multilayer insole 10 with the characteristics previously described. Furthermore, at least a layer of nonwoven fabric may be interposed between the external surface of the layer with rectangular base bonded to each other and the respective half-mould, such a nonwoven fabric being adapted to preserve the mechanical properties of the same layers with rectangular base during the
15 thermoforming phase, for then being removed ;
- c) Removal of the layers with rectangular base bonded and thermoformed, possible additional bonding of the third and/or fourth layer with rectangular base 42, 43, if not bonded to yet, and their final peripheral shaping by means of the diking die means.

Now, it will be described in detail a first example of manufacturing process using the above said

20 phases a), b) and c) :

- a) Bonding of layers with rectangular base:
 - Bonding in succession, by means of the flame coupling means or by means of polyurethane adhesive, of the first lower layer 40 with the second layer 41 with the third layer 42 and with the fourth layer 43, which is made of fabric or microfiber, in such a way that the perimeters
25 of all such layers coincide to each other, obtaining a multilayer body 44 with a rectangular

base (See Fig. 9) ;

b) Thermoforming:

- Positioning of the multilayer body 44 inside the thermoforming mould, with the two half-moulds spaced away to each other and by placing said nonwoven fabric layer between the first half-mould of the mould and the fourth layer 43, and in case by placing an additional nonwoven fabric layer between the second half-mould of the mould and the first lower layer 40, if this latter has a density comprised between 120 and 140 Kg/m³, such nonwoven fabric layers being adapted to preserve the mechanical properties of said third layer 42 and fourth layer 43 and in case of the first layer 40, mechanical properties that may be change if such layers come into direct contact with the respective part of mould during the operative phase thereof;
- Closing of the mould, by coupling the two half-moulds, with the first half-mould at a temperature comprised between 140°C and 165°C, and the second half-mould at a temperature comprised between 210°C and 280°C, and for a time comprised between 1'45" and 3'00" and a pressure comprised between 6 bar and 12 bar, depending on the thicknesses of the layers 40, 41 and the thicknesses of the multilayer insole that must be obtained after the thermoforming ;

c) Possible bonding of the fourth layer with rectangular base 43, if it has not bonded yet, and final peripheral shaping:

- Opening of the mould, that is by moving away two half-moulds, and extraction of the semi-finished shaped multilayer insole obtained by means of thermoforming, and removal of the at least nonwoven fabric layer ;
- Diking of the obtained semi-finished multilayer insole by means of a diking die means with the steel blade of the serrated type, for finishing the edges of the finished multilayer insole

10.

Now, it will be described in detail a second example of manufacturing process using the above said phases a), b) and c) :

a) Bonding of layers with rectangular base:

- Bonding in succession, by means of the flame coupling means or by means of adhesive material, preferably of the polyurethane type, of the first lower layer 40 with the second layer 41, in such a way that the perimeters of all such layers coincide to each other, obtaining a first multilayer body 46 with a rectangular base (See Fig. 10a) ;
- Bonding in succession, by means of adhesive material, preferably of the polyurethane type, of the third layer 42 and with the fourth layer 43, which is made of processed animal leather, in such a way that the perimeters of all such layers coincide to each other, obtaining a second multilayer body 46' with a rectangular base (See Fig. 10b) ;

b) Thermoforming:

- Positioning the first multilayer body 46 inside the thermoforming mould, with two half-moulds spaced away to each other, and by placing the said at least nonwoven fabric layer between the layer 41 and the first half-mould of the mould, and in case between the layer 40 and the second half-mould of the mould, if the layer 40 has a density comprised between 120 and 140 Kg/m³, the at least nonwoven fabric being adapted to preserve the mechanical properties of said multilayer body 46, mechanical properties that may be change if such layers come into direct contact with the respective part of mould during the operative phase thereof ;
- Closing of the mould, that is coupling of the two half-moulds, with the first half-mould at a temperature comprised between 140°C and 165°C, and the second half-mould at a temperature comprised between 210°C and 280°C, and for a time comprised between 1'45" and 3'00" and a pressure comprised between 6 bar and 12 bar, depending on the thicknesses of the layers 40, 41 and the thicknesses of the multilayer insole that must be obtained after

the thermoforming ;

c) Possible bonding of the third and fourth layers with rectangular base 42, 43, if they have not bonded yet, and final peripheral shaping:

- Opening of the mould, that is moving away two half-moulds, and extraction of the first semi-finished body shaped like insole-shape, and removal of the at least nonwoven fabric layer ;
- Bonding, by means of flame coupling means or by means of adhesive material, preferably of the polyurethane type, of the first multilayer body 46 with the second multilayer body 46', obtaining a semi-finished multilayer insole ;

- Diking of the obtained semi-finished multilayer insole by means of a diking die means with steel smooth blade, for finishing the edges of the finished multilayer insole 10 (See Fig. 2).

As it has already anticipated for the general description of the manufacturing process, by using, in the above said example of manufacturing processes, a thermoforming mould comprising two half-moulds which are able to be heated in an independent way and able to be coupled to each other for thermoforming layers of polyurethanic material with different densities, it is surprisingly advantageous for obtaining the multilayer insole with the desired characteristics. In particular, the intervals of temperature above cited for the single half-moulds used in two examples of manufacturing process are, in an unexpected manner, efficient for obtaining the desired properties of the particular layers of polyurethanic materials 40, 41 and the three-dimensional fabric 42, after their thermoforming.

The multilayer insole 10 with the required characteristics is now ready to be used, and wherein the initial lower layer 40 corresponds to the final lower layer 21, the second initial intermediate layer 41 corresponds to the final intermediate layer 22, the initial third layer 42 corresponds to the third upper layer 23, and the fourth initial layer 43 corresponds to the final coating layer 24.

Now, there are shown some not-limitative examples of the first and second layers made of open-cell

foamed polyurethane 40 and 41 bonded to each other for forming the multilayer insole 10, depending on their density and initial thicknesses before the thermoforming thereof, showing also a range of user's body weights depending to the density of the above used first and second layers 40, 41, in order to obtain a classification of the performances of the insole 10 that may be obtained depending on propulsive effect and accommodating effect of the foot.

First layer 40 made of open-cell foamed polyurethane with density of 120 Kg/m³ (adapted to a support and a cushioning of the foot for user with a body weight comprised between 40 and 65 Kg), second layer 41 made open-cell foamed polyurethane 41 with density of 115 Kg/m³:

- First layer 40 with a thickness of 5 mm, second layer 41 with a thickness of 4 mm (medium/high accommodation, medium upward thrust) ;
- First layer 40 with a thickness of 5 mm, second layer 41 with a thickness of 6 mm (high accommodation, medium/high upward thrust) ;

First layer 40 made of open-cell foamed polyurethane with density of 160 Kg/m³ (adapted to a support and a cushioning of the foot for user with a body weight comprised between 65 and 85 Kg), second layer 41 made open-cell foamed polyurethane 41 with density of 115 Kg/m³:

- First layer 40 with a thickness of 3,5 mm, second layer 41 with a thickness of 4 mm (medium accommodation, medium/low upward thrust) ;
- First layer 40 with a thickness of 6,5 mm, second layer 41 with a thickness of 6 mm (medium/high accommodation, high upward thrust) ;

First layer 40 made of open-cell foamed polyurethane with density of 200 Kg/m³ (adapted to a support and a cushioning of the foot for user with a body weight comprised between 105 and 120 Kg), second layer 41 made open-cell foamed polyurethane 41 with density of 115 Kg/m³:

- First layer 40 with a thickness of 3 mm, second layer 41 with a thickness of 8 mm (high accommodation, medium/high upward thrust) ;
- First layer 40 with a thickness of 4 mm, second layer 41 with a thickness of 4 mm

(medium/high accommodation, medium upward thrust). Such layers 40, 41 has been used for obtaining the insole used for the test whose results are shown in the graph of Fig. 7 ;

- First layer 40 with a thickness of 4 mm, second layer 41 with a thickness of 10 mm (very high accommodation, very high upward thrust) .

5 For selecting the type of desired accommodation, it is to be assessed if the user walks many time, by preferring an medium or medium/high accommodation, or if the user spends many time standing in an active way but in a position almost static, thereby preferring an high accommodation.

For selecting the desired upward thrust, it is to be assessed if the user performs only everyday activities, tendentially of the static type (i.e. Desk job, driver, ...), by preferring a low upward
10 thrust, or if the user performs activities in which he spends many time standing (i.e. little factory job, ...), by preferring a medium upward thrust, or if the user performs sport activities or ones that require e considerable effort for lifting the foot from the ground (i.e. run, jump, walk uphill, ...), by preferring medium/high or high upward thrust.

In conclusion, with the above said process, it is possible to obtain pair of multilayer insoles 10, left
15 and right, with the desired characteristics depending on the vertical upon force on the ground applied by a user with a certain weight that is wanted, in such a way that using a pair of multilayer insoles 10, identical for density and thickness to each other, said vertical upon forces on the ground during a gait remain almost identical both for the left insole and for the right insole, therefore giving to the user a balanced walk.

20 Now, it is described a thermoforming mould for obtaining a semi-finished multilayer insole by using the above said manufacturing process, after, said semi-finished multilayer insole must be die cut for obtaining the finished multilayer insole 10.

The substantial components of the thermoforming mould are shown in the Figures 11-17b, particularly, there are shown only the component of the thermoforming mould for obtaining a right
25 semi-finished multilayer insole, because, the components for obtaining a left semi-finished

multilayer insole are realized in a specular manner with respect to the ones here shown, and may be placed side by side to each other or obtained of piece flanked to each other.

Such a thermoforming mould, as already described, is constituted by a first half-mould 47 (male), used for thermoforming the upper part 13 of the semi-finished insole to be die cut after, and by a

5 second half-mould 48 (female), used for thermoforming the lower part 9 of the semi-finished insole to be die cut after.

Said two half-moulds 47, 48 are each shaped with a respective operating surfaces 49, 50 provided on respective parallelepiped bodies 47', 48', this latter being arranged facing each other with said operating surfaces 49, 50 counterposed each other.

10 Said half-moulds 47, 48 may be installed, horizontally or vertically to each other, in a pressing means and at least one of them may be moved by linear moving means of such a pressing means, moving closer and moving away one with respect the other one.

Preferably, said half-moulds 47, 48 are arranged vertically one with respect to the other one, and the one arranged in upper position may be moved vertically, whereas the one arranged in lower position
15 is stationary.

Said two half-moulds 47, 48 are advantageously heated in an independent way to each other for the thermoforming phase for obtaining a semi-finished multilayer insole, by means of heating means of the per se known type, at least partially integrated inside two said half-moulds 47, 48 and/or integrated said pressing means.

20 Said two operating surfaces 49, 50 are sized for being coupled to each other when two half-moulds 47, 48 are moved closer to each other and heated for being to carry out the thermoforming according to the process previously described, thereby obtaining a semi-finished insole, that will be later die cut for obtaining the finished insole 10.

Said operating surface 49 is shaped for obtaining the upper part 13 of the semi-finished multilayer insole, whereas the operating surface 50 is shaped for obtaining the lower part 9 of the semi-finished insole.

Said first half-mould 47 is shown in a first example of embodiment thereof in the Figures 11-13b, in which it may be noted the particular conformation of its operating surface 49.

For convenience, as visible in figure 12, such an operating surface 48 is divided, on its longitudinal extension, with a plurality of transversal cross-sections 51, 52, 53, 54, 55, 56, 57, 58, 59 (lines from sec. A-A to sec. I-I) equidistant to each other, and divided along its longitudinal centreline 60 with a respective cross-section (line sec. L-L).

Such cross-sections from sec. A-A to sec. I-I- are shown with respective back view in Figure 13a, whereas the sec. L-L is shown with a front view in Figure 13b.

Said operating surface 49 is shaped with a first back portion 61, that is raised with a curve concave towards its front part, following the longitudinal extension of the same operating surface 49, and that is connected in a convex way to its end portion 62 and is connected in a convex way with its front end portion 62' to a second front portion 63 that is lowered with a curve, convex towards the front end portion 64 of the operating surface 49, following the longitudinal extension of this latter. Said first and second portions 61, 63 are connected to each other almost in correspondence of the line 56 (sec. F-F).

Said back portion 61 is provided with at least a convex raised portion 65, extended with a longitudinal direction with respect to the extension of the operating surface 49, with a length correspondent to the segment of foot, of a possible user, comprised between its heel and its metatarsus, that is between its back end portion 66 and almost the line 56 (sec. F-F), such a convex raised portion 65 having a variable transversal bending radius and a peripheral shape adapted to follow the standard shape of the upper segment of insole 10 on which the part of foot comprised between its heel and its metatarsus will lean.

Laterally to said convex raised portion 65 there is present a flat surface 65' that follows the longitudinal conformation of said back portion 61.

Said convex raised portion 65 is adapted to obtain the upper portion of insole 10 on which the segment of foot comprised between its heel and its metatarsus will lean.

- 5 Said second front portion 63 is adapted to obtain the upper portion of insole 10 on which the segment of foot comprised its phalanges will lean.

Said convex raised portion 65 has an upper transversal curvature composed by the connection of three curved segments with different radius to each other, of which two said side curved segments 67, 68 and one upper curve segment 69.

- 10 The first curved segment 67 corresponds to the inner part of the insole 10 on which the foot will lean, that is the part turned toward the other foot, whereas the second curved segment 68 correspond to the external part of the same insole 10.

As visible in Figure 12 and in the views of Figure 13b, in the segment comprised between the back end portion 66 and almost the line 51 (sec. A-A), said raised portion 65 has a semi-spherical shape.

- 15 By continuing toward the front part, in the segment comprised between the lines 51 and 53, the internal curved segment 67 increases its radius whereas the external curved segment 68 remains constant.

In the segment comprised between the lines 53 and 54, the radius of the segment 67 remains constant, whereas the radius of the segment 68 increases, and its joining point with the side surface 65' raises constantly.

20

In the segment comprised between the lines 54 and 55, the radius of the segment 67 increases and its joining point with the side surface 65' raises, and also the radius of the segment 68 increases and its joining point with the side surface 65' raises, remaining always higher than the joining point between the segment 67 and the side surface 65'.

- 25 In the segment comprised between the lines 55 and 56, where the back portion 61 completes and

connects then to the front portion 63, the radius of the segment 67 increases and its joining point with the side surface 65' raises, whereas the radius of the segment 68 remains tendentially constant and its joining point with the side surface 65' remains a position less raised with respect to the joining point between the segment 67 and the side surface 65'.

- 5 Next, said front portion 63 has a inclined surface 71, comprised between the line 56 and the front end portion 64 of the body 47', that is convex with a constant transversal bend radius and has an inclination with opposed direction with respect to the back portion 61, maintaining its internal end portion 72 always higher than its external end portion 73, where for internal end portion it is intended the one on the side of the body 47' where the segment 67 is present on, whereas the
- 10 external end portion is on the side of the body 47' where the segment 68 is present on.

Such a surface 71 is adapted to obtain the upper front part of the semi-finished insole, that is where the phalanges of the user will lean on.

The front end portion 71' of said surface 71 and the portion of surface 65' placed behind the raised portion 65 create a flat horizontal plane.

- 15 The raised portion 65 is provided on the entire width thereof of three transversal raised elongated ribs 74, 75, 76, spaced away to each other and adapted to obtain said demarcation lines 45 on the insole 10, therefore by dividing such a raised portion 65 in a first area 77, corresponding to the area of insole 10 to be obtained on which the heel of the foot will lean, a second area 78, that corresponds to the area of insole 10 to be obtained on which the foot arc will lean, a third area 79,
- 20 that corresponds to the area of insole 10 to be obtained on which the foot's metatarsus will lean, and a fourth area 80, that corresponds to the area of insole 10 to be obtained on which the fingers of the foot will lean.

- As it may be noted in Figure 12, said first rib 74 is comprised between the lines 52 and 53, said second rib 75 is astride the line 55, and said third rib 76 is comprised between the lines 56 and the
- 25 segment constituted by the liens 57, 58.

Therefore, by positioning spatially said ribs 74, 75 and 76 inside the lines 51-59 it is possible to be attributed the position of such lines 51-59 with respect to the portions of such an insole 10 that will be obtained and the portion of foot that will lean on.

Referring to Figure 14, in which it is shown a top view of a second example of embodiment of the first half-mould 47, it may be noted that the operating surface 49 is shaped in an identical manner with respect to the first example of embodiment described above, but in which said raised portion 65 is provided with a plurality of recesses 81 having a transversal or longitudinal lengthened extension on the horizontal plane with respect to the longitudinal extension of the same operating surface 49, or having a cylindrical or oval extension on the horizontal plane, such recesses 81 being divided by raised edges 81'. The above said types of extensions of recesses 81 may be present on a part of the upper surface of the raised portion 65, or on the entire said upper surface, in a repeated single shape thereof, or in combination between at least other types of such extensions.

Such recesses 81 are adapted to obtain the portions 13' of the second example of embodiment of the multilayer insole 10, shown in Figure 3a.

Said second half-mould 48 is shown in a possible embodiment thereof in Figures 15-17b, in which it may be noted the particular conformation of the operating surface 50.

For convenience, as visible in Figure 16, such an operating surface 50 has been divided on its longitudinal extension with a plurality of transversal cross-sections 82, 83, 84, 85, 86, 87, 88, 89, 90 (lines from sec. A-A to sec. I-I-), which are equidistant to each other, and divided along its longitudinal centreline 91 with a respective cross-section (line sec. L-L).

Such sections from sec- A-A to sec. I-I are shown with respective back views in the Figure 16a, whereas the sec. L-L is shown with a front view in the Figure 16b.

Said half-mould 48 is constituted by a parallelepiped body 48' having an operating surface 50, adapted, as already said, to obtain the lower surface 9 of the insole 10, object of the present invention.

Particularly, such an operating surface 50 is shaped with a first inclined back portion 92 and a second inclined front portion 93.

Said inclined back portion 92 is extended longitudinally with a convex curve lowering towards the front portion 93 of the body 48', whereas the second inclined front portion is extended

5 longitudinally with a convex curve lowering toward the back portion 92 of the body 48', said inclined portions 92, 93 being connected to each other in the lowest part 94' thereof with a concave curve.

Said back portion 92 is provided with a central concave seat 94, that with its perimeter follows the external peripheral shape of a back portion of the insole 10 to be obtained, and its inner external

10 perimeter is provide with a raised curb 95, which has a constant thickness and a variable height.

Said concave seat 94 is adapted to obtain the lower portion of the insole 10 on which the segment of foot comprised between its heel and its metatarsus.

Said second front 93 is adapted to obtain the lower surface of the insole 10 in which the segment of foot comprising its finger will lean on.

15 Said second front portion 93 is provided at its front vertexes with two raised portions 96, 97, which create a horizontal plane with the back end portion 98 of said raised curb 95.

Such a curb 95, as visible in Figure 16, has a peripheral profile, that already indicated, follows the external shape of the portion of insole 10 to be obtained on which the segment of foot comprised

between its heel and its metatarsus will lean on, that is, such peripheral profile of the back part of

20 the portion 92, where it is shaped with a curved segment 99 almost concentric with respect to the centreline 91 of the operating surface 50, and is extended with a first extended part 101 in

correspondence of the inner part of the foot, that is that part turned towards the other foot of the user, and a second extended part 102 in correspondence of the external part of the foot.

Said first extended part 101 comprise a first segment 103 almost rectilinear, spaced away and

25 parallel to the centreline 91, and finishing almost at 25% of the extension of the portion 92, that is

such a segment 103 being comprised almost between the sec. A-A and sec. D-D, for then being inclined towards the relative external edge 104 of the body 48' with a second segment 105, that is such a segment 105 being comprised between sec. D-D and F-F, and finishing almost at 85% of the extension of the portion 92 and in correspondence of the external edge 104, for then prosecuting
5 along the external edge 104 with a third segment 106 up to the end of the portion 92 that is in correspondence of sec. G-G.

Said second extended part 102 comprise a first segment 103' almost rectilinear, spaced way to the centreline 91 and inclined slightly towards the respective external edge 107 of the body 48', and is finishing almost at 25% of the extension of the portion 92, that is such a segment 103' being
10 comprised between approximately the sec. A-A and sec. D-D, for then increasing its inclination towards the relative external edge 107 of the body 48' with a second segment 108, that is such a segment 108 being comprised between the sec. D-D and sec. E-E and being specular with respect to the first part of the segment 105 of the first extended part 101, and finishing almost at 50% of the extension of the portion 92 and in correspondence of the external edge 107, for then prosecuting
15 along the same external edge 107 with a third segment 109 up to the start of the area 54, that is by exceeding partially the line of sec. G-G.

The respective front end portions 110, 111 of two extended parts 101, 102 finish with a surface inclined frontally towards to and on the upper surface 112 of the portion 93.

In the direction of the vertical extension, such a curb 95 has a constant height in correspondence of
20 its back edge, up to the sec. B-B, for then having the second extended part 102 lowerly than the first extended part 101, up to the sec. F-F, where both profiles lower in the remaining front part up to be coplanar to the upper surface 112 of the portion 93.

Said first concave seat 94, as visible in particular in the back views of the sec. A-A and sec. B-B of Figure 13a and in the front view of sec. L-L of Figure 13b, is shaped with a back horizontal arc 113
25 with a constant radius connected to the concave lower surface 115, provided with a radius, that for

largeness, tends to be rectilinear, and inclined frontwards.

In the view of sec. C-C of Figure 13a, it may be noted that the inner arc 116 for connecting the lower surface 115 to the curb 95, that is the one turned inwards of the foot that will use the insole 10, and joined on the back to the front end portion of the connecting arc 113, increases its radius with respect to the radius of the same connecting arc 113, whereas the external arc 117 for connecting the lower surface 115 to the curb 95, that is the one turned outward to the foot that will use the insole 10 and joined on the back to the front end portion of the connecting arc 113, remains constant.

By continuing longitudinally frontwards, it may be noted that the internal connecting arc 116 increases continuously, as also the external connecting arc 117, furthermore, the part of curb 95 that corresponds to the external connecting arc 117 raises its joining point with the portion 92.

In the segment comprised between the sec. F-F- and the front end portion of the front portion 93, that is the surface 112, it may be noted that this latter is concave with a transversal arc that has an increasing radius frontwards, maintaining its external end portion 117, which corresponds to the external part of foot that will lean on the insole 10, in a higher position with respect to its internal end portion 104, which corresponds to the internal part of foot that will lean on the insole 10.

Said two half-moulds 47, 48, and particularly the operating surfaces 49, 50, are shaped and sized for coupling to each other in such a way that the convex raised portion 65 is positioned inside the concave seat 94, maintaining a pre-determined distance between the upper surface of the same raised portion 95 and the lower surface 115 of the concave seat, for been able to insert one or more of said layers 40, 41, 42, 43 to be thermoformed for obtaining the semi-finished multilayer insole, according to the manufacturing process described above, with the raised curb 95 that is leant on the surface 65' and next to the lower external profile of said raised portion 65, whereas the two raised portions 69, 67 lean on the front end portion of the surface 7 of said front portion 63, in such a way to have an empty space between the portion 93 and the same surface 71 and opened on its sides.

The thermoforming mould with this coupling configuration between the half-moulds 47, 48 allows to obtain the insole 10 as described previously by means of the above described process, furthermore, by maintaining closed the area comprised between two half-moulds 47, 48, which corresponds to the segment of foot comprised between its heel and its metatarsus, allows to obtain
5 said raised rib 15 of the insole 10, whereas the empty space comprised between the portion 93 and the surface 71, that is opened on its sides, prevents the formation of such a raised rib 15 in correspondence of the segment of foot comprising the phalanges.

After, the front part of the semi-finished insole may be die cut with the desired dimension.

The portion 93 of the half-mould 48 may be provided with a plurality of segments 118, shaped with
10 raised arcs, for engraving of respective arc grooves on the surface 9 of the semi-finished 9, that remain also after the die cut phase, for the cutting signs for choosing of the insole's size needed for the user.

The bend radiuses of the convex raised portion 65 and the arc 116, 117, for connecting between the internal surface 115 and the raised curb 95, are sized in such a way that raised rib 15 is positioned in
15 an adequate on the insole 10, as already described, therefore, by varying the size of such radiuses of connecting arcs, the raised rib 15 may be positioned more internally or more externally with respect to the longitudinal centreline and to the back end portion of the insole 10, that is, by varying the size of such radius of connecting arcs, it is possible to choose the position in which the raised rib 15 must be created on the surface 13 with respect the longitudinal centreline and to the back end
20 portion of the insole 10.

CLAIMS

1. Multilayer insole (10) usable inside footwear of various kind, and adapted to support the user of such footwear with such an insole (10), both during the static phase and during the walk, and in particular adapted to produce a support for all the joints of the foot and the tibiotarsic joint, a cushioning, an upward thrust and an accommodation of the user's foot depending on the weight of the user and the activity that is carrying out, said multilayer insole (10) having a peripheral profile (11) of the standard type and comprising at least a first lower layer (21) and at least a second layer (22) made open-cell foamed polyurethane, and extended for the entire area of the same multilayer insole (10) and bonded overlapped to each other and thermoformed, furthermore, said insole (10) being shaped with an upper surface (13) slightly concave on its upper back part, flat on its front part, and convex on its upper part almost at its central part (14), insole (10) **characterized in that** it comprises at least an additional third upper layer (23) constituted by a three-dimensional fabric realized in filaments made of polyester, and adapted to create an additional cushioning effect of the insole (10) and to create a continuous and various air flow inside the footwear, said first lower layer (21) having also a density equal to a percentage comprised approximately between 104% and 222% with respect of the density of the second layer (22), and being adapted to support all the upper layers (22, 23) overlapped to it, and to exert a cushioning when a pressure is applied in a downward direction by the foot, or at least a part of it, said second layer (22) being adapted to provide an accommodation and cushioning effect of the user's foot, or a part of it, when this latter applies a pressure in a downward direction, and being also adapted to provide a thrust in the upward direction when the pressure applies in the downward direction by the foot decreases, namely when the foot is raised up, said insole (10) being subdivided, in the longitudinal extension thereof in four areas by thickness and density, a first area (17) corresponding to the heel of the user's foot, a second area (18) corresponding to the arch of the user's foot and comprising said convex part (14), a third area (19) corresponding to the metatarsus of the user's foot and a fourth area (20) corresponding to the

phalanges of the user's foot, in such a way that such a same multilayer insole (10) be adapted to have for each of said four areas a predetermined accommodation, cushioning and upward thrust during at each gait, considered the thickness of the first area (17) the 100%, the average central thickness of the second area (18) corresponding to a percentage comprised between approximately 105% and 107% with respect to the thickness of the first area (17), the average central thickness of the third area (19) corresponding to a percentage comprised between approximately 92% and 93% with respect to the thickness of the first area (17), the average central thickness of the fourth area (20) corresponding to a percentage comprised between approximately 63% and 73% with respect to the thickness of the first area (17).

2. Multilayer insole according to claim 1, **characterized in that** said upper surface (13) comprises lengthened raised rib (15) made integral, shaped preferably with a upwardly convex semi-cylindrical section and with a reduced width, and extended inside and in a spaced way in correspondence of the peripheral profile (11) by interesting the area of the metatarsus (19), the arch of foot (18) and the heel (17), remaining opened in front in such a way to not interfere with the metatarsal heads and with the phalanges of the user's foot, such a rib (15) having a central thickness comprises between approximately 0,30 mm and 1,00 mm, proportional in an increasing way with respect the values of the thickness of the first area (17), and being adapted to create a slightly suspension of the central area of the arch of the user's foot, for increasing the cushioning during the impact phase and by assisting the propulsive phase in the initial swing phase when the foot detaches from the ground, and being adapted to help the user's foot to centre itself on the multilayer insole (10) without inclinations.

3. Multilayer insole according to claim 2, **characterized in that** the polyester filaments of the three-dimensional fabric of said third upper layer (23) are spun and bonded for creating a structure constituted by two external flat layers, upper one (26) and lower one (27), joined to each other by a plurality of pairs of polyester filaments (28), arranged extended in rectilinear way or slightly curved

and angled to each other, preferably in an orthogonal way and at 45° with respect to the two external layers (26, 27) and with longitudinal or transversal direction with respect to the longitudinal development of the insole (10), such a filaments (28) being sized in such a way that, under the pressure of one or more portions of the foot, in the area in which such a pressure is applied to, rotate around the intermediate joint point (29) between two filaments (28) crossed to each other, thereby moving closer their specular end portions and decreasing their angulation, and consequently moving closer two external layers (26, 27), for then return in the start position when such a pressure is lacking.

4. Multilayer insole according to claim 1, **characterized in that** the first area (17) has an average central thickness comprised between approximately 8,00 mm and 14,00 mm, the second area (18) has an average central thickness comprised between approximately 8,40 mm and 15,00 mm, the third area (19) has an average central thickness comprised between approximately 7,40 mm and 13,00 mm and the fourth area (20) has an average central thickness comprised between approximately 5,00 mm and 10,20 mm, the above said thickness varying in dependence of the available inner space of the footwear in which the insole (10) must be inserted to.

5. Multilayer insole according to claim 2, **characterized in that** an upper coating (24), made of fabric and/or leather o equivalent material, is bonded, by means of a flame coupling means or by means of adhesive material, as for example of the polyurethane type, on the upper part of the said third layer (23), following its contour.

6. Multilayer insole according to claim 1, **characterized in that** said first layer (21) has an initial pre-thermoforming density comprised between 120 and 200 Kg/m³, whereas the second layer (22) has an initial pre-thermoforming density comprised between 90 and 115 Kg/m³, preferably of 115 Kg/m³.

7. Multilayer insole according to claim 6, **characterized in that** for users having a body weight comprised between 40 and 65 Kg, it is used a first lower layer (40) with an initial pre-

thermoforming density comprised between 120 and 140 Kg/m³, for users having a body weight comprised between 65 and 85 Kg, it is used a first lower layer (40) with an initial pre-thermoforming density comprised between 140 and 160 Kg/m³, for users having a body weight comprised between 85 and 105 Kg, it is used a first lower layer (40) with an initial pre-thermoforming density comprised between 160 and 180 Kg/m³, for users having a body weight comprised between 105 and 120 Kg, it is used a first lower layer (40) with an initial pre-thermoforming density comprised between 180 and 200 Kg/m³.

8. Multilayer insole according to claim 1, **characterized in that** such four areas (17, 18, 19, 20) are subdivided and identifiable by respective demarcation lines (45), rectilinear or curved and arranged transversally with respect to the longitudinal extension of the insole (10).

9. Multilayer insole according to claim 1, **characterized in that** the upper surface (13) of the insole (10) is shaped with a plurality of top convex semi-cylindrical portions (13') having transversal or longitudinal extension on the horizontal plane with respect to the extension of the same insole (10), or having cylindrical or oval extension on the horizontal plane, such portions (13') being divided by grooves (13''), and being adapted to increase the cushioning effect of the insole (10).

10. Manufacturing process of a multilayer insole (10) according to claims 1-11 for which there are used substantially the following equipment :

- A flame coupling means for thermoplastic polymers of the per se known type and/or adhesive material, preferably polyurethane glue ;
- A thermoforming mould constituted by a stationary half-mould (male) and by a movable half-mould (female), which may be heated in an independent way to each other, and shaped for obtaining a semi-finished insole with desired shape and dimensions, wherein the female is use for thermoforming the lower part of the insole (10), whereas the male is used for thermoforming the upper part of the insole (10) ;
- A diking die means, as for example a diking die with a smooth blade made of steel or

diking die with a serrated blade made of steel ;

and in which there are used the following component elements :

- a first lower layer (40) with rectangular base and made of open-cell foamed polyurethane, having a length and width such to result greater than the desired size, with a thickness comprised
5 between 2 mm and 6 mm, and a density comprised between 120 and 200 Kg/m³ ;
- a second intermediate layer (41) with rectangular base and made of open-cell foamed polyurethane, having a length and width identical to the ones of the first layer (40), and with a thickness comprised between 2 mm and 10 mm, and a density comprised between 90 and 115 Kg/m³, preferably of /m³ ;
- 10 - a third upper layer (42) with rectangular base constituted by a three-dimensional fabric ;
- a fourth layer (43) with a rectangular base made of fabric or microfiber or in alternative of processed animal leather, having a shape with a length and width identical to the ones of the first three layers (40, 41, 42) ;

and that provides the following phases :

- 15 a) the bonding of at least said first two layers with rectangular base (40, 41) having different density to each other ;
- b) the thermoforming of such bonded layers with rectangular base inside said thermoforming mould ;
- c) removal of the layers with rectangular base bonded and thermoformed, possible additional
20 bonding of the third and/or fourth layer with rectangular base (42, 43), if not bonded to yet, and their final peripheral shaping by means of the diking die means ;

characterized in that, said three-dimensional fabric of the third upper layer (42) is structured in order not to lose its shape and mechanical characteristics up to temperature of 160°C-165°C, and that said thermoforming phase provides the maintenance of a difference of temperature
25 between the first half-mould and the second half-mould, which are able to be heated in an

independent way to each other, such that the lower temperature be applied to the layer with rectangular base having the lower density or to the third layer (42) and at least a layer of nonwoven fabric being interposed between the external surface of the layers with rectangular base bonded to each other and the respective half-mould, such a nonwoven fabric being adapted to preserve the mechanical properties the same layers with rectangular base during the thermoforming phase, for then being removed at the end of the thermoforming.

11. Manufacturing process according to claim 10, **characterized in that** the filaments of the three-dimensional fabric of the third upper layer (42) with rectangular base are spun to each other creating a structure constituted by two external flat layers, upper one (26) and lower one (27), joined to each other by a plurality of pairs of filaments (28), made of polyester, arranged angled to each other, preferably in an orthogonal way and at 45° with respect to the two external layers (26, 27), such filaments (28) intersected to each other, in the rest position thereof, are arranged extended in a rectilinear, or slightly curved, way, maintaining spaced away the two external layers (26, 27) to each other, and is structured in order to not lose its shape and mechanical characteristics up to temperature of 160°C-165°C.

12. Manufacturing process according to claim 10, **characterized in that** the difference of temperature between two half-moulds of the thermoforming mould is comprised between 10°C and 20°C.

13. Manufacturing process according to claim 12, **characterized in that** the phase a) provides the bonding in succession, by means of the flame coupling means or by means of adhesive material, preferably polyurethane glue, of the first lower layer (40), the second layer (41), the third layer (42) and the fourth layer (43), which is made of fabric or microfiber, in such a way that the perimeters of all such layers coincide to each other, obtaining a multilayer body (44) with a rectangular base, that the phase b) provides the positioning of the multilayer body (44) inside the thermoforming mould, with two half-moulds spaced to each other and by interposing said nonwoven fabric layer between

the first half- mould and the fourth layer (43), and in case by interposing an additional nonwoven fabric layer between the second half-mould and the first lower layer (40), and provides the closing of the mould, that is the coupling of two half-moulds, with the first half-mould at a temperature comprised between 140°C and 165°C, and the second half-mould at a temperature comprised
5 between 210°C and 280°C, and for a time comprised between 1'45" and 3'00" and a pressure comprised between 6 bar and 12 bar, depending on the thicknesses of the layers (40, 41) and the thicknesses of the multilayer insole (10) that must be obtained after the thermoforming, and that the phase c) provides the opening of the mould and the extraction of the semi-finished shaped multilayer insole obtained by means of thermoforming, and removal of the at least nonwoven fabric
10 layer, and following the diking of the obtained semi-finished multilayer insole by means of a diking die means with serrated blade, for finishing the edges of the finished multilayer insole (10).

14. Manufacturing process according to claim 12, **characterized in that** the phase a) provides the bonding in succession, by means of the flame coupling means or by means of adhesive material, preferably of the polyurethane type, of the first lower layer (40) and the second layer (41), in such a
15 way that the perimeters of such layers coincide to each other, obtaining a first multilayer body (46) with a rectangular base, and the bonding in succession, by means of adhesive material, preferably of the polyurethane type, of the third layer (42) and the fourth layer (43), which is made of processed animal leather, in such a way that the perimeters of such layers coincide to each other, obtaining a second multilayer body (46') with a rectangular base, that the phase b) provides the positioning of
20 the first multilayer body (46) inside the thermoforming mould, with two half-moulds thereof spaced to each other, and by placing the said at least nonwoven fabric layer between the layer (40) and the male of the mould, and between the layer (41) having a density comprised between 120 and 140 Kg/m³ and the female of the mould, and provides the closing of the mould with the first half-mould at a temperature comprised between 140°C and 165°C, and the second half-mould at a temperature
25 comprised between 210°C and 280°C, and for a time comprised between 1'45" and 3'00" and a

pressure comprised between 6 bar and 12 bar, depending on the thicknesses of the layers (40, 41) and the thicknesses of the multilayer insole that must be obtained after the thermoforming, that the phase c) provides the opening of the mould and extraction of the first semi-finished body shaped like insole-shape, and removal of the at least nonwoven fabric layer, the bonding, by means of flame coupling means or by means of adhesive material, preferably of the polyurethane type, of the first multilayer body (46) with the second multilayer body (46'), obtaining a semi-finished multilayer insole, and provides the diking of the obtained semi-finished multilayer insole by means of a diking die means with smooth blade, for finishing the edges of the finished multilayer insole (10).

15. Thermoforming mould used in the manufacturing process according to claim 10 for a multilayer insole (10) according claims 1-9, comprising:

- a first half-mould (47), constituted by a parallelepiped body (48') provided with a first operating surface (49), this latter being used for thermoforming the upper part (13) of the semi-finished multilayer insole ;

- a second half-mould (48), constituted by a parallelepiped body (49') provided with a second operating surface (50), this latter being used for thermoforming the lower part (9) of the semi-finished multilayer insole ;

said bodies (47', 48') being arranged with the respective operating surfaces (49, 50) counterposed to each other, and at least one of two bodies (47', 48') being able to be moved by linear moving means of pressing means, moving closer and moving away with respect the other body (47' or 48'), with the interposition of at least two layers (40, 41, 42) to be thermoformed for obtaining the semi-finished multilayer insole, **characterized in that** said two half-moulds (47, 48 are able to be heated in an independent way to each other.

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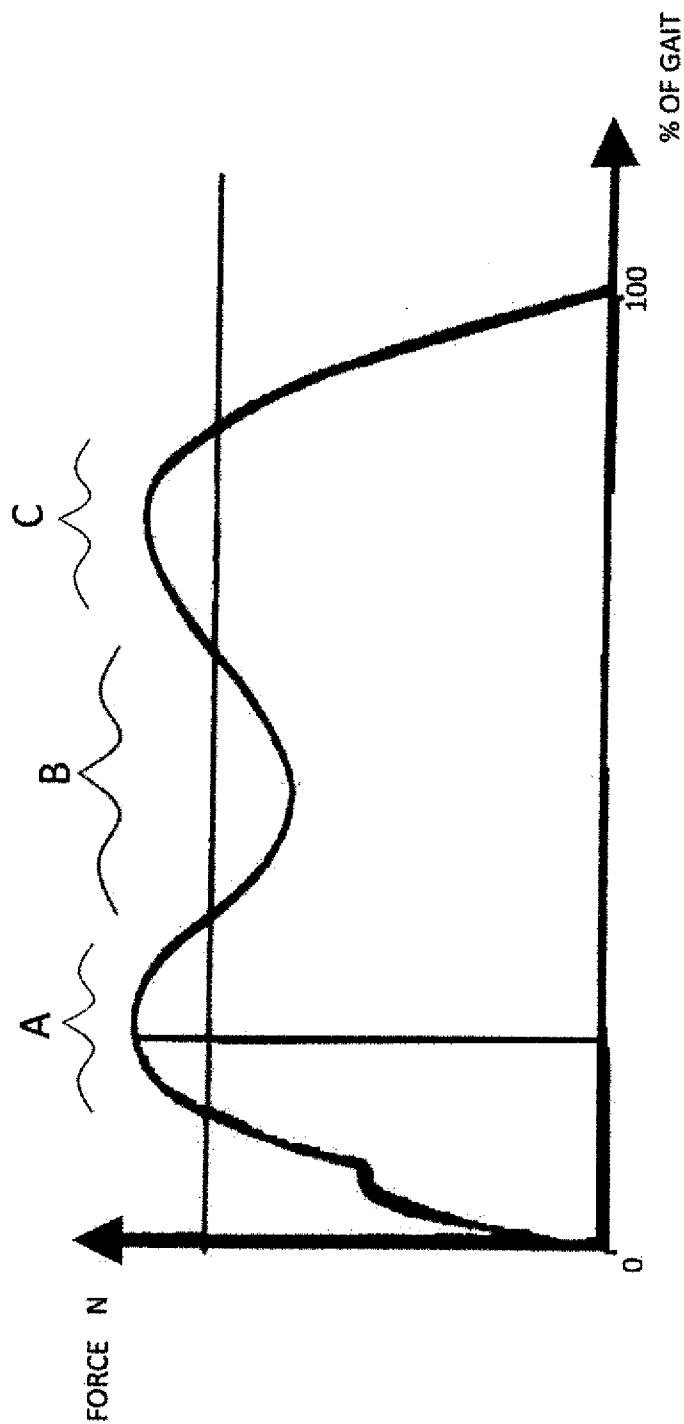


FIG. 1

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FIG. 2

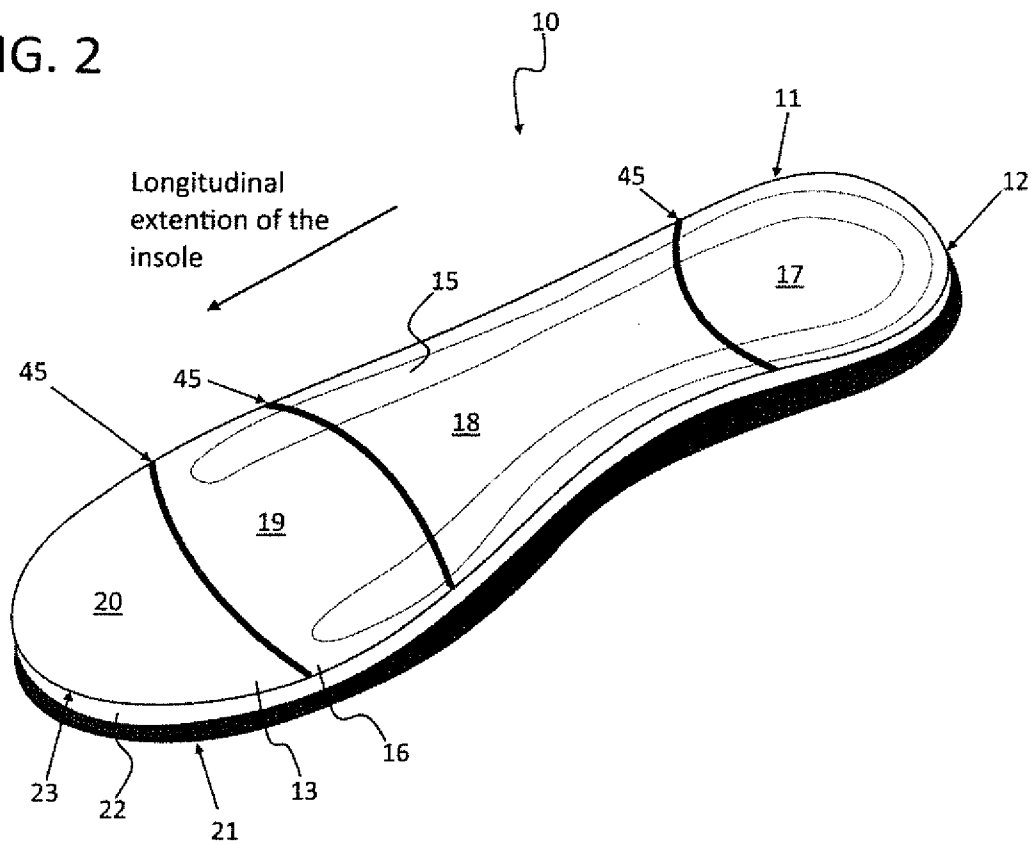
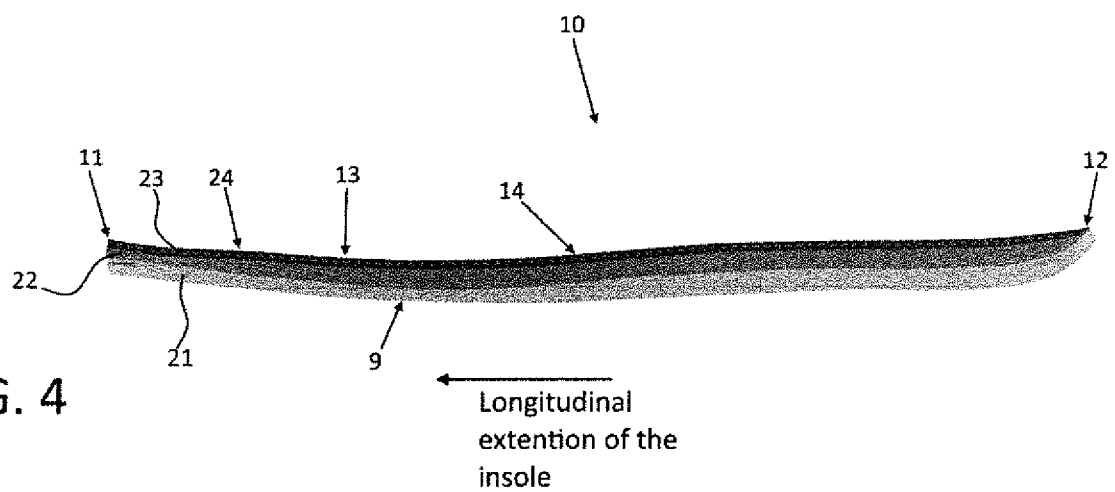


FIG. 4



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FIG. 3

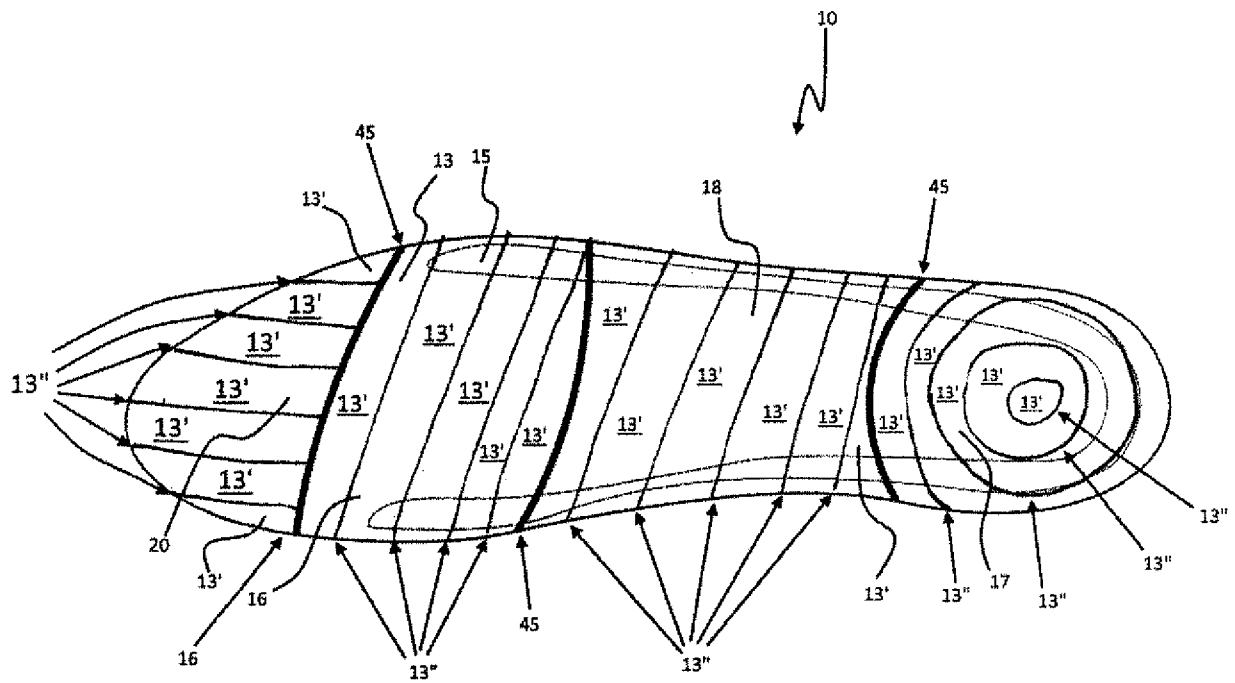
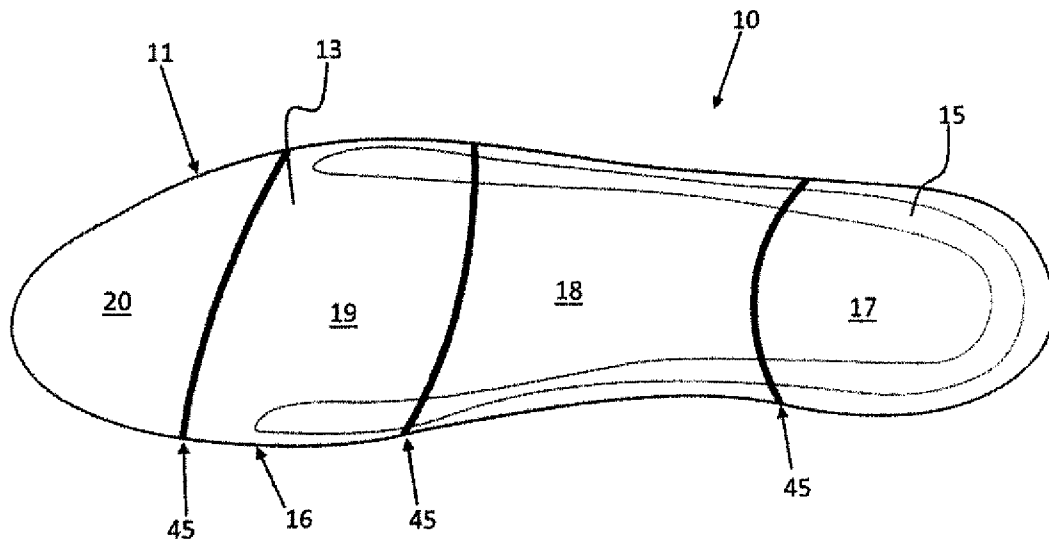
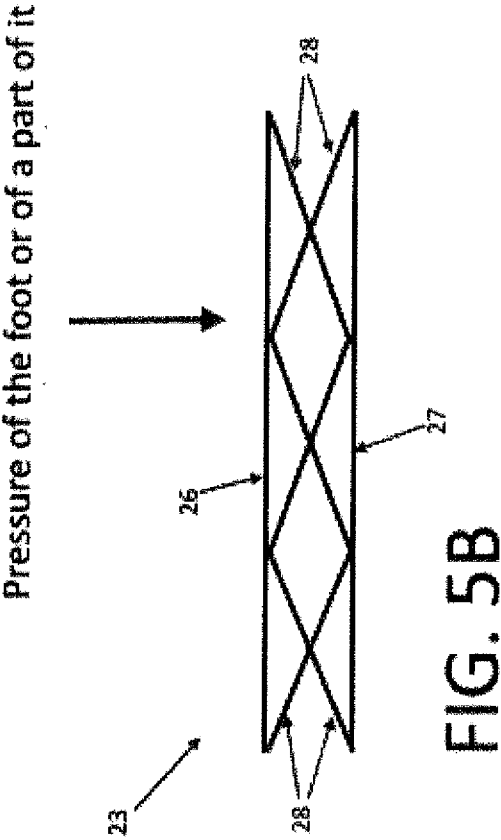
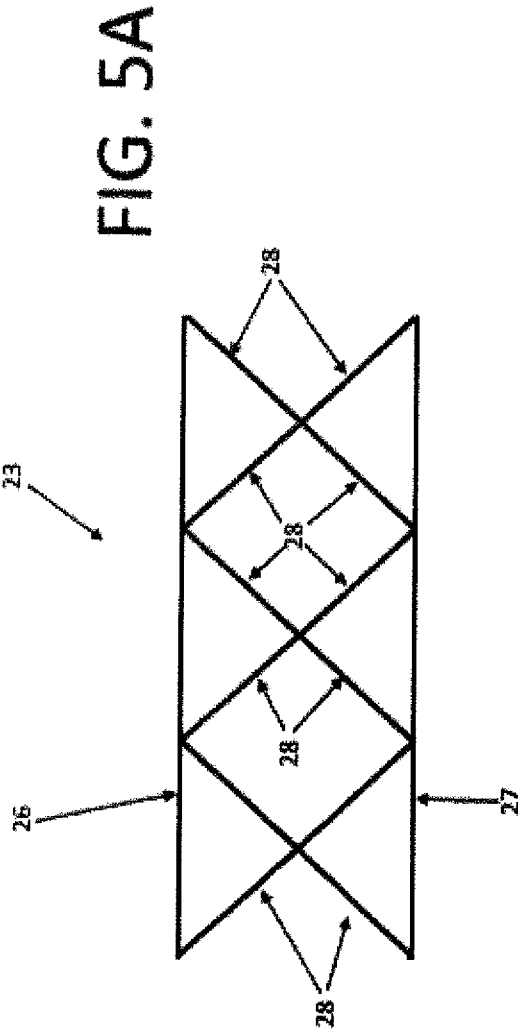


FIG. 3A



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FIG. 6

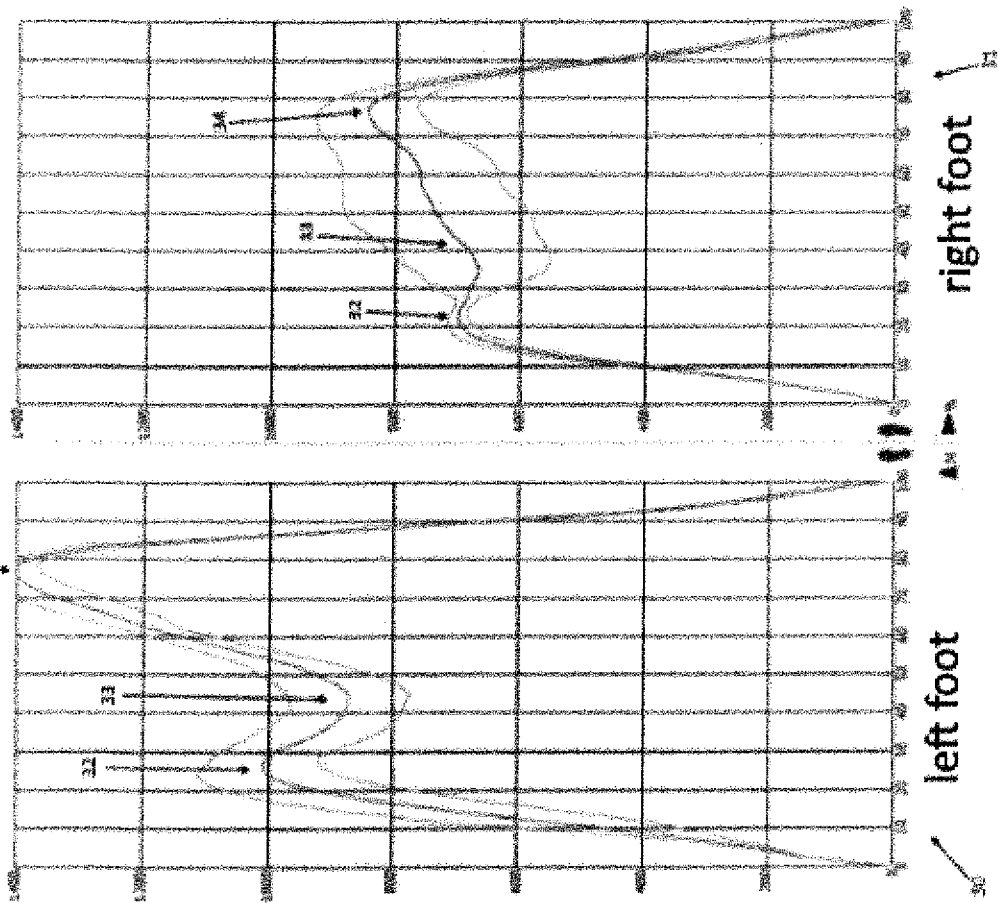
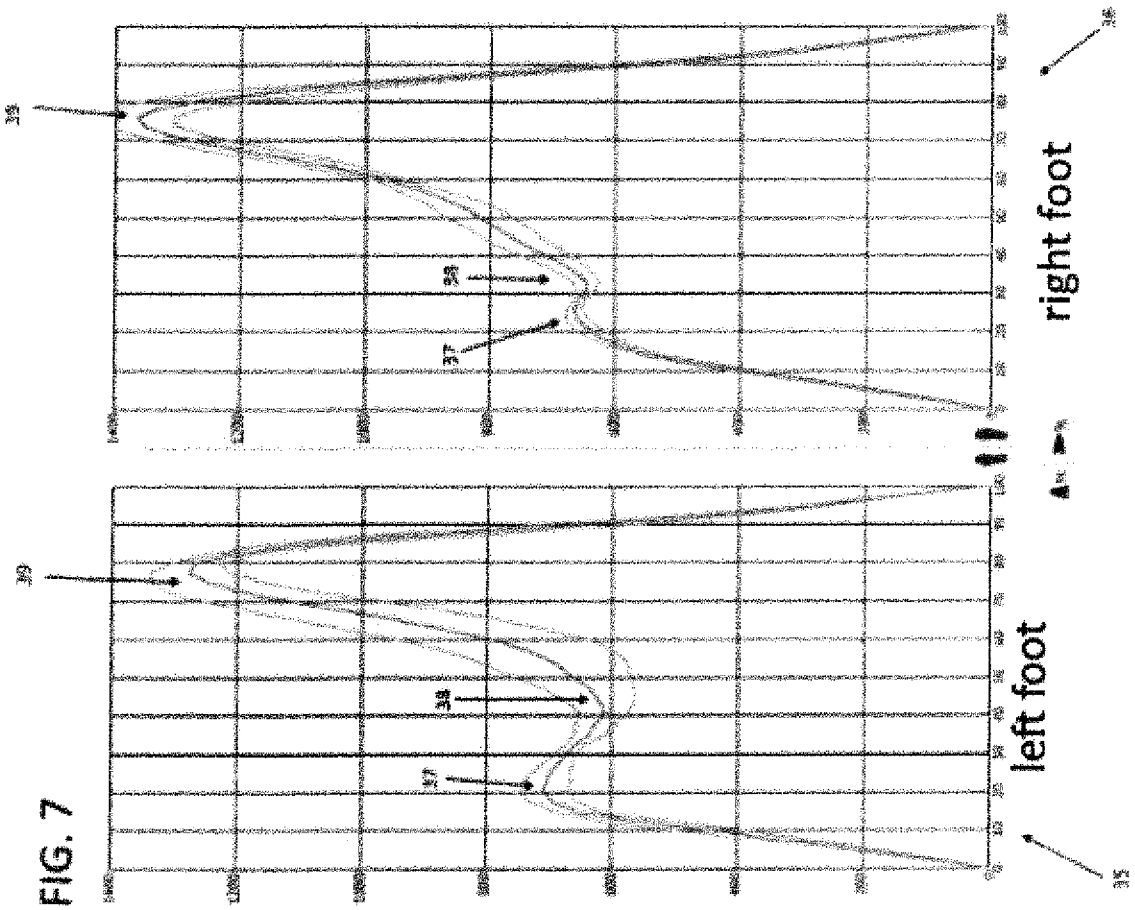
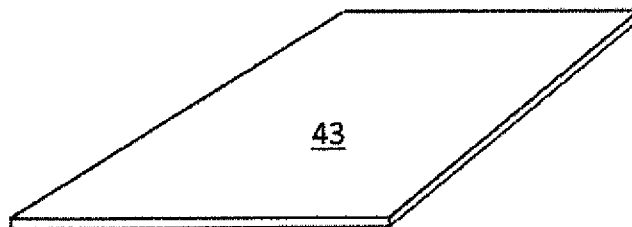
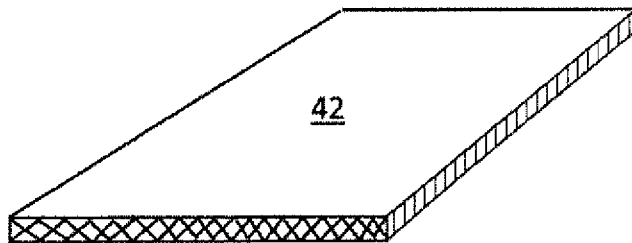
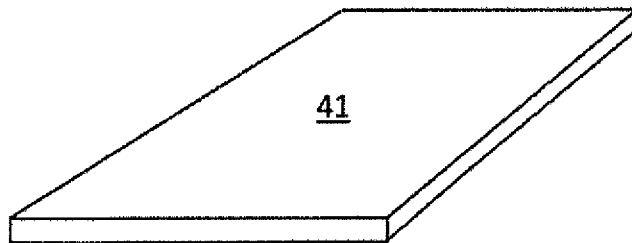
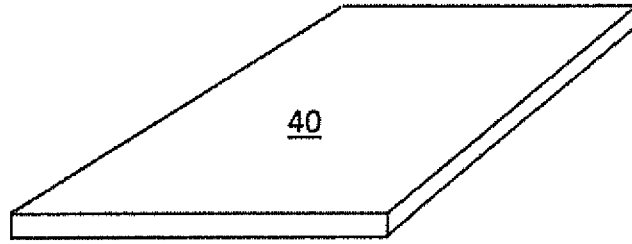


FIG. 7



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FIG. 8



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FIG. 9

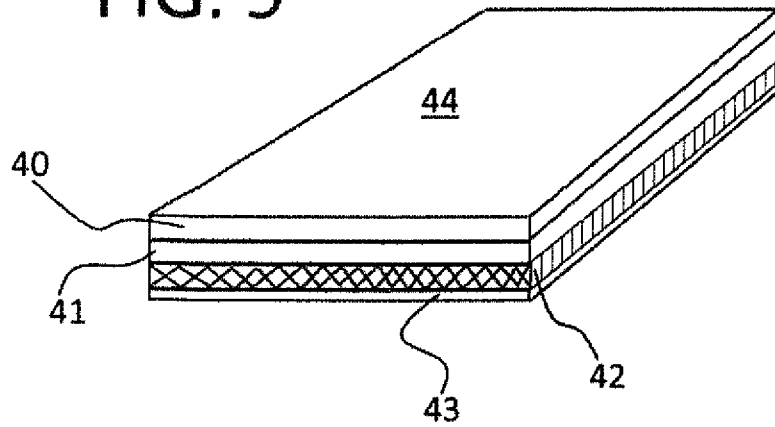


FIG. 10A

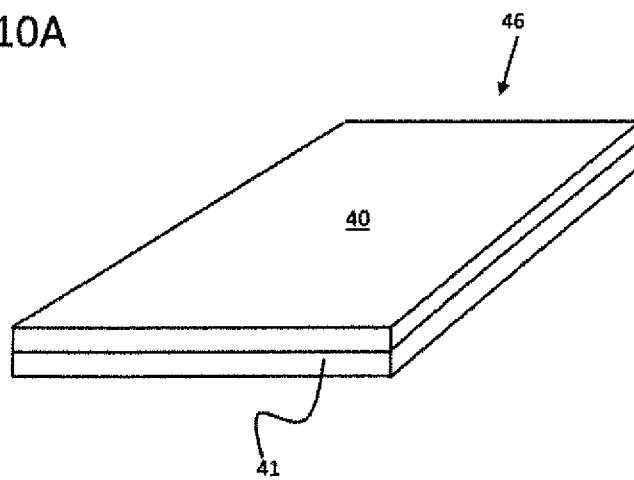
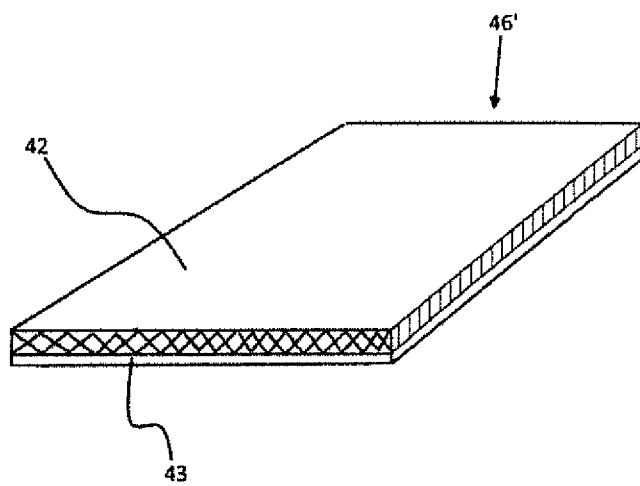
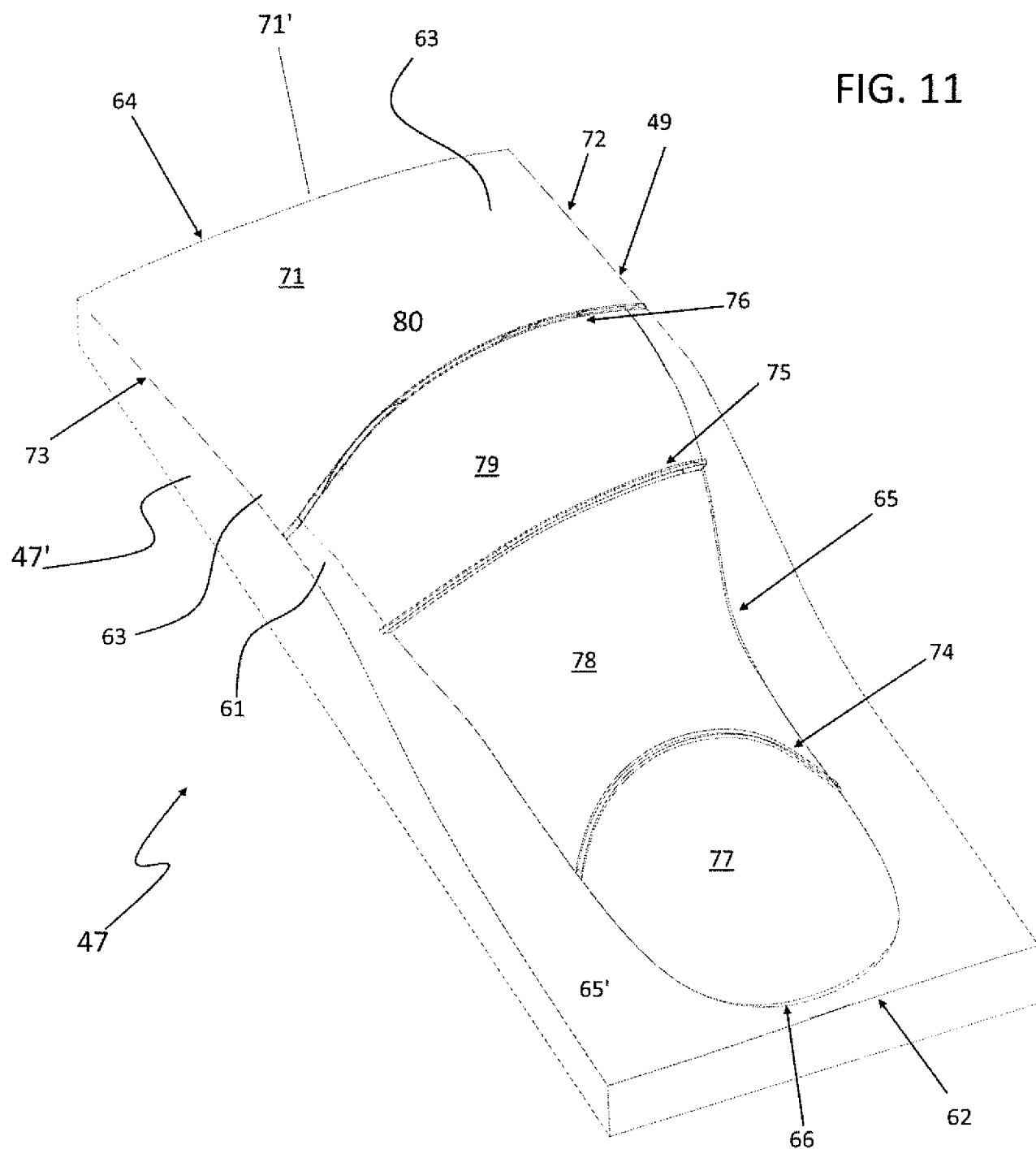


FIG. 10B



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FIG. 11

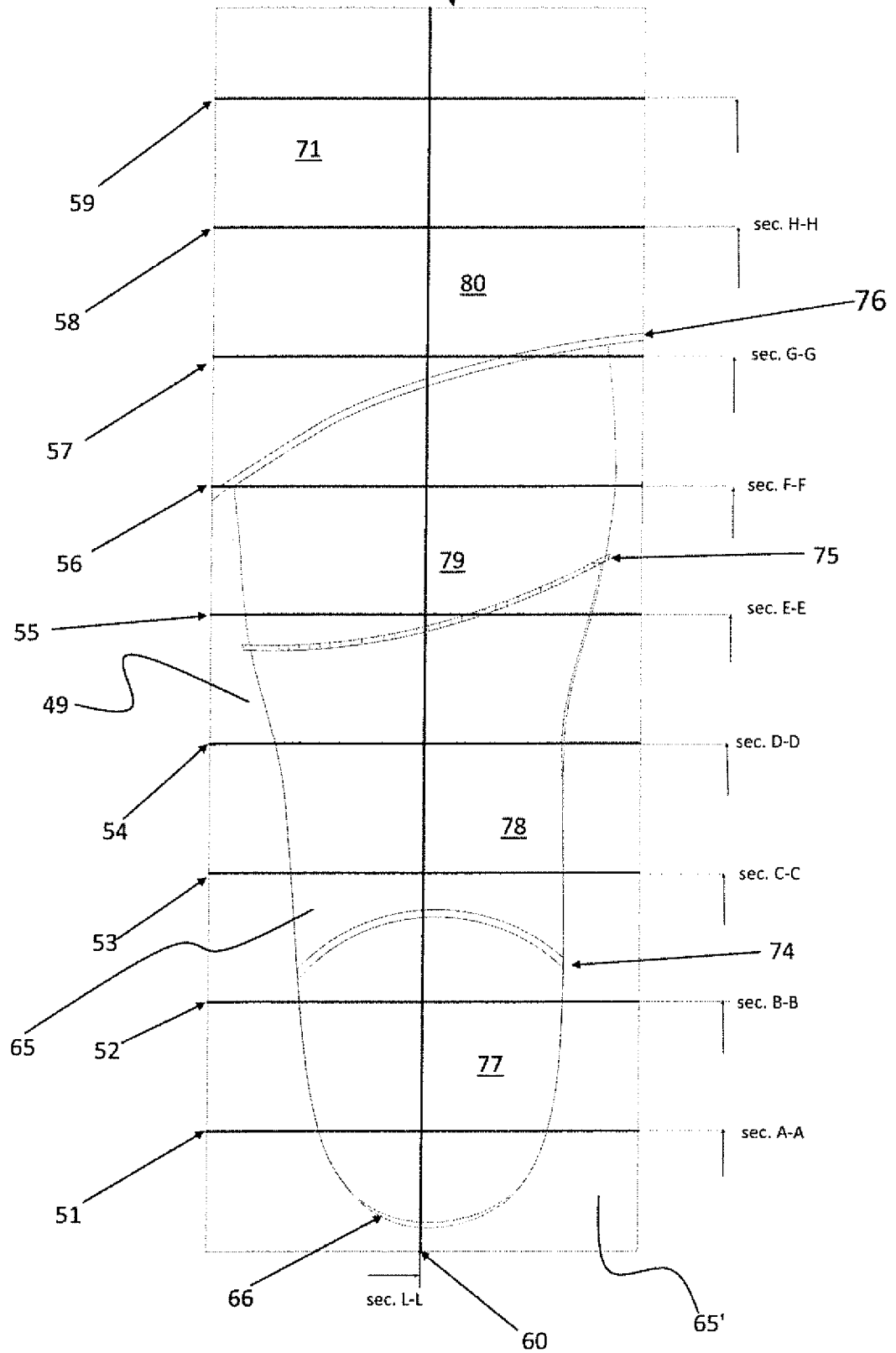


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47

64

FIG. 12



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FIG. 13B

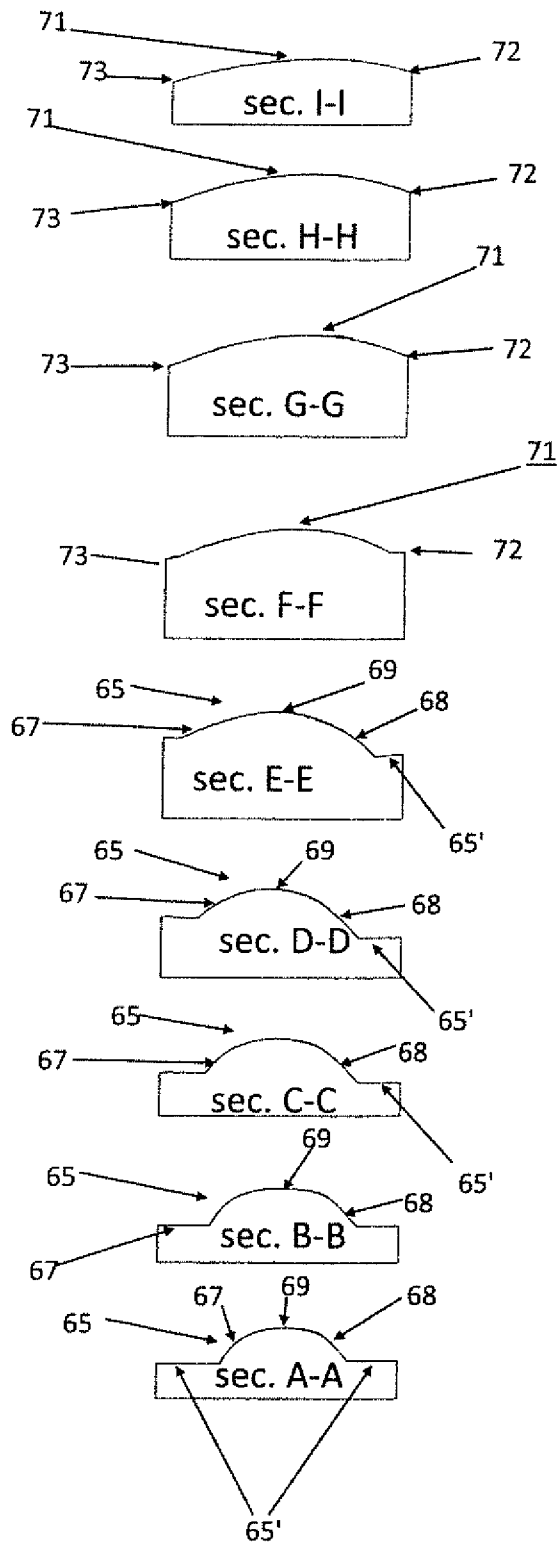
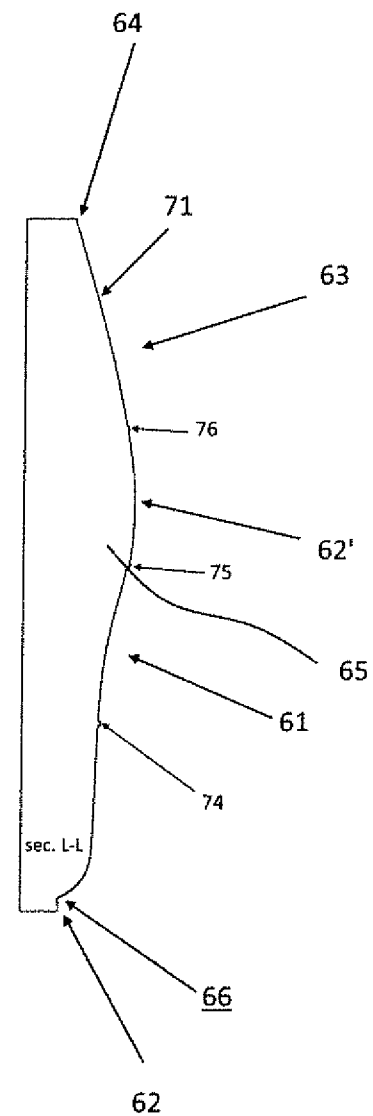
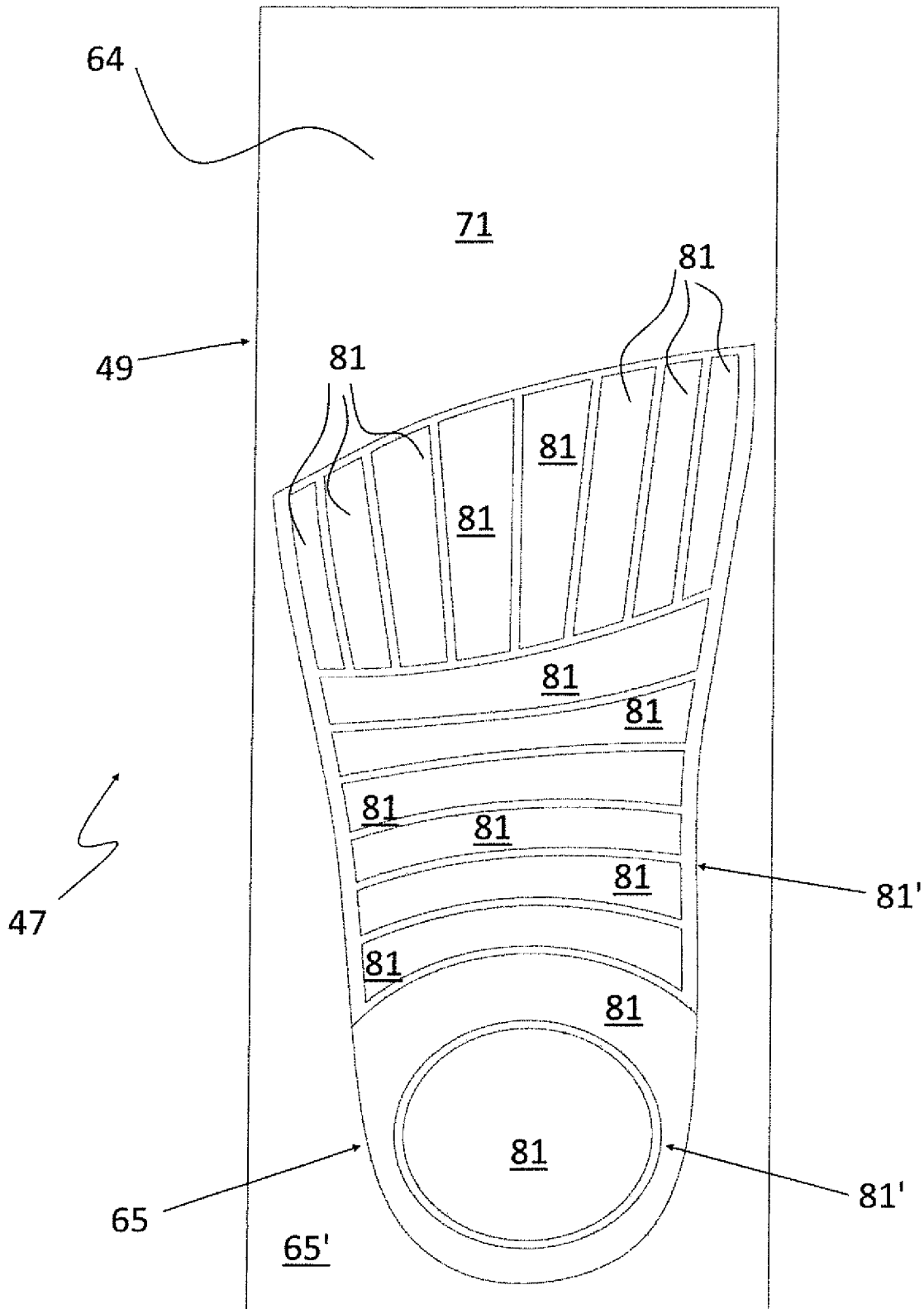


FIG. 13A



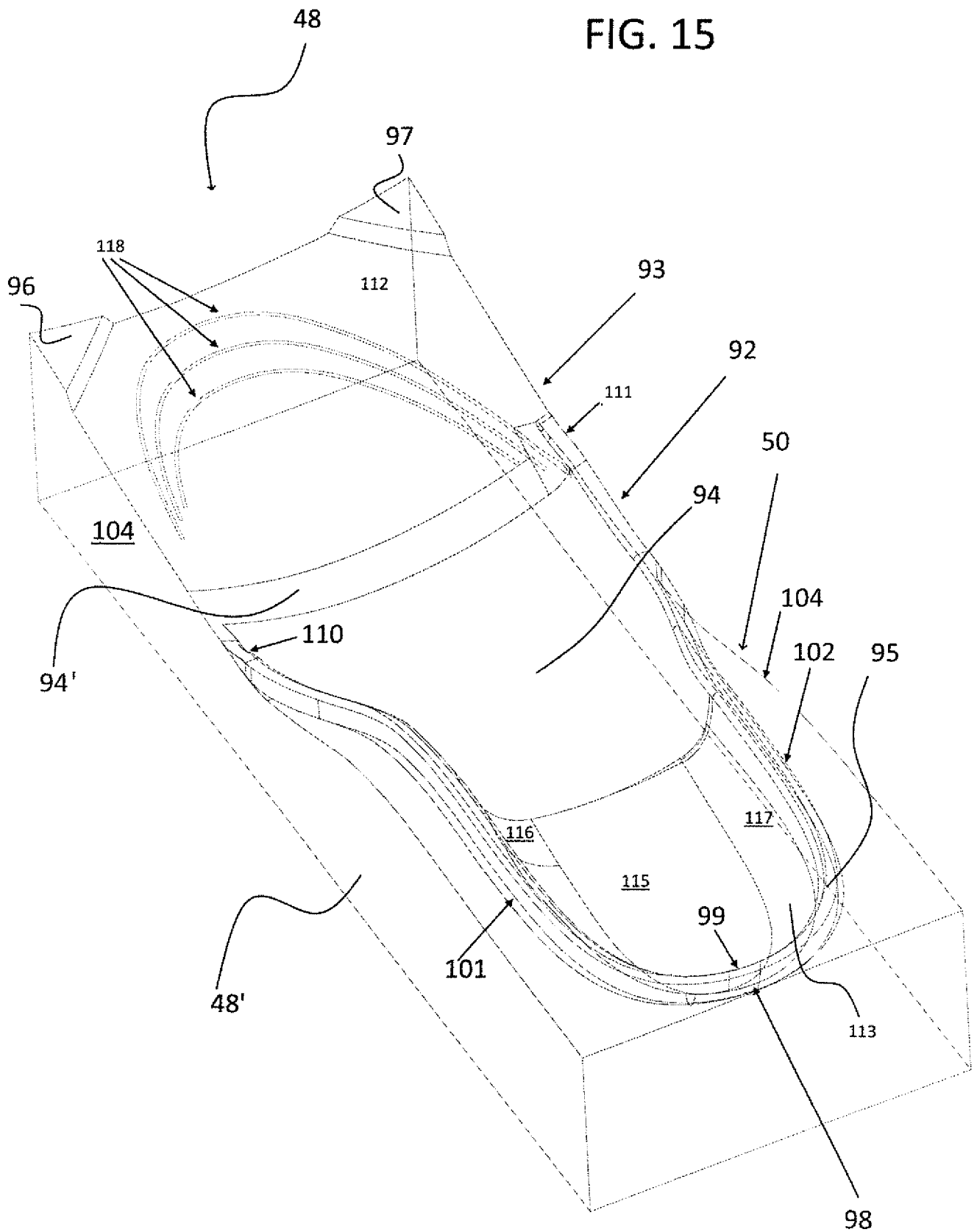
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FIG. 14



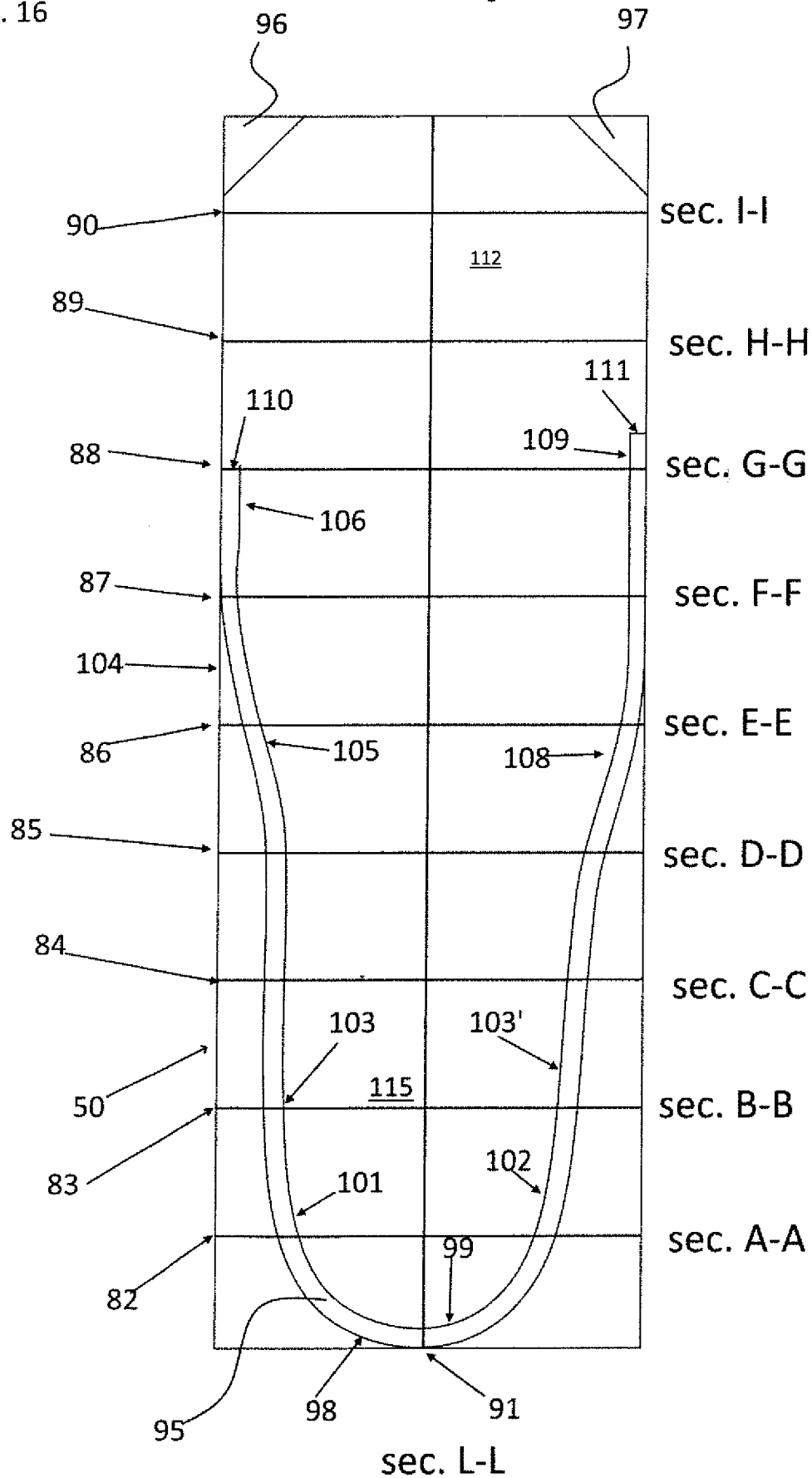
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FIG. 15



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FIG. 16



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FIG. 17B

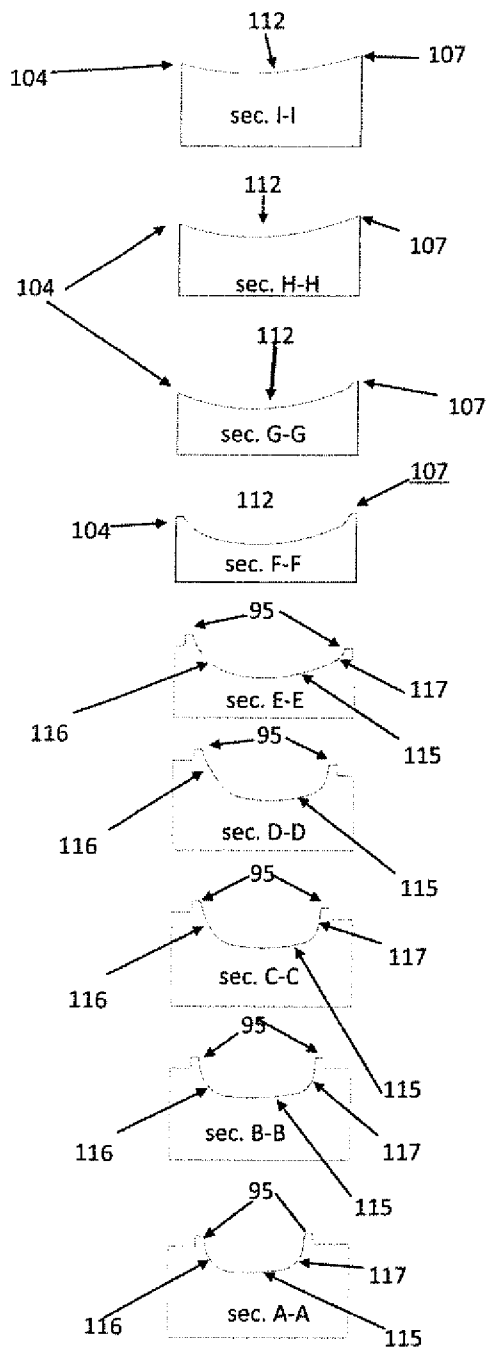
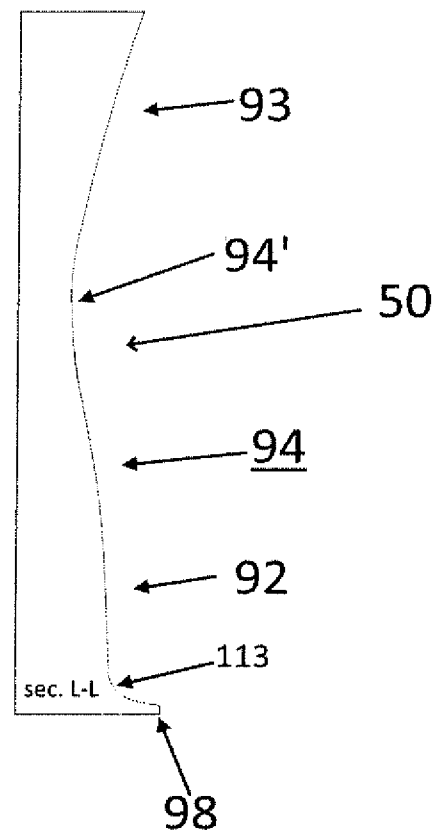


FIG. 17A



INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2020/000086

A. CLASSIFICATION OF SUBJECT MATTER INV. A43B7/14 A43B17/00 A43B17/14 B29D35/14 A43B13/38 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) A43B B29D		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/026866 A1 (AVENT RICHARD T [US] ET AL) 9 February 2006 (2006-02-09) paragraphs [0035] - [0056], [0064], [0068]; figures -----	1-15
X	US 2006/185197 A1 (RHENTER JEAN-LUC [CH]) 24 August 2006 (2006-08-24) paragraphs [0040], [0042], [0045] - [0050], [0068] - [0073]; figures -----	1-14
A	EP 2 002 742 A1 (CHI CHENG-HSIAN [TW]) 17 December 2008 (2008-12-17) paragraphs [0007] - [0015]; claims 1-5; figures -----	15
X	----- -/--	1-14
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 7 September 2021		Date of mailing of the international search report 17/09/2021
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Chirvase, Lucian

INTERNATIONAL SEARCH REPORT

International application No

PCT/IT2020/000086

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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