



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
30.01.2008 Bulletin 2008/05

(51) Int Cl.:
A43B 7/08 (2006.01) **A43B 7/06** (2006.01)
A43B 13/18 (2006.01) **A43B 17/08** (2006.01)

(21) Application number: **07104802.9**

(22) Date of filing: **23.03.2007**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

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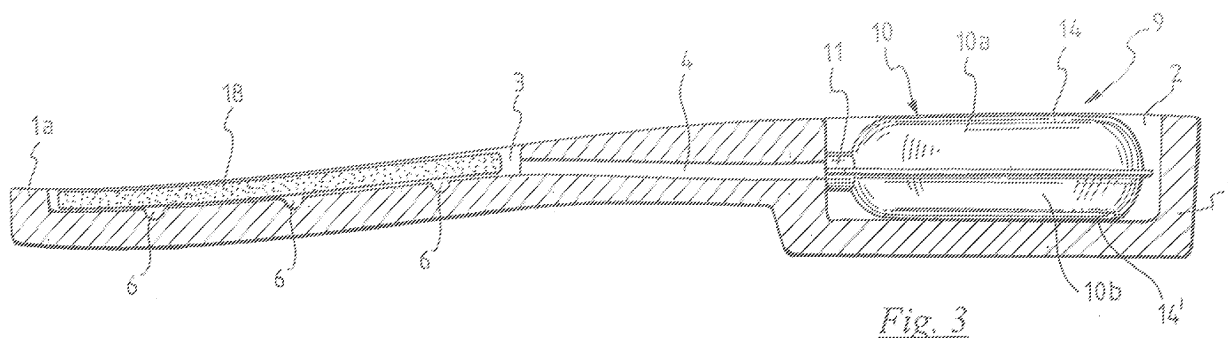
(30) Priority: **24.07.2006 WOPCT/IT2006/000559**

(54) **Aeration system and device for shoes**

(57) The present invention concerns an aeration system for shoes comprising an aeration device, specifically pumping means like a bellows pump, which constitutes a further object of the invention.

More specifically, the present invention concerns an aeration system for shoes, comprising a hollow sole (1) having an aeration device in fluid communication both

with the inside of the shoe and with the outside, at least one first and a second cavity (2, 3) being formed inside said hollow sole (1), pumping means (9) being housed in said at least one first cavity (2), wherein said pumping means (9) comprise a shell (10) and a distribution nozzle (11), a flexible core (12) being housed inside said shell (10), and a pad (18) is housed in said second cavity (3).



Description

[0001] The present invention concerns an aeration system for shoes comprising an aeration device, specifically pumping means like a bellows pump, which constitutes a further object of the invention.

[0002] Both hygienic and medical reasons dictate the importance of keeping the foot dry and well aerated. Good aeration, as well as dissipating bad smells, promotes the evaporation of the sweat that inevitably forms, above all in hot weather or during physical effort. The sole of the foot is indeed one of the parts of the human body where the sweat glands are most concentrated. The problem of excessive sweating has become more serious with the appearance of the rubber sole replacing the leather sole. The rubber sole, indeed, whilst being advantageous in terms of both heat insulation and waterproofing of the foot and the possibility of modelling the tread to make it grip better on the ground, is nevertheless impermeable to air and does not allow sweat to transpire.

[0003] Various attempts have been made to solve this problem. For example, hollow soles have been provided comprising outside release valves, but the amount of air exchanged is small and therefore does not allow effective aeration of the foot. A solution that has achieved substantial success is the one that foresees coating the inside of a perforated rubber sole with a microporous membrane, thus impermeable to water but permeable to air and sweat in the form of water vapour. However, this solution also has some drawbacks. First of all, it is a passive aeration system, since there is no device inside the shoe that promotes the circulation of air. The exchange of air only occurs when the sole is lifted from the ground. Moreover, after a few uses the micropores can be blocked by dust and dirt and therefore are no longer able to carry out their aeration function.

[0004] The problem forming the bases of the present invention is therefore that of providing an aeration system for shoes that allows an effective and efficient exchange of air and vapour between inside and outside of the shoe.

[0005] Such a problem is solved by an aeration system and device for shoes as outlined in the attached claims.

[0006] Further features and advantages of the present invention will be better understood from the description of some exemplary embodiments, which is given below by way of non-limiting illustration, with reference to the following figures:

Fig. 1 represents a plan and section view of the sole according to the invention;

Fig. 2 represents a section view according to the direction II-II of Fig. 1;

Fig. 3 represents a side section view of the sole for shoes according to the invention;

Fig. 4 represents a perspective view of the aeration device according to the invention;

Fig. 5 represents a perspective view of the core of the aeration device of Fig. 4;

Fig. 6 represents a plan view of the aeration device according to a different embodiment;

Fig. 7 represents a side section view of a shoe comprising the aeration system according to the invention;

Fig. 8 represents an exploded perspective view of a further embodiment of the present invention;

Fig. 9 represents a perspective view of a detail of the embodiment of Fig. 8 in assembled condition;

Fig. 10 represents a perspective view of an insole according to a further embodiment of the invention;

Fig. 11 represents a plan view from below of the insole of Fig. 10;

Fig. 12 represents a front side view of the insole of Fig. 11 according to the section XII-XII.

Fig. 13 is a planar view from below of a second embodiment of the insole according to the invention;

Fig. 14 represents a top perspective view of a further embodiment of the insole of the invention;

Fig. 15 represents an exploded perspective view of a different embodiment of the aeration device of the invention;

Fig. 16 represents a perspective exploded view of a further embodiment of the aeration device of the invention;

Fig. 17 represents a perspective exploded view of yet another embodiment of the aeration device of the invention;

Fig. 18 represents a phantom side view of a further embodiment of the aeration device of the invention;

Fig. 19 represents a side view of a different embodiment of the elastic core of the invention;

Fig. 20 represents a bottom view of a further embodiment of the elastic core of the invention;

Fig. 21 represents a phantom perspective view of an elastic core according to the invention;

Fig. 22 represents a side view of the elastic core in Fig. 21.

Fig. 23 represents a phantom side view of a different version of the elastic core in Fig. 21;

Fig. 24 represents a bottom view of the elastic core in Fig. 23.

[0007] With reference to the figures, the aeration system being the object of the present invention shall now be described.

[0008] The aeration system of the invention comprises a hollow sole 1, typically but not exclusively a hollow sole made from rubber or another synthetic material. The sole may of course also be made from leather or comprise a leather tread.

[0009] The hollow sole 1 comprises a first cavity 2, formed substantially at the heel area, and a second cavity 3, positioned substantially at the sole of the foot and defined by an edge 1a. Said cavities 2, 3 are open on top, i.e. at the inside of the shoe. The first cavity 2 and the second cavity 3 are in fluid communication through a channel 4 that is formed in the thickness of the sole and

that continues, at the second cavity 3, in a groove 5. To the right and left of the groove 5, a plurality of ramifications 6 project, in a substantially transversal direction, which, similarly to the main groove 5, extend up to the edge 1a.

[0010] At the distal end of said main groove 5 and of said ramifications 6, the edge 1a of the sole 1 comprises transversal holes 7, which place the cavity 3 in fluid communication with the outside. At the mouth of the holes 7 towards the outside valve means 8 are arranged. The valve means 8 typically consist of a one-way valve for shoes. This type of valve is conventional and substantially consists of a small cylinder inside which a flap is placed that only opens if the air flow is towards the outside, whilst it does not allow the entry of air from the outside. Said valve means 8 may also simply consist of a dividing wall or membrane made from microporous material (for example, GORETEX®), which allows air and water to pass, but is waterproof.

[0011] An aeration device is housed in the sole 1 according to the invention. Such an aeration device preferably comprises pumping means 9, typically a bellows pump, housed in the first cavity 2 of the sole 1. Such pumping means 9 comprise a shell 10, formed from two half-shells 10a, 10b, and a distribution nozzle 11. The opening of the nozzle 11 is placed at the channel 4. Said shell 10 is made from a plastic material that ensures a certain degree of flexibility. Preferably, the shell 10 shall have a Shore A hardness of over 80, more preferably equal to or greater than 90. In a preferred version, the shell 10 shall be made from polyurethane, such as an adipate ester polyurethane having the Shore A hardnesses outlined above.

[0012] The shell 10 houses an elastic core 12 therein. The main function of such an elastic core 12 is to increase resistance to stepping and to act as a "shock absorber". Indeed, it has been seen that the provision of a hollow pump without inner core at the heel leads to excessive yielding of the footbed at that point and consequently causes an irregular and not very comfortable gait. Moreover, if the hollow pump collapses, it is no longer able to recover its initial shape and the pumping function is thus ended.

[0013] The elastic core 12 can consist of conventional elastic means, like a spring. However, in the preferred embodiment shown in the drawings, such an elastic core comprises an elastic insert made from an elastomer, like for example polyethylene. Preferably, such an elastomer shall have a Shore D hardness of over 60, more preferably over 80, even more preferably over 90. In another preferred embodiment, the elastomer used for the elastic core 12 shall have a Shore A hardness of between 15 and 30, more preferably about 20.

[0014] In order to avoid the elastic core 12 filling the entire volume inside the shell 10, drastically reducing the volume of air pumped, such an elastic core 12 is of a size, in particular a thickness, such as to create a gap between the core and the inner walls of the shell 10. In practice, the shape of the elastic insert substantially fol-

lows that of the shell 10, but it has smaller dimensions so as to create the gap described above. More preferably, the length and width of the elastic insert will be about 50% the length and width of shell 10.

[0015] For the same purpose, according to the preferred embodiment shown in Fig. 5, the elastic core is perforated on three sides, so that a network of small channels 13, 13', 13'', 13''', 13'''' is formed therein. In this way, the elastic core 12 itself forms a bellows pump that is associated in action with that of the shell 10.

[0016] According to a particularly preferred embodiment of the invention, the elastic core 12 and/or the shell 10 shall contain perfume. Typically, a "compound" of the rubber/plastic material shall be made with the perfume, which shall thus be absorbed in the material and shall be released very gradually. Alternatively, the perfume can be contained in microspheres arranged inside and/or outside the elastic core 12 or on the surface of the shell 10, so as to have an even longer-lasting release, mediated by the mechanical action (rubbing) and not just by the normal evaporation of the perfume.

[0017] The shell 10 preferably has substantially flat base surfaces 14, 14' and a side surface 15 that has sides with concave profile joined by rounded corners. This shape allows the side surface 15 to be stiffened, keeping a good flexibility of the base surfaces 14, 14'. In this way the bellows pump can easily carry out its pumping action without collapsing, not even partially, under the weight of the heel. In another preferred version, shown in Figs 8 and 9, the shell 110 has the long sides with a rectilinear profile and the end portions rounded.

[0018] By way of example, the shell 10 can have the following size: about 6 cm length, about 4 cm width, about 2 cm thickness. In this case, it has been determined that the inventive device allows the recirculation of about 15-17 cc air/vapour within the shoe. Such a volume shall decrease according to the bulk of the elastic core 12 arranged inside the shell 10, but it shall in any case be between 5 and 10 cc.

[0019] It is understood that it may be possible to vary the dimensions of the shell 10 according to requirements, for example according to the type of shoe or the size.

[0020] As shown in Fig. 6, one or both of the base surfaces 14, 14' may comprise a pumping button 16 formed integrally in the thickness of the shell 10 by shaping a substantially C-shaped or horseshoe-shaped blind groove 17 on the base surface. In this way, the base surface 14, 14' is strengthened, since the groove 17 acts as a reinforcing rib, without for this reason losing pumping capacity.

[0021] As shown in Fig. 3, according to a preferred embodiment of the invention the second cavity 3 houses a pad 18. Such a pad 18, which has the function of supporting the sole of the foot increasing the comfort of walking, can preferably be made from an expanded synthetic material with open cells, like latex foam or polyester-based expanded polyurethane. Alternatively, the pad 18 can be made from a needled material, like a needled non-

woven fabric, preferably with continuous needled thread, a needled felt or a needled synthetic material (PE or PP). Alternatively, the pad 18 shall be made from an elastomer in which holes or microholes shall be made to make it porous. With the described materials, the pad 18 shall be permeable to air/vapour and shall contribute to the pump effect created by the pumping means 9 arranged at the heel.

[0022] In another embodiment, shown in Fig. 8, the pad 118 shall be made from rubber or another elastomer and shall comprise a perforated top surface 130 and a bottom surface from which a plurality of flexible flaps 131 project. The flaps 131 may be arranged perpendicular to the bottom surface of the pad 118 or else in an inclined position and may have various shapes, for example with rectilinear or curved profile, etc. The function of the pad 118 is totally similar to the one described above for the pad 18, however the structure with flaps 131 allows a possible blockage of the groove 5 and/or of the ramifications 6 to be avoided when walking.

[0023] The shape of the pad 18, 118 shall basically follow the shape of the cavity 3 in which it is housed, but it shall preferably have slightly smaller dimensions, so as to create a gap along the perimeter of the cavity.

[0024] In a particularly preferred embodiment of the invention, the pad 18, 118 shall contain a perfume. The same technologies, *per se* known, described above may be used for the elastic core 12 and for the shell 10 of the pumping means 9.

[0025] Fig. 7 shows the section of a shoe 19 that comprises the sole 1 according to the invention and a vamp 21. The vamp 21 can be made from any material normally used for shoes, even from a waterproof material.

[0026] As usual a footbed 20 is fixed on the sole 1, at the side facing towards the inside of the shoe. Such a footbed 20 shall preferably be a perforated footbed, so as to promote the passage of air/vapour. In any case, it must be a breathable footbed. It is also important that the footbed 20, if coupled with the sole by gluing, be fixed just along the edges, to avoid the layer of glue compromising the breathability of the footbed 20.

[0027] If desired, this footbed 20 may also comprise a perfume, as described above, or a sanitising, antibacterial substance, etc. The technology of the microspheres may be particularly preferred in this case.

[0028] In the preferred embodiment of Fig. 7, the vamp comprises a breathable layer 22 of air/vapour-permeable material therein. Such a material can generally be one of the materials described above for the pad 18 and can possibly contain a perfume or a sanitising or antibacterial substance.

[0029] The inner side of said breathable layer 22 may, in turn, be coated with a thin layer of skin or another finishing material for shoes.

[0030] Figs 8 and 9 show a different embodiment of the sole 1 of the invention. The sole comprises a base body 101 on which an insole 132 is housed. The insole 132 is arranged on an impression 133 formed on the top

surface of the base body 101 and having a shape matching that of the bottom surface of the insole 132.

[0031] In turn, the insole 132 comprises a first cavity 102, arranged at the area of the heel, and a second cavity 103, arranged at the area of the sole of the foot, such cavities being totally similar to the cavities 2, 3 described for the embodiment of Fig. 1. A channel 104 joins the first cavity 102 with the second cavity 103. A second channel 134 places the second cavity 103 in communication with the outer edge of the insole 132 and therefore, through the corresponding hole 135a arranged on the side surface of the base body 101, with the outside. A further channel 136, together with the hole 135b arranged on the side surface of the base body 101, in the heel area, places the first cavity 102 in communication with the outside.

[0032] The sole 1 also in this case comprises an aeration device. Such an aeration device, as described above, preferably comprises pumping means 109, typically a bellows pump, housed in the first cavity 102 of the insole 132. The pumping means 109 comprise a shell 110, also formed from two half-shells as described previously, in which an elastic core 112 totally similar to the one described previously is housed. The elastic core 112 shall therefore also have a plurality of channels 113, 113', 113'', 113''', 113'''' formed therein. The shape of the shell 110 and, correspondingly, of the elastic core 112 is as stated different to that of the shell 10 and of the elastic core 12 described previously, but the latter may be used irrespectively.

[0033] The shell 110 also comprises two nozzles 111a, 111b arranged at the two ends, intended to align with the channels 104, 136 that place the first cavity 102 in communication with the second cavity 103 and with the outside, respectively. The shell 110, on the joining line of the two half-shells, also has a projecting edge 137, intended to rest on a step 138 formed along the side walls of the first cavity 102.

[0034] In a particular embodiment, at the nozzles 111a, 111b and therefore at the hole 135b and the channel 104, respectively, valve means 108a, 108b shall be arranged, preferably consisting of a one-way valve as described above. The valve means 108a can allow just the entry of air from the outside, whereas the valve means 108b shall allow the air sucked in to be sent to the second cavity 103 and from here, through the holes of the pad 118, inside the shoe. This solution shall be particularly useful in hot weather conditions, since it allows fresh air to be introduced inside the shoe, avoiding overheating of the foot and thus increasing the feeling of comfort. Alternatively, preferably in cold weather conditions, the valve 108a shall just allow foul air to be ejected to the outside from inside the shoe, whereas the inner valve 108b shall allow the foul air to be sucked in from the cavity 103 and therefore from inside the shoe. In this way a forced circulation of air around the foot will be always obtained, without however injecting cold air that would cause excessive cooling of the foot. This solution, which we can

define "winter system" in contrast with the so-called "summer system" described above, may be obtained by simply mounting the valve means 108a, 108b in inverted position or even more simply by inverting the positioning of the pumping means 109.

[0035] In this embodiment, unidirectional valve means 108c are also preferably arranged at the channel 134 and the hole 135a, which for example shall allow air to be sucked in from the outside in the "summer system" and foul air to be ejected in the "winter system" described above.

[0036] It should be noted that the provision of the channel 134 and of the hole 135a, to place the second cavity 103 in communication with the outside, is not necessary and can therefore be omitted, so as to allow just the exchange of air between the second cavity 103 and the inside of the shoe.

[0037] Advantageously, a pad 18, 118 is housed in the second cavity 103 as described previously.

[0038] A perforated footbed 20 can advantageously be arranged on the insole 132.

[0039] Figures 10, 11 and 12 show a different embodiment of the present invention. The figures show an insole 232 to be inserted on a base body 101 of a sole suitably arranged and carrying a matching impression on top.

[0040] The insole 232 is integral and comprises a thickened rear portion 232a, corresponding to the heel region, and a front portion 232b carrying a plurality of through holes.

[0041] The rear portion 232a comprises an opening 240 intended to house the pumping means 209, similar to those described above and thus consisting of a shell 210 in which an elastic core 212 is housed. The shell 210, formed from two half-shells, has a raised edge 237 and a nozzle 211 that constitutes the air inlet/ejection opening in the area where they meet. The raised edge 237 snap inserts into a suitable groove 241 formed along the side wall of the opening 240. The elasticity of the elastomeric material from which the insole 232 is made allows its deformation and therefore the insertion or removal of the pumping means 209.

[0042] As shown in Fig. 12, the shell 210 projects on top and below from the thickness of the insole 232, so as to promote the pumping action while walking.

[0043] As shown in Fig. 11, the bottom surface of the insole 232 has a plurality of ridges 242 defining empty spaces that, overall, form an air chamber between the bottom surface of the insole 232 and the inner surface of the sole on which the insole rests. Again on the bottom surface of the insole 232, at the area where the nozzle 211 of the pumping means 209 is arranged, two ribs 243a, 243b are arranged that go for a first portion substantially parallel and then diverge until they reach the edge of the insole. Such ribs 243a, 243b constitute a channel for the air sucked in/ejected through the hole 244 arranged on the side edge of the insole 232. At such hole 244, the bottom surface of the insole 232 further comprises a seat 245 for valve means of the type de-

scribed above.

[0044] In an embodiment not shown, the shell 210 shall be similar to the shell 110 and shall thus be equipped with two nozzles, the first nozzle 211 facing towards the inside and the second nozzle at a channel communicating with the outside in the region of the heel. Unidirectional valve means shall preferably be positioned at the nozzles; this embodiment is therefore similar to that which has been outlined above for the embodiment of Fig. 8 and shall not be described any further. In this case, the opening 244 and the relative unidirectional valve means can also be omitted.

[0045] The use of the insole 232 can also avoid the positioning of a footbed 20 inside the shoe.

[0046] Fig. 13 and 14 show further embodiments of an insole 332 or 423 according to the invention.

[0047] The insole 332 has the function of a footbed and then replaces the latter in a shoe. The insole 332 can be thus adapted to any shoe, which will not require to be arranged for receiving the insole. As will be better understood from the description below, the aeration device coupled to the insole 332 will not require any air intake or vent, either inwardly or outwardly, respectively, since it will cause an inner air circulation of a sufficient amount to promote the removal of sweat, while maintaining foot thermostating.

[0048] Similarly to what has been described in relation with the insole in Fig. 10, the insole 332 is integrally formed, and comprises a thickened rear portion 332a, corresponding to the heel region, and a front portion 332b carrying a plurality of through holes.

[0049] The rear portion 332a comprises an opening 340 intended to house pumping means similar to those described above and thus consisting of a shell with an elastic core being housed therein.

[0050] A preferred embodiment of pumping means 309 suitable for the insole 332 is shown in Fig. 15. The shell, formed by two half-shells 310a, 310b has, in the area where they meet, a raised edge 337 and a nozzle 311 which is the air inlet/ejection port. The raised edge 337 snap inserts within a suitable groove 341 that is formed along the side wall of opening 340. The elasticity of the elastomeric material from which the insole 332 is made allows the latter to be deformed, and thus the insertion or removal of the pumping means 309. The shell 310 projects on top and below from the thickness of the insole 332, so as to promote the pumping action while walking.

[0051] An elastic core 312 is housed within the shell, which in this embodiment is elongated cap-shaped, the support edge 350 thereof being interrupted by a series of notches 351. The notches 351 have the function of promoting the displacement of the material when the core is pressed, and the subsequent elastic return thereof. In a preferred embodiment, the notches 351 will have a greater depth at the bent ends of the core 312, and a lower depth at the long sides, such as to give more resistance and elastic return to the core 312.

[0052] Preferably, the elastic core 312 is made of a SBS elastomer (Stirene-Butadiene-Stirene) admixed with stirene polymers or of a SEBS elastomer (Stirene-Ethylene-Butylene-Stirene) admixed with polyolefins such as polypropylene (PP), polyethylene (PE) or ethylene vinyl acetate (EVA) or of the same polyurethane material as described above with respect to the shell. Preferably, these elastomer compounds have a Shore A hardness (after 3 seconds) ranging between 40 and 70, more preferably between 40 and 65 (ISO 868).

[0053] A suction/delivery cannula 352 for the air is associated with the nozzle 311.

[0054] As shown in Fig. 13, the lower surface of insole 332 is run through by a longitudinal channel 353 that starts from the opening 340, at the area in which the pumping means nozzle 311 is positioned, and runs to the tip of insole 332. In the first length, the channel 353 acts as a seat for the cannula 352 of the pumping means 309, whereas in the second length, at the foot sole area, it opens into a plurality of branches 354, which are substantially fish-bone arranged and accommodate the through holes 355 that communicate with the upper surface of insole 332.

[0055] Fig. 14 shows a different embodiment of an insole 432 according to the invention, which is also designed to be universally used, like insole 332, with those shoes that are not arranged to receive an aeration system.

[0056] In this case, unlike the insole 332, the pumping means 309 will be received by the upper surface of insole 432. To the purpose, the upper surface 432' will comprise, in the heel area (which is thickened to the purpose) a seat 440 for the pumping means 309. The seat 440 is blind, such as to have a bottom surface that acts as a support for the pumping means, and comprises, along the side surface thereof, a groove 441 for snap-engagement with the raised edge 337 of shell 310. From the seat 440 there starts a longitudinal channel 453, which is intended to accommodate the cannula 352 of the pumping means 309. The channel 453 opens into a recessed chamber 456 in which a pad 18, 118 can be housed, as set forth above.

[0057] Both the insole 332 in Fig. 13 and the insole 432 in Fig. 14 may comprise, on the upper surface thereof that is intended to come in contact with the foot, a finishing layer of fabric, leather or other suitable material, duly drilled in order to allow the air to pass therethrough.

[0058] In a particularly preferred embodiment of the invention, the insole 332, 432 and the pumping means thereof are integrally made, such that the raised edge 337 of the latter results to be drowned in the insole material.

[0059] Fig. 16 shows a different embodiment of the pumping means according to the invention. In this embodiment, the shell comprises two half-shells 410a, 410b which are totally similar to those described above, except for two nozzles 411a, 411b being arranged along the raised edge 437 in a diametrically opposite position. One-

way valves 453', 453" of the type described above are associated with the nozzles 411a, 411b. The front valve 453', associated with the nozzle 411a in which the cannula 352 is inserted, will be generally mounted such as to allow the air to be delivered by the pumping means 409 to the foot sole, while the rear valve 453" will be mounted in the opposite direction, such as to allow only the suction of air from the heel area. The embodiment in Fig. 16 has been specifically designed for summer use, or however in hot climates. In fact, the external air is sucked from the outside through the slit provided between the heel and shoe instep and is thus fed into the shoe, thus aerating the latter. Under cold climate conditions, this would lead to an excessive cooling of the foot. On the contrary, the embodiment in Fig. 15 allows the circulation of the same air being within the shoe, thus obtaining a good thermostating, while causing a turbulence suitable to keep the foot dry.

[0060] Fig. 17 shows a further embodiment of the aeration device of the invention. The pumping means 509 comprise two half-shells 510a, 510b having a raised edge 537, a nozzle 511, with which a cannula 352 can be associated, and elastic means 512 consisting of a spring. Of course, the version similar to that in Fig. 16 can be also provided, i.e. the summer version with two nozzles provided with unidirectional valves. The inward face of half-shells 510a, 510b has holding ridges 560, 560' intended to act as a stop for both ends of the spring.

[0061] The elastic means 512 preferably consist of a helical spring developing substantially in a truncated-cone shape with elongated annular profile.

[0062] According to a particularly preferred embodiment, as shown in Fig. 21, the elastic means consist of a flexural spring 912 consisting of an elongated annular base 975 and a treading plate 976, which are joined to each other by means of pantograph-shaped bending elements 977, 977'. The bending elements 977, 977' are >-shaped and <-shaped, respectively, and consist of a lower arm 977a, 977a' and an upper arm 977b, 977b'. The bending elements 977, 977' are arranged in an inversed position, i.e. the first bending element 977 originates from a first rectilinear side 978 of the base 975, at a first end of base 975, and develops like > until it is connected to a first end of the treading plate 976; on the contrary, the second bending element 977' originates from a second side 978' of base 975, at a second end of base 975 opposite to said first end, and develops like < until it is connected proximate to a second end of the treading plate 976.

[0063] The treading plate 976 comprises, along both rectilinear sides, rectangular notches having a complementary shape to that of the upper arms 977b, 977b' of the bending elements 977, 977', of which the function is to allow the complete bending of the upper arms 977b, 977b'. For the same reason, the respective lower arms 977a, 977a' are laterally fastened relative to the rectilinear sides 978, 978' of base 975, such as to avoid interfering therewith during bending.

[0064] Preferably, the flexural spring 912 is made of polymeric material. More preferably, said polymeric material will have a bending resistance ranging between 850 and 1100 Kg/cm² (ASTM D790) and a bending modulus ranging between 24000 and 28000 Kg/cm² (ASTM D790). Most preferably, the polymeric material will be an acetal polyoxymethylene copolymer having about 950 Kg/cm² bending resistance and about 26000 Kg/cm² bending modulus.

[0065] In Fig. 22 is shown a different embodiment of the flexural spring 912, in which, below the treading plate 976 is provided an elastic cylinder 1000. The elastic cylinder 1000 is hollow, such as to form a tubular structure and is made of an elastomer, such as polyethylene. Preferably, such an elastomer shall have a Shore D hardness of over 60, more preferably over 80, even more preferably over 90. In another preferred embodiment, the elastomer used for the elastic cylinder 1000 shall have a Shore A hardness of between 15 and 30, more preferably about 20.

[0066] The upper end of the elastic cylinder 1000 is housed in a suitable annular seat 999 formed on the lower face of the treading plate 976, such as to be held therein. To the purpose, the elastic cylinder 1000 can advantageously be fixed, for example, by gluing to the annular seat 999.

[0067] The function of the elastic cylinder 1000 is both of allowing a better elastic return of the spring 912 even after long treading cycles, and increasing the comfort of walking.

[0068] Fig. 18 shows a different embodiment of a shell 609 in which the elastic core 312 can be seen. As in the above versions, the shell consists of two half-shells 610a, 610b that are coupled to form a raised edge 637 along which a nozzle 611 is placed (the summer version with two nozzles and the unidirectional valves can be provided also in this case). In this embodiment, however, the upper half-shell 610a has a convex portion 670a, and a flat portion 670b. The convex portion is intended to protrude on top of the insole 332, 432, thereby being an operating push-button for the pumping means 609. This embodiment is conceived for a women or child shoe, wherein the heel portion is less extended and thus requires, also for walking comfort purposes, a small-sized operating push-button for the pump. The version in Fig. 18 has the purpose of reducing the size of the operating push-button, without substantially reducing the volume of pumped air, and thus the efficacy of the pumping means 609.

[0069] Fig. 19 shows, on the other hand, a different embodiment of the elastic core 712 according to the invention. Also in this case, the elastic core 712 is elongated cap-shaped, but instead of the notches, it has a plurality of holes 780 in the vicinity of the contour thereof, such as to create as many air vents when the pumping means are being pressed. The elastic core 712 can be advantageously made of the same materials as described above for the embodiment in Fig. 15.

[0070] Fig. 20 is a bottom view of an elongated cap-

shaped elastic core 812 entirely similar to the variant in Fig. 15, though comprising, on the lower surface thereof, a series of reinforcement ribs 890. It may happen, indeed, that the elastic core tends to lose its elastic return feature due to continued treading. This drawback can be overcome, either by increasing the thickness of the piece (which is normally 1-2 mm), with the risk of stiffening it too much, or introducing the ribs 890.

[0071] In all the variants shown above, the shell 10, 110, 210, 310, 410, 510, 610 has a height ranging between 8 and 20 mm, preferably between 10 and 14 mm, most preferably about 12 mm and is however structured such as to project above the insole plane by 3-6 mm. This can be obtained either by providing the two half-shells symmetrically shaped, i.e. having the same height (for example, 6 mm the lower half-shell and 6 mm the upper half-shell) or by coupling a higher half-shell with a less projecting one (for example, 8 mm and 12 mm, respectively).

[0072] In a particularly preferred embodiment of the present invention, the footbed 20 and/or the vamp 21 and/or the insole 332, 432 shall comprise a phase-change material. Phase-change materials, known with the acronym PCM, are materials able to pass from solid state to liquid state and vice-versa when a particular temperature is reached that falls within the range of weather conditions of common use, in particular for an item of clothing. Such weather conditions, in the case of a shoe, correspond to a temperature in the order of 25°-30°C. PCMs exploit the physical principle that when a material changes its physical state, it maintains the temperature equivalent to its melting point until all of the material has changed state. If the material melts after the climatic temperature has risen, it absorbs heat, vice-versa if it solidifies following cooling, it releases heat and by doing so maintains its temperature constant. It is thus clear that by inserting a PCM in a shoe, it shall take care of avoiding overheating or cooling of the foot, absorbing the excess heat from inside the shoe or releasing heat in the case of external cooling.

[0073] PCMs used for the purpose of the present invention consist of mixtures of paraffins having different melting points and high heat of fusion, encapsulated in microcapsules that are used to coat a substrate or to be included in said substrate. In particular, the material used is known as Outlast Thermocules. Preferably, the PCM shall be present at least on the face of the footbed 20 and/or of the vamp 21 facing towards the foot.

[0074] The use of a PCM in the present invention is of particular value. Indeed, the active air circulation system described above has the limitation of only providing efficient ventilation during walking, whereas in still conditions it is reduced to a passive system. In these conditions a heating or cooling of the foot could therefore occur, according to the weather conditions. The phase-change material thus takes care of keeping the temperature of the foot constant when not moving. On the other hand, the use of just PCM, without the active ventilation system,

would not be sufficient: as stated above, the ability of the PCM to keep the temperature constant runs out when all of the material has changed phase, and therefore lasts a limited amount of time. In the present case, when walking once again, the active ventilation system of the invention takes care of thermostating the shoe and regenerating the PCM, i.e. heating the inside of the shoe in cold weather and cooling it down in hot weather. It goes without saying that with the alternation of stopping and moving, typical of normal daily use of the shoe, the system of the present invention allows perfect thermostating.

[0075] The aeration system of the invention works in the following way.

[0076] The inside of the shoe is in fluid communication, through the perforated footbed 20, with the cavities 2, 102 or opening 209 and cavities 3, 103 of the sole and therefore, through the holes 7, 135a, 135b, 244 and the valve means 8, 108a, 108c, 245, with the outside. In the embodiment of Fig. 7, a further way of communication with the outside consists of the breathable layer 22 that allows air to enter/exit from the instep of the shoe, as shown by the arrows.

[0077] In practice, in each step the first thing to be placed down is the heel, therefore the pumping means 9, 109, 209 are compressed causing a flow of air/vapour from the first cavity 2, 102 or opening 209 to the second cavity 3, 103 and then towards the outside. Then the sole of the foot is placed down, with relative compression of the pad 18, 118 and further pushing of air/vapour towards the outside. When the heel (first) and the sole of the foot (after) are raised, the aeration device - pumping means 9, 109, 209 and pad 18, 118 - causes a sucking of air/vapour from inside the shoe 19, through the holes of the footbed 20, as schematised by the arrows. A continuous and consistent air circulation is thus created, which has the effect of taking away sweat, keeping the foot dry, and of thermostating the inside of the shoe, avoiding overheating of the foot above all in hotter weather and/or during physical effort.

[0078] In the embodiment of Fig. 8 and 9, the presence of the unidirectional valves 108a, 108b, as explained above, according to weather conditions, allows air to be taken in just from the outside and the circulation of such air inside the shoe; or else, in cold weather, the air present in the shoe to be ejected to the outside without substantial intake from the outside.

[0079] The insoles 332, 423 shown in Fig. 13 and 14, as stated above, are universal, i.e. they can be inserted in place of the footbed in any shoe, without requiring any pre-arrangement. Therefore, the individual air-exchange point with the external environment is the shoe neck. The operation of the device is, however, completely similar to that described above.

[0080] The advantages of the aeration system of the invention are clear and in part have already been highlighted in the description above.

[0081] The aeration system of the invention, in prac-

tice, constitutes an active and not passive system. Indeed, the air/vapour is not simply vented through aeration holes, as in many solutions of the prior art, but a sort of forced circulation is created that substantially increases the efficiency of aeration.

[0082] The aeration device - pumping means 9, 109, 209 and pad 18, 118 - acts as a lung, taking in and letting out air/vapour in each step, thus the volume of circulated fluid is high.

[0083] As well as the effect of keeping the foot dry and thermostatted, the preferred provision of perfume in a slow-release form allows the problem of bad smells to be solved for a long if not indefinite time.

[0084] The combination of the active ventilation system of the invention and a phase-change material (PCM) allows the advantages of the invention to last longer even when not walking.

[0085] The aeration device, i.e. the pumping means 9, 109, 209 and the pad 18, 118, also acts as a shock absorber, above all thanks to the provision of the elastic core 12, 112, 212 inside the pumping means 9, 109, 209. In this way, the pumping effect is also associated with considerable comfort when walking, which allows the use of the aeration system of the invention also for sports and technical shoes.

[0086] In particular, the aeration system of the invention may be used both in normal shoes and in tennis and/or athletics shoes, in hiking and walking shoes in general or in work shoes and anti-industrial accident shoes.

[0087] It is understood that only some particular embodiments of the aeration system for shoes object of the present invention have been described, to which the man skilled in the art shall be able to bring any modifications required to adapt it to particular applications, without however departing from the scope of protection of the present invention.

[0088] It shall, for example, be possible to provide that the footbed 20 be removable, so as to allow access to the bellows pump 9 or to the pad 18 to replace them or impregnate them with more perfume.

Claims

1. An aeration system for shoes, comprising a hollow sole (1) having an aeration device in fluid communication both with the inside of the shoe and with the outside, at least one first cavity (2, 102) or opening (240) being formed inside said hollow sole (1; 101, 132; 232), pumping means (9, 109, 209, 309, 409, 509, 609) being housed in said at least one first cavity (2, 102) or opening (240), **characterised in that** said pumping means (9, 109, 209, 309, 409, 509, 609) comprise a shell (10, 110, 210, 310, 410, 510, 610) and one or more distribution nozzles (11; 111a, 111b; 211; 311; 411a, 411b; 511; 611), a flexible core (12, 112, 212, 312, 512, 712, 812) being housed

- inside said shell (10, 110, 210, 310, 410, 510, 610).
2. The aeration system for shoes according to claim 1, in which said elastic core (12, 112, 212) comprises an elastic insert made from an elastomer. 5
 3. The aeration system for shoes according to claim 2, in which said elastomer has a Shore D hardness of over 60, preferably over 80, most preferably over 90. 10
 4. The aeration system for shoes according to claim 2, in which said elastomer has a Shore A hardness of between 15 and 30, preferably about 20. 15
 5. The aeration system for shoes according to any claim 2 to 4, in which the shape of said elastic insert substantially follows that of the shell (10, 110, 210) in which it is housed, but it has smaller dimensions so as to create a gap between the core and the inner walls of said shell (10, 110, 210). 20
 6. The aeration system for shoes according to any claim 2 to 5, in which said elastic insert is perforated on three sides, so that a network of small channels (13, 13', 13", 13''', 13''''; 113, 113', 113", 113''', 113''''') is formed therein. 25
 7. The aeration system for shoes according to claim 1, wherein said elastic core (312, 712, 812) has an elongated cap shape and is made of a SBS elastomer (Stirene-Butadiene-Stirene) admixed with styrene polymers or of a SEBS elastomer (Stirene-Ethylene-Butylene-Stirene) admixed with polyolefins such as polypropylene (PP), polyethylene (PE) or ethylene vinyl acetate (EVA), or of a polyurethane material such as an adipate ester polyurethane. 30
 8. The aeration system for shoes according to claim 7, wherein said elastomeric compound has a Shore A hardness (after 3 seconds) ranging between 40 and 70, or between 40 and 65 (ISO 868). 40
 9. The aeration system for shoes according to claim 7 or 8, wherein said elastic core (312) comprises a support edge (350) interrupted by a series of notches (351). 45
 10. The aeration system for shoes according to claim 9, wherein said notches (351) have a greater depth at the bent ends of the elastic core (312) and a lower depth at the long sides. 50
 11. The aeration system for shoes according to claim 7 or 8, wherein said elastic core (712) comprises a plurality of holes (780) at the contour thereof. 55
 12. The aeration system for shoes according to any claim 7 to 11, wherein the lower face of the elastic core (812) has a series of reinforcement ribs (890).
 13. The aeration system for shoes according to any claim 1 to 12, wherein said shell (609) consist of two half-shells (610a, 610b) that are coupled to form a raised edge (637) along which at least one nozzle (611) is placed, the upper half-shell (610a) having a convex portion (670a) and a flat portion (670b), wherein said convex portion (670a) is intended to project on top to form an operation push-button for the pumping means (609).
 14. The aeration system for shoes according to claim 1, in which said elastic core is a spring.
 15. The aeration system for shoes according to claim 14, wherein said spring is a helical spring (512) having a truncated-cone development and an elongated annular profile.
 16. The aeration system for shoes according to claim 14, wherein said spring is a flexural spring (912).
 17. The aeration system for shoes according to claim 16, wherein said flexural spring (912) consist of an elongated annular base (975) and a treading plate (976), which are joined by pantograph-shaped bending elements (977, 977').
 18. The aeration system according to claim 17, wherein said bending elements (977, 977') are >-shaped and <-shaped, respectively, and consist of a lower arm (977a, 977a') and an upper arm (977b, 977b').
 19. The aeration system according to claim 18, wherein said bending elements (977, 977') are arranged so that the first bending element (977) originates from a first rectilinear side (978) of the base (975), proximate to a first end of base (975), and develops like > until it is connected to a first end of the treading plate (976); the second bending element (977') originates from a second rectilinear side (978') of base (975), at a second end of base (975) opposite to said first end, and develops like < until it is connected proximate to a second end of the treading plate (976).
 20. The aeration system according to claim 17 or 18, wherein said treading plate (976) comprises, along both the rectilinear sides, rectangular notches having a complementary shape relative to that of upper arms (977b, 977b') of the bending elements (977, 977') and wherein the respective lower arms (977a, 977a') are laterally fastened relative to the rectilinear sides (978, 978') of base (975), such as to avoid interfering therewith while bending.
 21. The aeration system for shoes according to any claim 17 to 20, wherein an elastic cylinder (1000) is

placed below said treading plate (976).

22. The aeration system for shoes according to claim 21, wherein said elastic cylinder (1000) is hollow such as to form a tubular structure and is made of an elastomer preferably having a Shore D hardness higher than 60, or higher than 80, or higher than 90; or the elastomer will have a Shore A hardness ranging between 15 and 30, preferably about 20.
23. The aeration system for shoes according to claim 22, wherein said elastomer is polyethylene.
24. The aeration system for shoes according to claim 22 or 23, wherein the upper end of the elastic cylinder (1000) is housed within the suitable annular seat (999) formed on the lower face of the treading plate (976) and is preferably fixed by gluing.
25. The aeration system for shoes according to any claim 14 to 24, wherein said spring is made of polymeric material.
26. The aeration system for shoes according to claim 25, wherein said polymeric material has a bending resistance ranging between 850 and 1100 Kg/cm² (ASTM D790) and a bending modulus ranging between 24000 and 28000 Kg/cm² (ASTM D790).
27. The aeration system for shoes according to claim 25 or 26, wherein the polymeric material is an acetal polyoxymethylene copolymer having about 950 Kg/cm bending resistance and about 26000 Kg/cm² bending modulus.
28. The aeration system for shoes according to any claim 14 to 27, said spring (512, 912) being contained within a shell (510) consisting of two half-shells (510a, 510b), the inner surface of said half-shells (510a, 510b) comprising holding ridges (560, 560') intended to act as a stop for both ends of the spring.
29. The aeration system for shoes according to any claim 1 to 28, wherein a cannula (352) for the suction/delivery of air is associated with a nozzle (311, 411, 511, 611) of said shell.
30. The aeration system for shoes according to any claim 2 to 29, wherein said elastic core (12, 112, 212, 312, 512, 712, 812, 912) and/or said shell (10, 110, 210, 310, 410, 510, 610) contain a perfume.
31. The aeration system for shoes according to claim 30, in which said perfume is absorbed in the material of the elastic core (12, 112, 212, 312, 512, 712, 812, 912) and/or of the shell (10, 110, 210, 310, 410, 510, 610) or is associated with it in the form of microspheres.

32. The aeration system for shoes according to any claim 1 to 31, in which said pumping means (9, 109, 209, 309, 409, 509, 609) are a bellows pump.

33. The aeration system for shoes according to any claim 1 to 32, in which said hollow sole (1) comprises at least one second cavity (3, 103), positioned substantially at the sole of the foot and defined by an edge (1a, 101a), said at least one second cavity (3, 103) being in fluid communication with said at least one first cavity (2, 102) through a channel (4, 104).

34. The aeration system for shoes according to claim 33, in which said channel (4) continues, at said at least one second cavity (3), in a groove (5), with a plurality of ramifications (6) projecting to the right and left of said groove (5), in a substantially transversal direction, said main groove (5) and said ramifications (6) extending up to said edge (1a).

35. The aeration system for shoes according to claim 34, in which, at the distal end of said main groove (5) and of said ramifications (6), the edge (1a) of the hollow sole (1) comprises transversal holes (7), which place said at least one cavity (3) in fluid communication with the outside.

36. The aeration system for shoes according to claim 35, wherein valve means (8) are arranged at the mouth of said holes (7) towards the outside.

37. The aeration system for shoes according to any claim 33 to 36, in which said at least one second cavity (3, 103) houses a pad (18, 118).

38. The aeration system for shoes according to claim 37, in which said pad (18, 118) is made from an expanded synthetic material with open cells, like latex foam or polyester-based expanded polyurethane, or else a needled material, like a needled non-woven fabric, preferably with continuous needled thread, a needled felt or a needled synthetic material (PE or PP), or else from a perforated or microperforated elastomer.

39. The aeration system for shoes according to claim 37 or 38, in which said pad (18, 118) comprises a perfume.

40. The aeration system for shoes according to any claim 1 to 39, wherein said hollow sole (1) comprises a base body (101) and an insole (132, 232), said base body (101) comprising an impression (133) of a shape matching the shape of the bottom surface of the insole (132, 232) and on which said insole (132, 232) is arranged.

41. The aeration system for shoes according to claim

- 40, wherein said insole (132) comprises a first cavity (102), arranged at the area of the heel and in which said pumping means (109) are arranged, and a second cavity (103), arranged at the area of the sole of the foot, and in which a first channel (104) joins said first cavity (102) with said second cavity (103); a second channel (134) placing said second cavity (103) in communication with the outer edge of the insole (132) and therefore, through the corresponding hole (135a) arranged on the side surface of the base body (101), with the outside.
42. The aeration system for shoes according to claim 41, wherein a third channel (136), together with the hole (135b) arranged on the side surface of the base body (101) in the area of the heel, places said first cavity (102) in communication with the outside.
43. The aeration system according to any claim 40 to 42, wherein said shell (110) comprises two nozzles (111a, 111b) arranged at the two ends, intended to be aligned with said channels (104, 136) that place said first cavity (102) in communication with the second cavity (103) and with the outside, respectively.
44. The aeration system for shoes according to claim 43, wherein , at said nozzles (111a, 111b) and therefore at the hole (135b) and the first channel (104), respectively, first and second unidirectional valve means (108a, 108b) shall be placed, mounted so that said first valve means (108a) allow just the entry of air from the outside, whereas said second valve means (108b) allow air to be sent from the outside to said second cavity (103) and from here, through the holes of the pad (118), inside the shoe; or else said first and second valve means (108a, 108b) are mounted so as to allow an inverse air circulation.
45. The aeration system for shoes according to any claims 41 to 44, wherein , at said channel (134) and at the hole (135a) unidirectional valve means (108c) are arranged, said valve means (108c) being mounted so as to allow air to be taken in from the outside; or else said valve means (108c) are mounted so as to allow air to be ejected from the inside.
46. The aeration system for shoes according to claim 40, wherein said insole (232) is integral and comprises a thickened rear portion (232a), corresponding to the region of the heel, and a front portion (232b) carrying a plurality of through holes.
47. The aeration system for shoes according to claim 46, wherein said rear portion (232a) of said insole (232) comprises an opening (240) intended to house said pumping means (209).
48. The aeration system for shoes according to claim 46
- or 47, wherein the shell (210) of said pumping means (209) has a raised perimetric edge (237) and at least one nozzle (211) that constitutes the opening for taking in/ejecting air, said raised edge (237) being able to be snap inserted in a groove (241) formed along the side wall of the opening (240).
49. The aeration system for shoes according to any claim 40 to 48, wherein the bottom surface of the insole (232) has a plurality of ridges (242) defining empty spaces that, overall, form an air chamber between the bottom surface of the insole (232) and the inner surface of the base body (101) on which the insole rests.
50. The aeration system for shoes according to any claim 46 to 49, wherein two ribs (243a, 243b) are arranged on the bottom surface of the insole (232), at the area in which the nozzle (211) of the pumping means (209) is arranged, which extend for a first portion substantially parallel and then diverge until they reach the edge of the insole (232), said ribs (243a, 243b) constituting a channel for the air taken in/ejected through a hole (244) arranged on the side edge of the insole (232).
51. The aeration system for shoes according to any claim 46 to 50, wherein, at said hole (244), the bottom surface of the insole (232) comprises a seat (245) for unidirectional valve means.
52. The aeration system for shoes according to any claim 1 to 51, wherein said shoe (19) comprises said hollow sole (1) as described in the previous claims and a vamp (21), a breathable footbed (20) being arranged on said hollow sole (1), at the side facing towards the inside of the shoe (19).
53. The aeration system for shoes according to claim 52, wherein said footbed (20) is perforated.
54. The aeration system for shoes according to claim 52 or 53, wherein said footbed (20) is coupled with said hollow sole (1) by gluing just along the edges.
55. The aeration system for shoes according to any claim 52 to 54, wherein said footbed (20) comprises a perfume, a sanitising or an antibacterial substance.
56. The aeration system for shoes according to any claim 52 to 55, wherein said vamp (21) comprises a breathable layer (22) of air/vapour-permeable material therein.
57. The aeration system for shoes according to claim 56, said breathable layer (22) being made from an expanded synthetic material with open cells, like latex foam or polyester-based expanded poly-

- urethane, or else from a needled material, like a needled non-woven fabric, preferably with continuous needled thread, a needled felt or a needled synthetic material (PE or PP), or else from a perforated or microperforated elastomer.
58. The aeration system for shoes according to claim 56 or 57, wherein said breathable layer (22) comprises a perfume, a sanitising or an antibacterial substance.
59. The aeration system for shoes according to any of claims from 52 to 58, wherein said footbed (20) is removable, so that to allow access to the pumping means (9) and/or to the pad (18) for replacing them or for impregnating them with the perfume.
60. The aeration system for shoes according to any of claims from 47 to 54, wherein the footbed (20) and/or the vamp (21) and/or the insole (332, 432) comprise a phase changing material.
61. The aeration system for shoes according to claim 60, wherein said phase-change material comprises mixtures of paraffins having different melting points and high heat of fusion, encapsulated in microcapsules.
62. A shoe (19) comprising an aeration system as outlined in any claim 1 to 61.
63. An aeration device comprising pumping means (9, 109, 209, 309, 409, 509, 609) as described in any preceding claim.
64. The aeration device according to claim 63, said device being a universal use insole (332, 432).
65. The aeration device according to claim 64, wherein said insole (332) comprises a rear thickened portion (332a), corresponding to the heel region, and a front portion (332b) carrying a plurality of through holes, said rear portion (332a) comprising an opening (340) intended to house said pumping means (9, 109, 209, 309, 409, 509, 609), wherein the lower surface of insole (332) is run through by a longitudinal channel (353) starting from the opening (340), at the positioning area of the nozzle (11; 111a, 111b; 211; 311; 411a, 411b; 511; 611) of the pumping means (9, 109, 209, 309, 409, 509, 609), and develops proximate to the tip of insole (332), said channel (353), at the foot sole area, by opening into a plurality of branches (354) that are substantially fish-bone arranged and house the through holes (355) communicating with the upper surface of insole (332).
66. The aeration device according to claim 64, the upper surface (432') of said insole (432) comprising a seat (440) in the heel area for said pumping means (9, 109, 209, 309, 409, 509, 609), the seat (440) being blind, such as to have a bottom surface, and comprising along the side surface thereof a groove (441) for snap-engagement with said pumping means (9, 109, 209, 309, 409, 509, 609), and wherein from the seat (440) there starts a longitudinal channel (453) that opens into a recessed chamber (456) that is suitable to house a pad (18, 118).
67. The aeration device according to claim 64, 65 or 66, wherein said insole (332, 432) and said pumping means (9, 109, 209, 309, 409, 509, 609) are integrally formed.
68. The aeration device according to any claims 63 to 67, wherein the upper surface of said insole (332, 432) comprises a finishing layer of fabric, leather or other suitable material.
69. A flexural spring (912) consisting of an elongated annular base (975) and a treading plate (976), which are joined by bending elements (977, 977'), wherein said bending elements (977, 977') are >-shaped and <-shaped, respectively, and consist of a lower arm (977a, 977a') and an upper arm (977b, 977b'), and wherein said bending elements (977, 977') are arranged such that the first bending element (977) originates from a first rectilinear side (978) of base (975), proximate to a first end of base (975), and develops like > until it is connected to a first end of the treading plate (976); the second bending element (977') originates from a second rectilinear side (978') of base (975), proximate to a second end of base (975) opposite said first end, and develops like < until it is connected to a second end of the treading plate (976); wherein said treading plate (976) further comprises, along both rectilinear sides thereof, rectangular notches having a complementary shape relative to that of upper arms (977b, 977b') of the bending elements (977, 977'), and wherein the respective lower arms (977a, 977a') are laterally fastened relative to the rectilinear sides (978, 978') of base (975), such as to avoid interfering with the latter while bending.
70. The flexural spring (912) according to claim 69, wherein an elastic cylinder (1000) is placed below said treading plate (976), and wherein said elastic cylinder (1000) is hollow such as to form a tubular structure and is made of an elastomer preferably having a Shore D hardness higher than 60, or higher than 80, or higher than 90; or the elastomer will have a Shore A hardness ranging between 15 and 30, preferably about 20.
71. The flexural spring (912) according to claim 70, wherein the upper end of the elastic cylinder (1000) is housed in a suitable annular seat (999) formed on

the lower face of the treading plate (976) and is preferably fixed by gluing.

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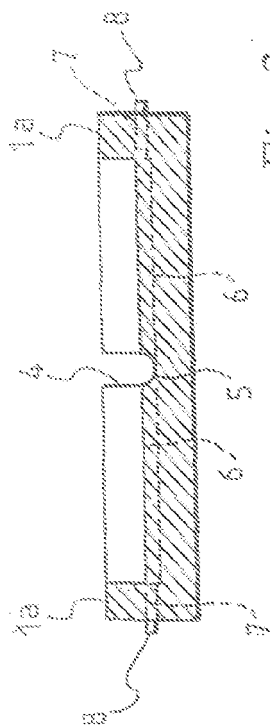


Fig. 2

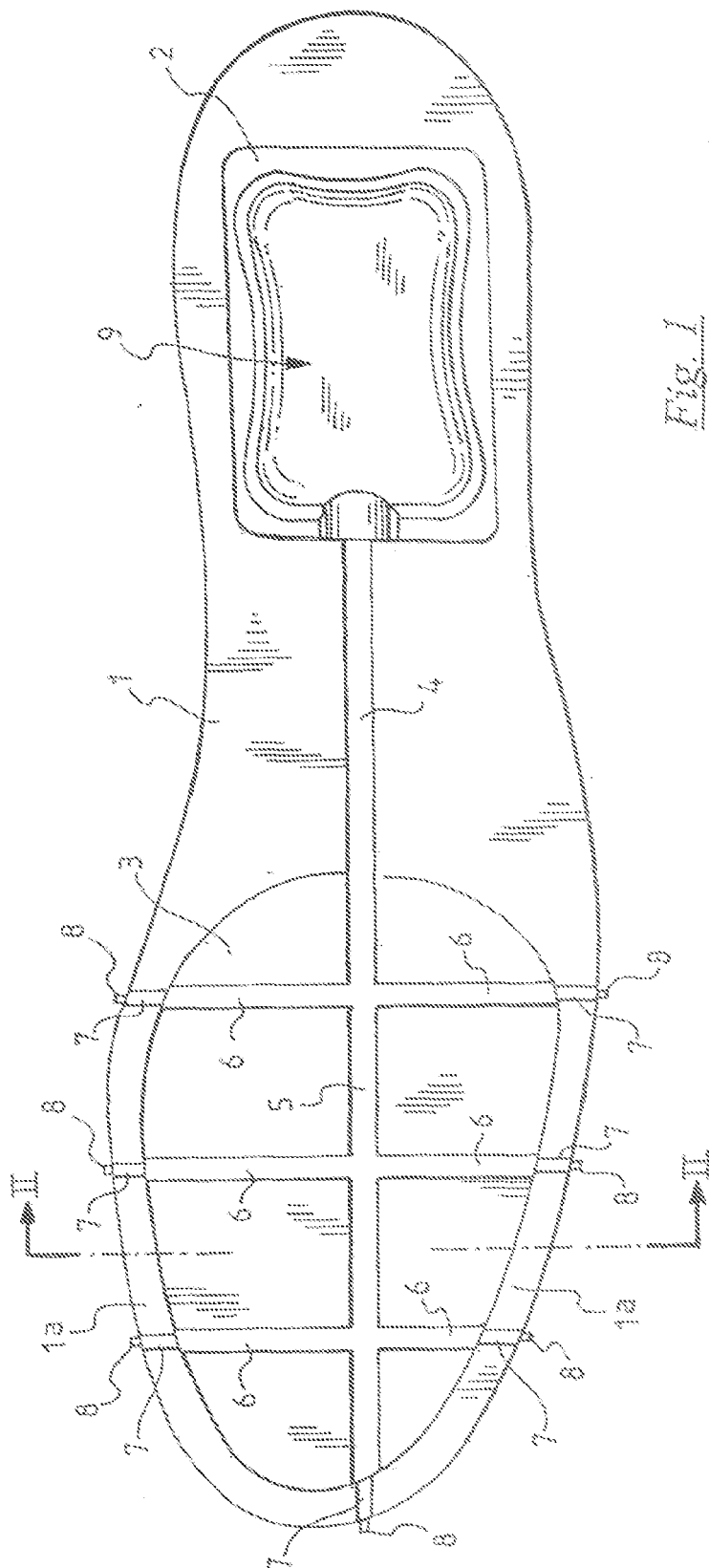
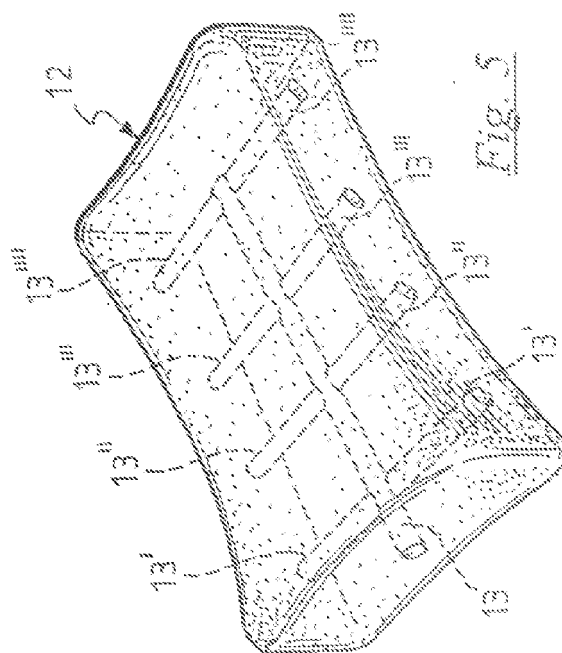
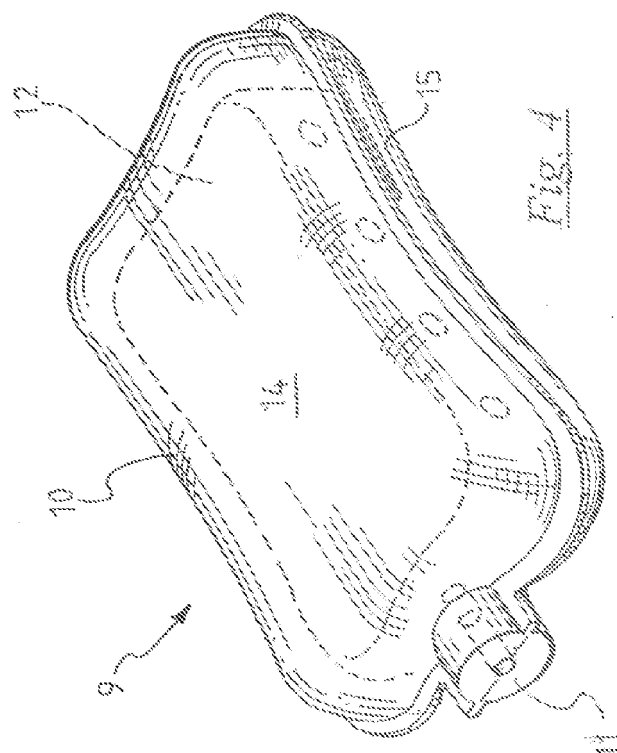
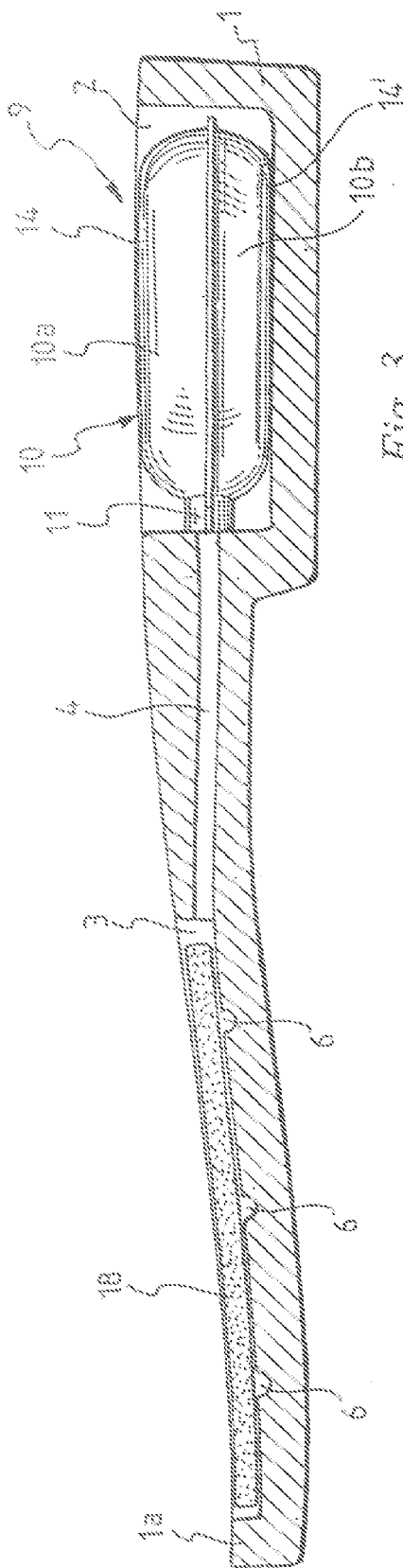
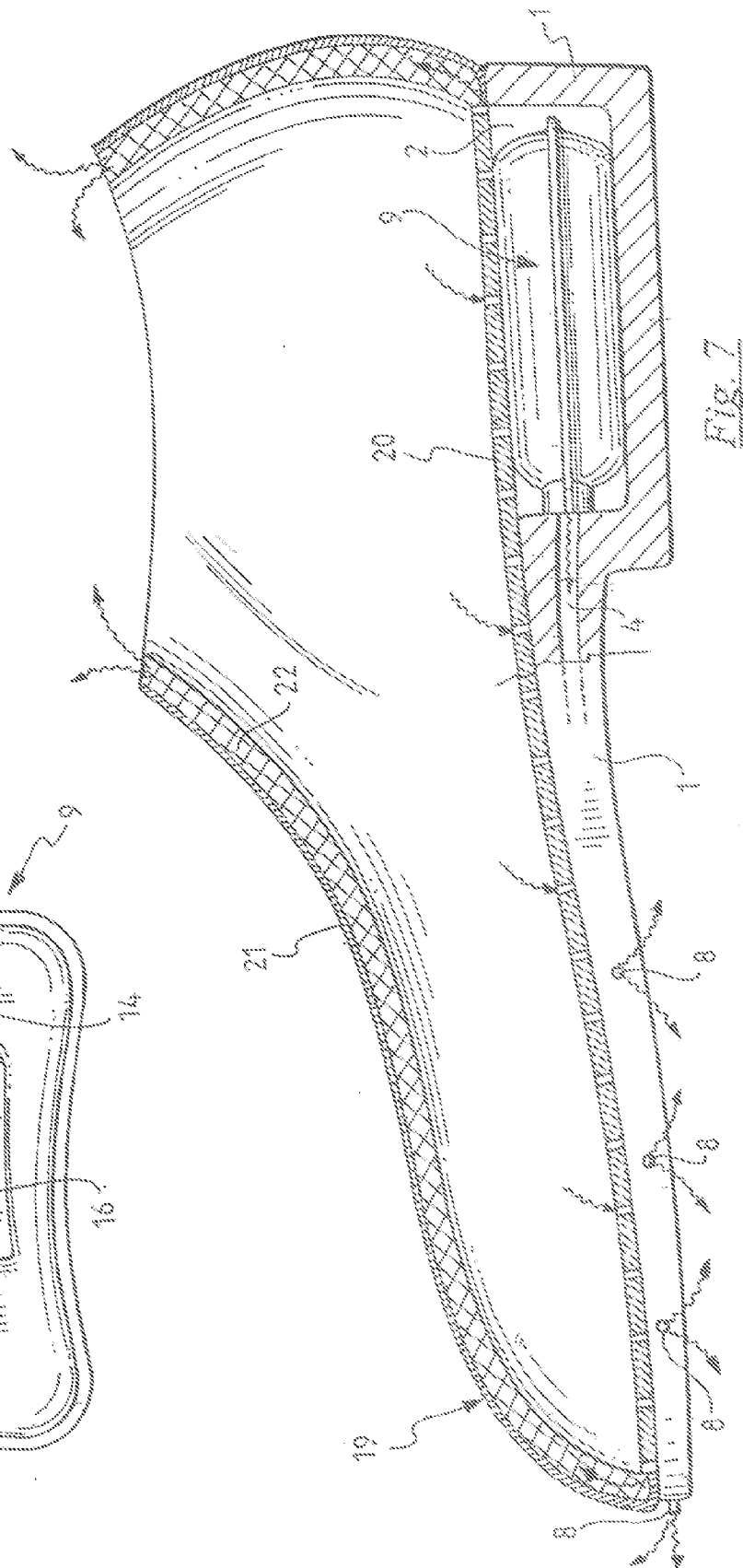
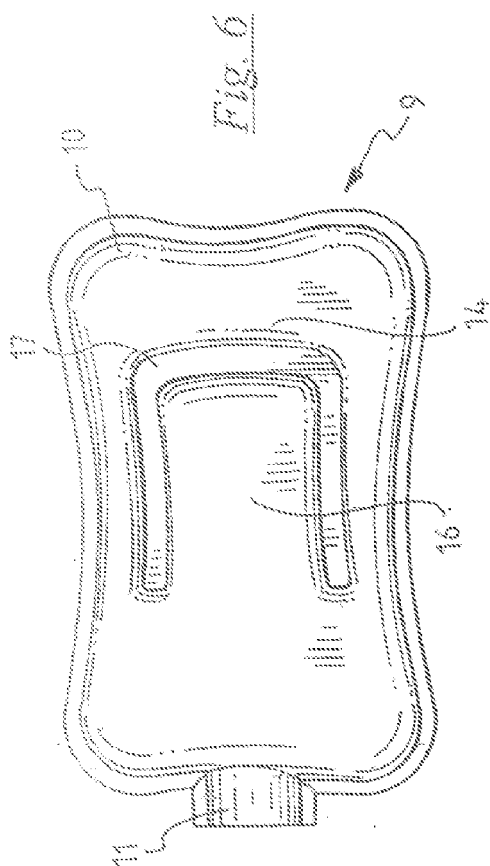


Fig. 1





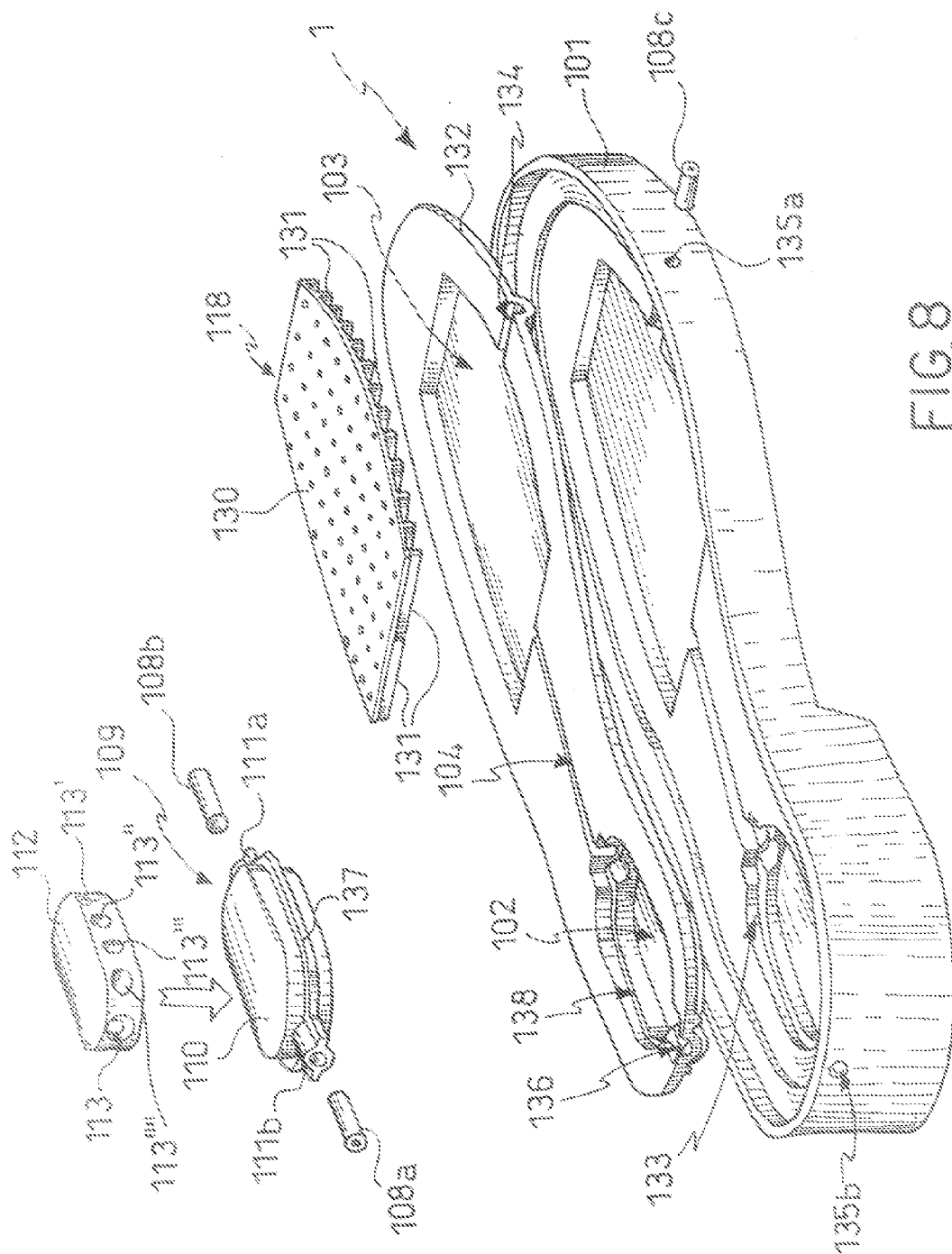


FIG. 8

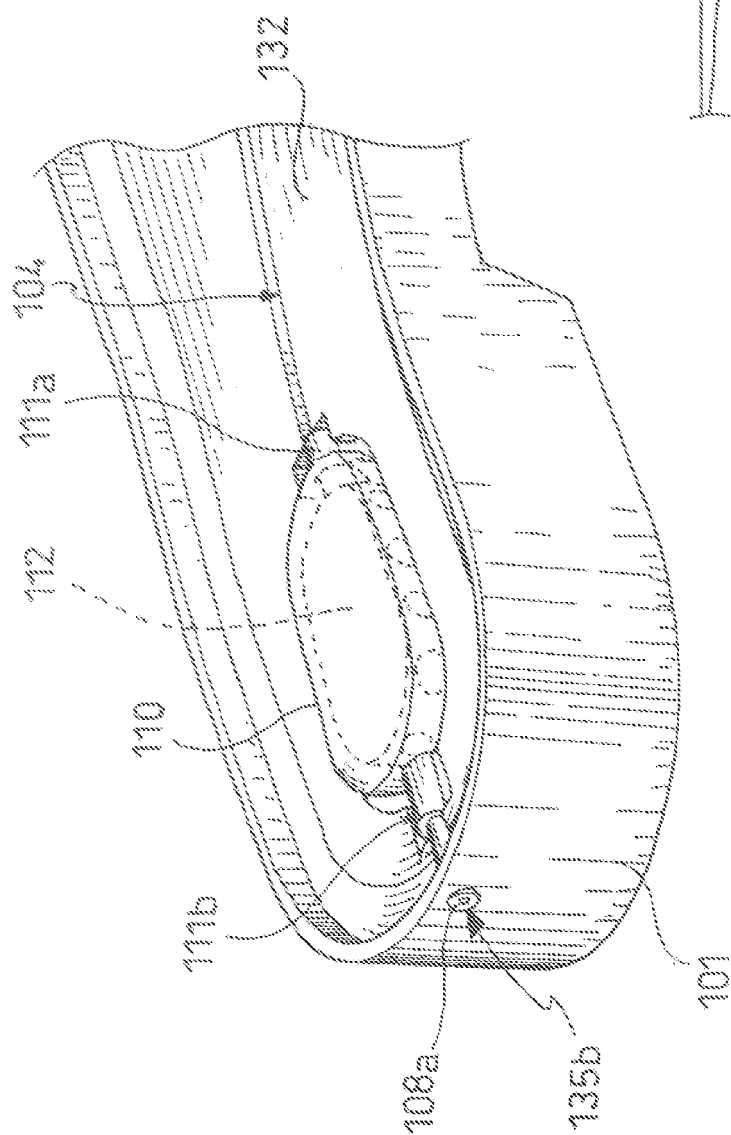


FIG. 9

209

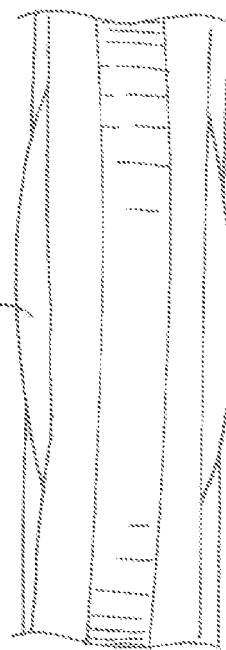
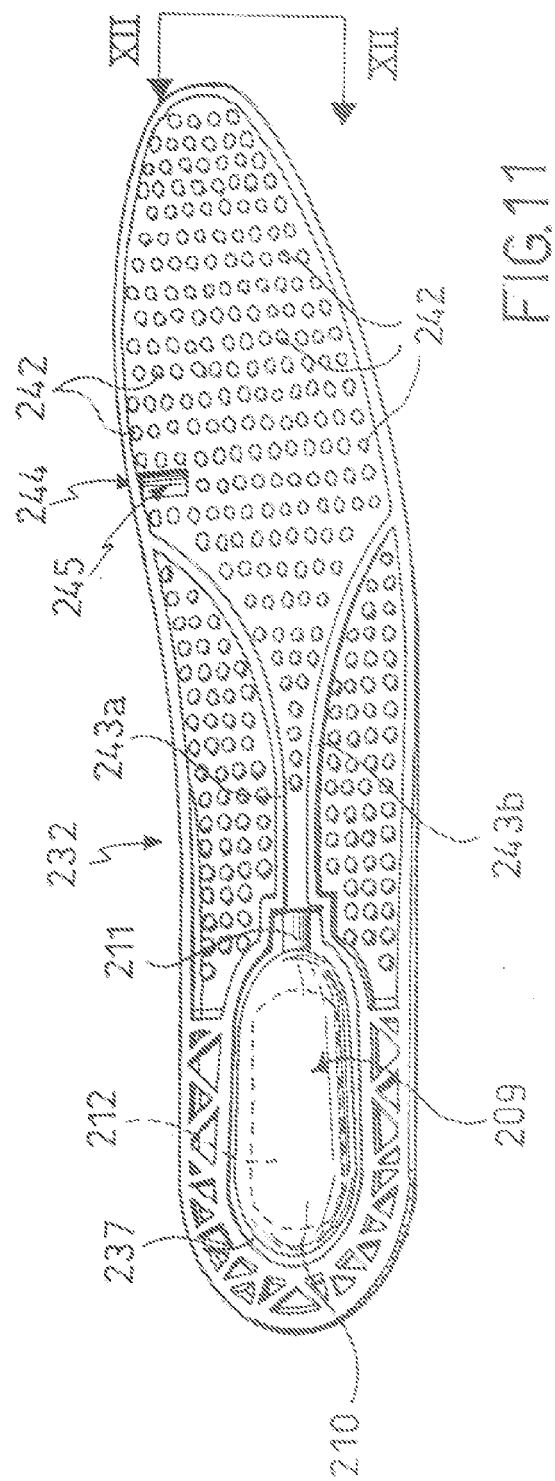
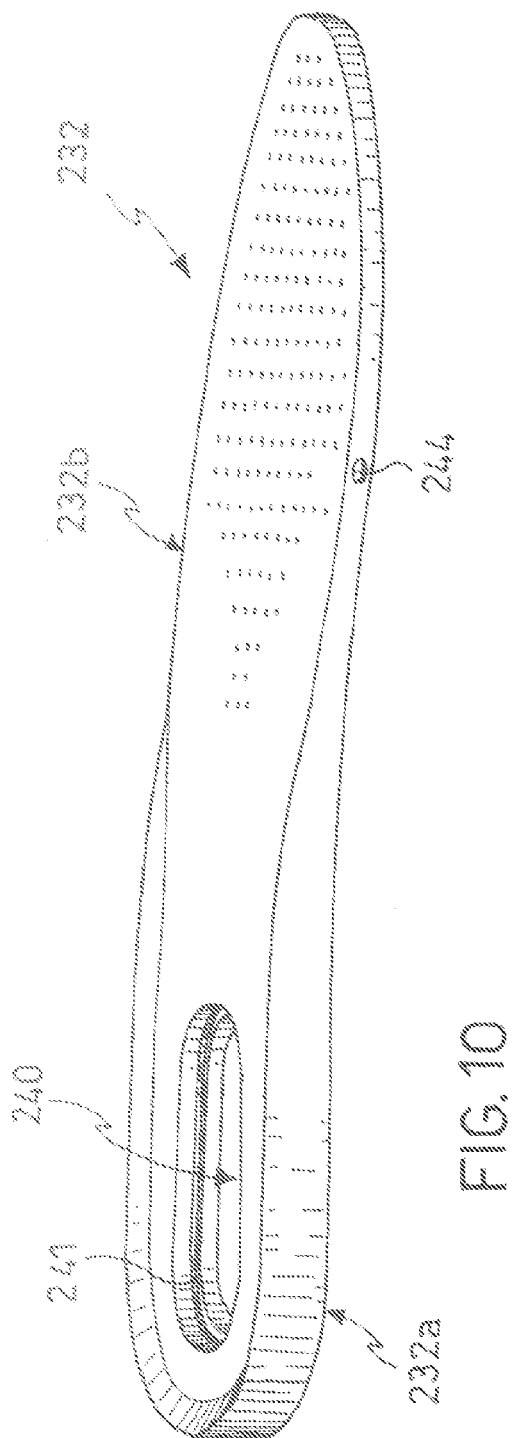


FIG. 12

232



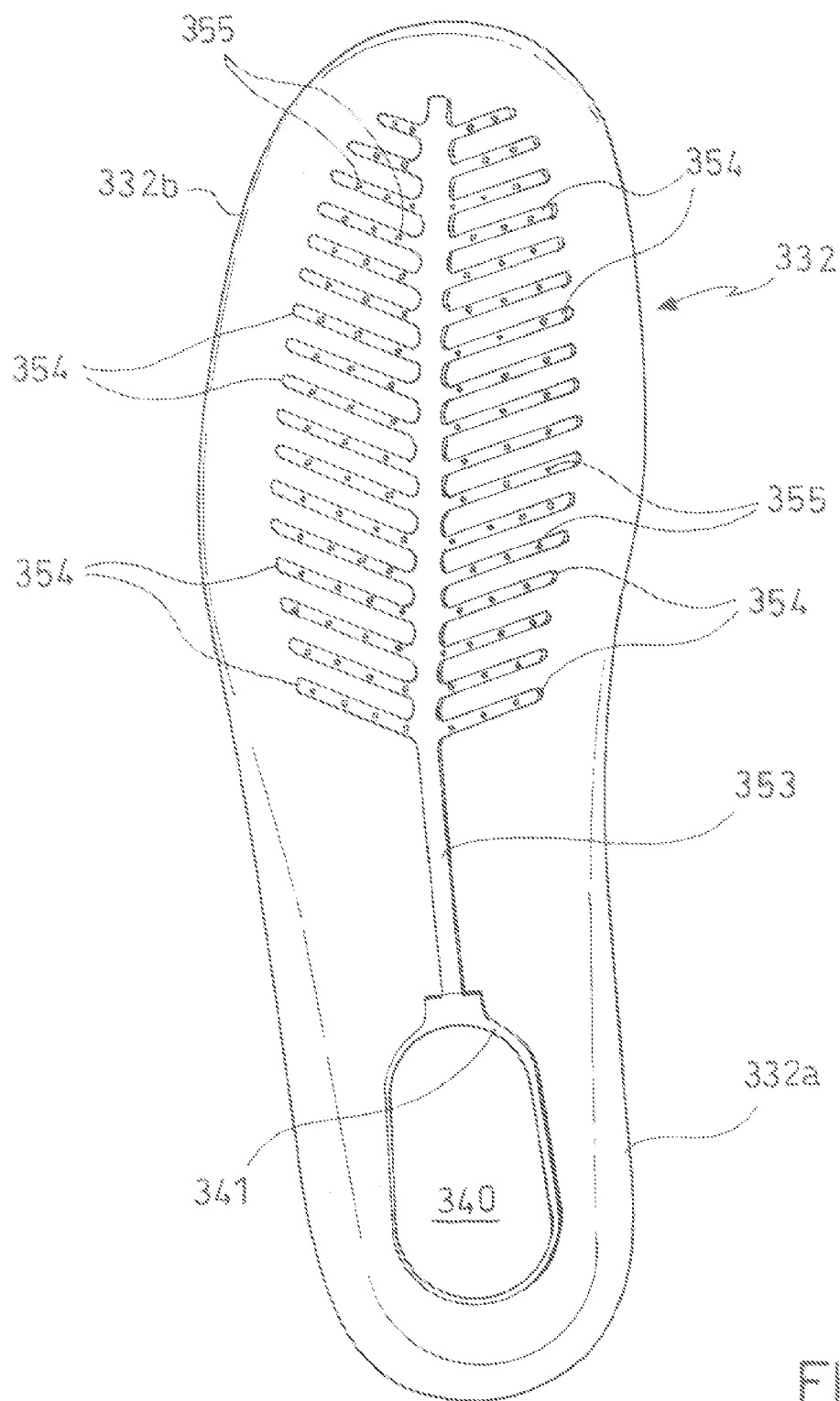
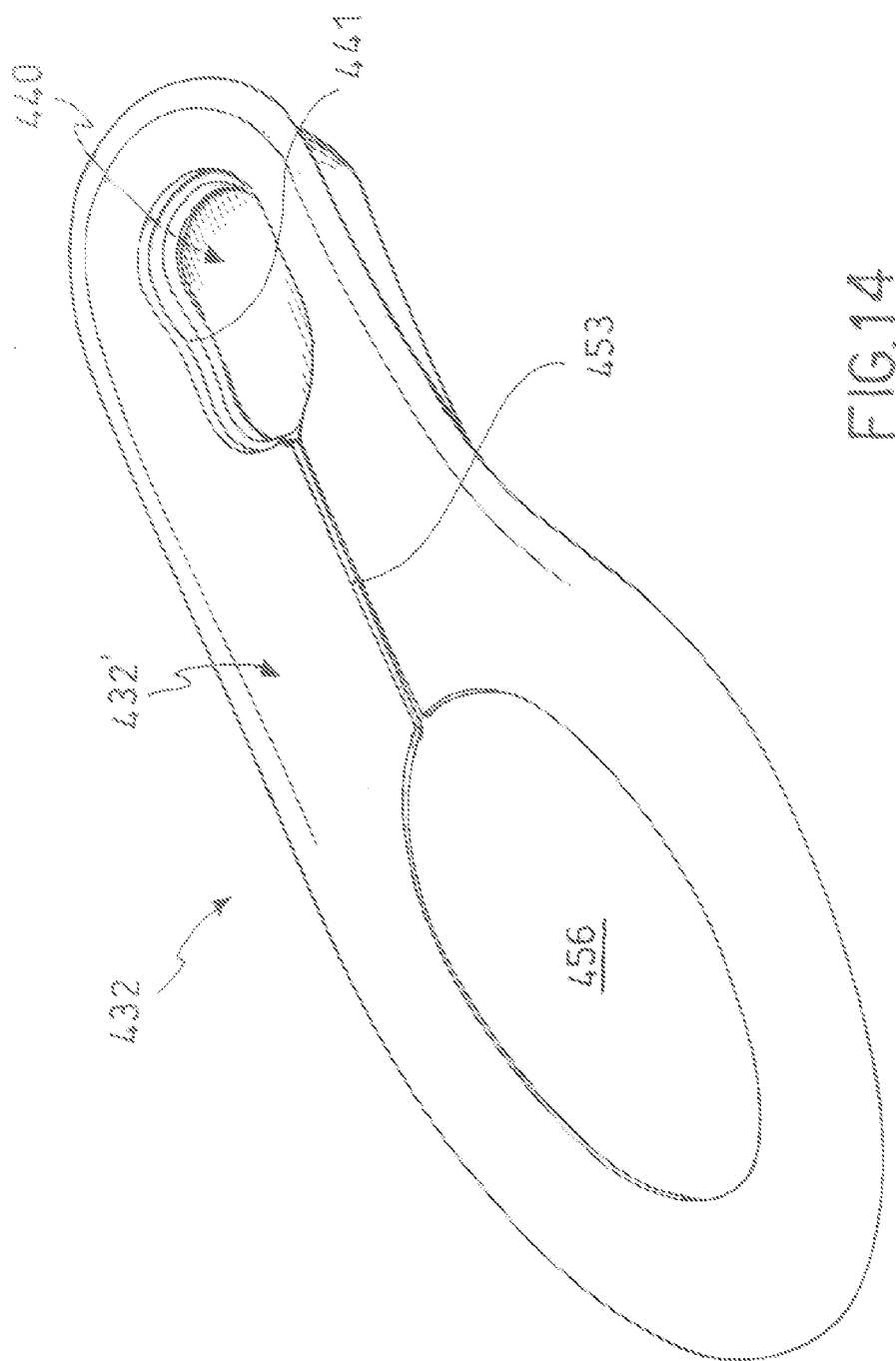


FIG.13



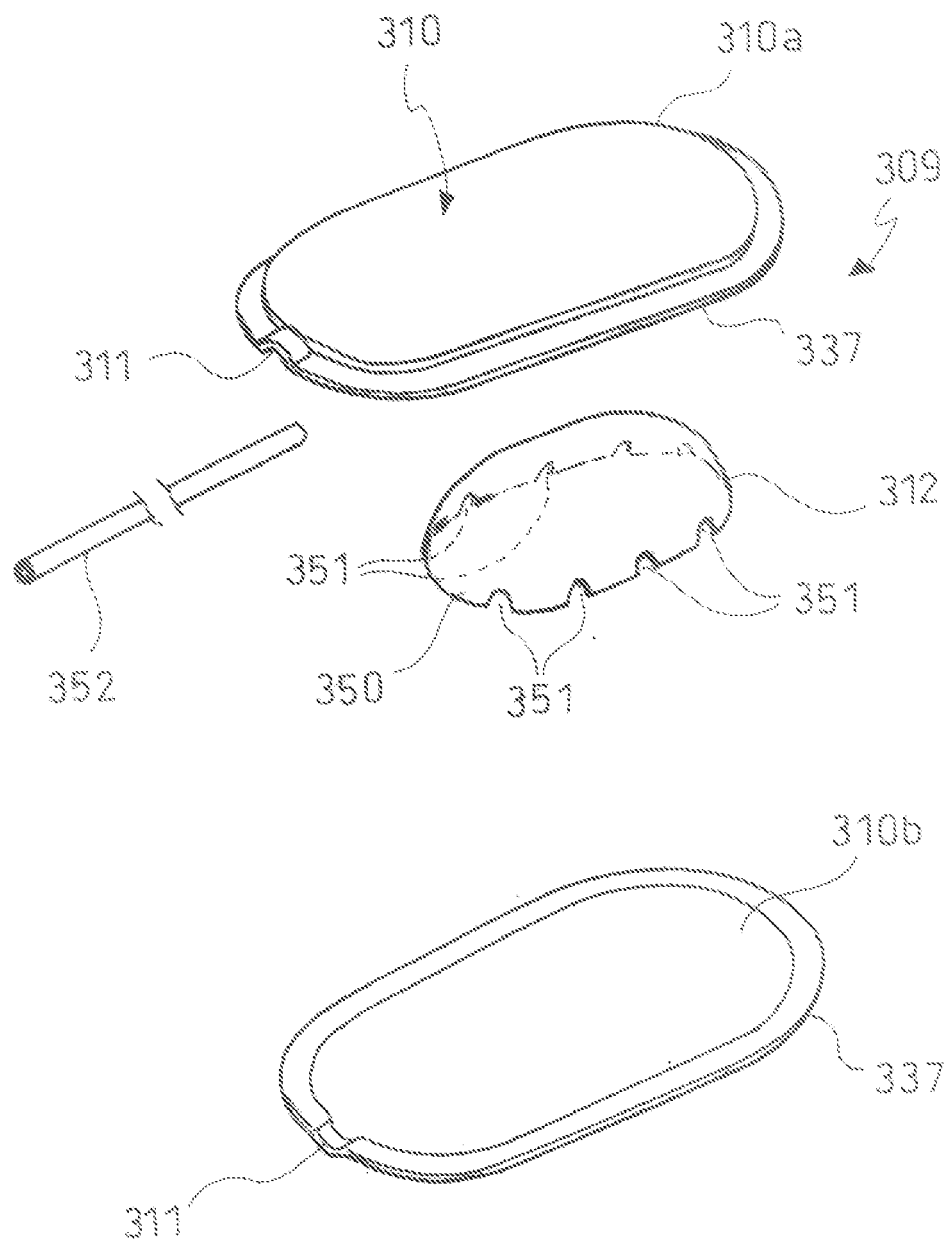


FIG. 15

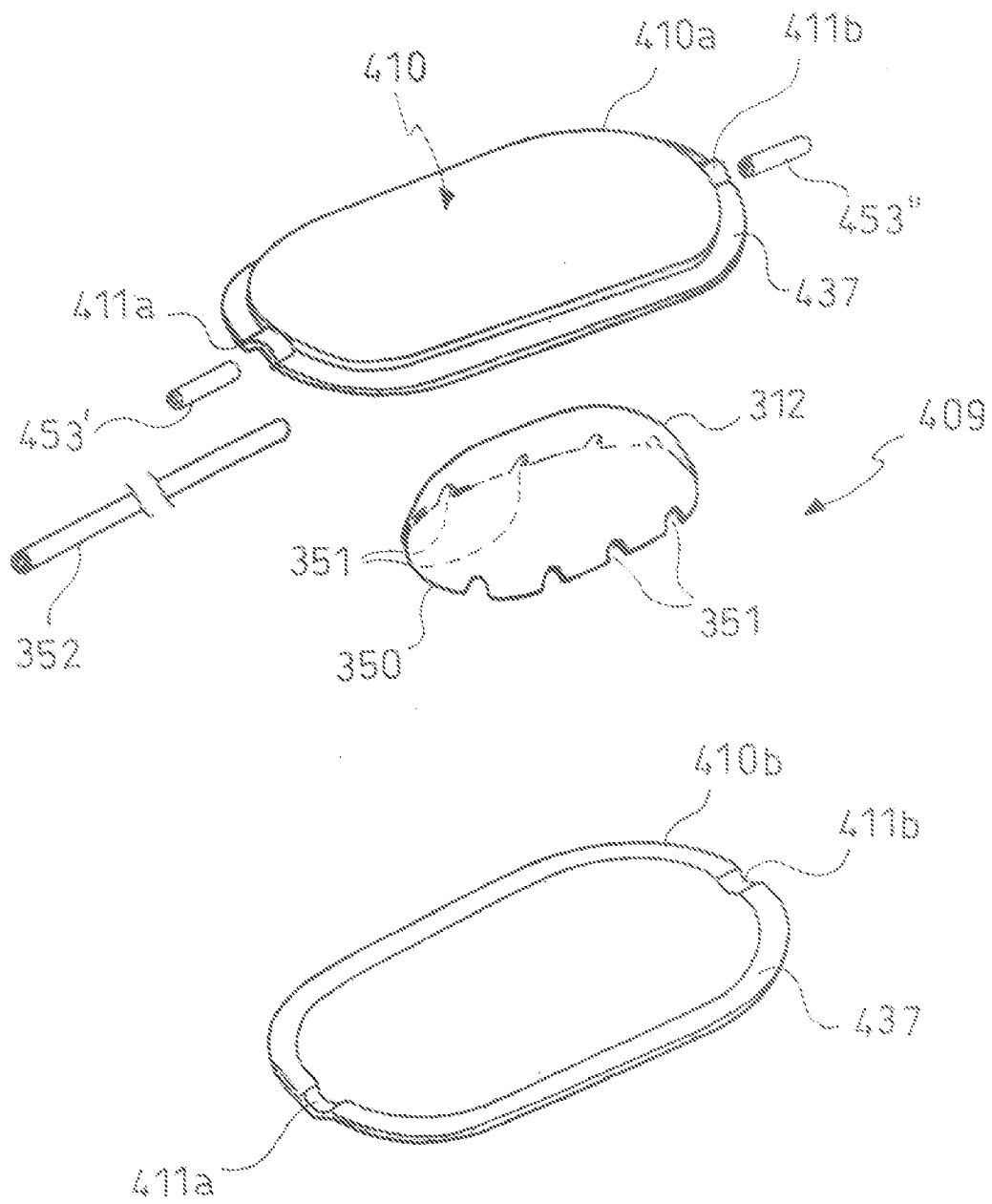


FIG. 16

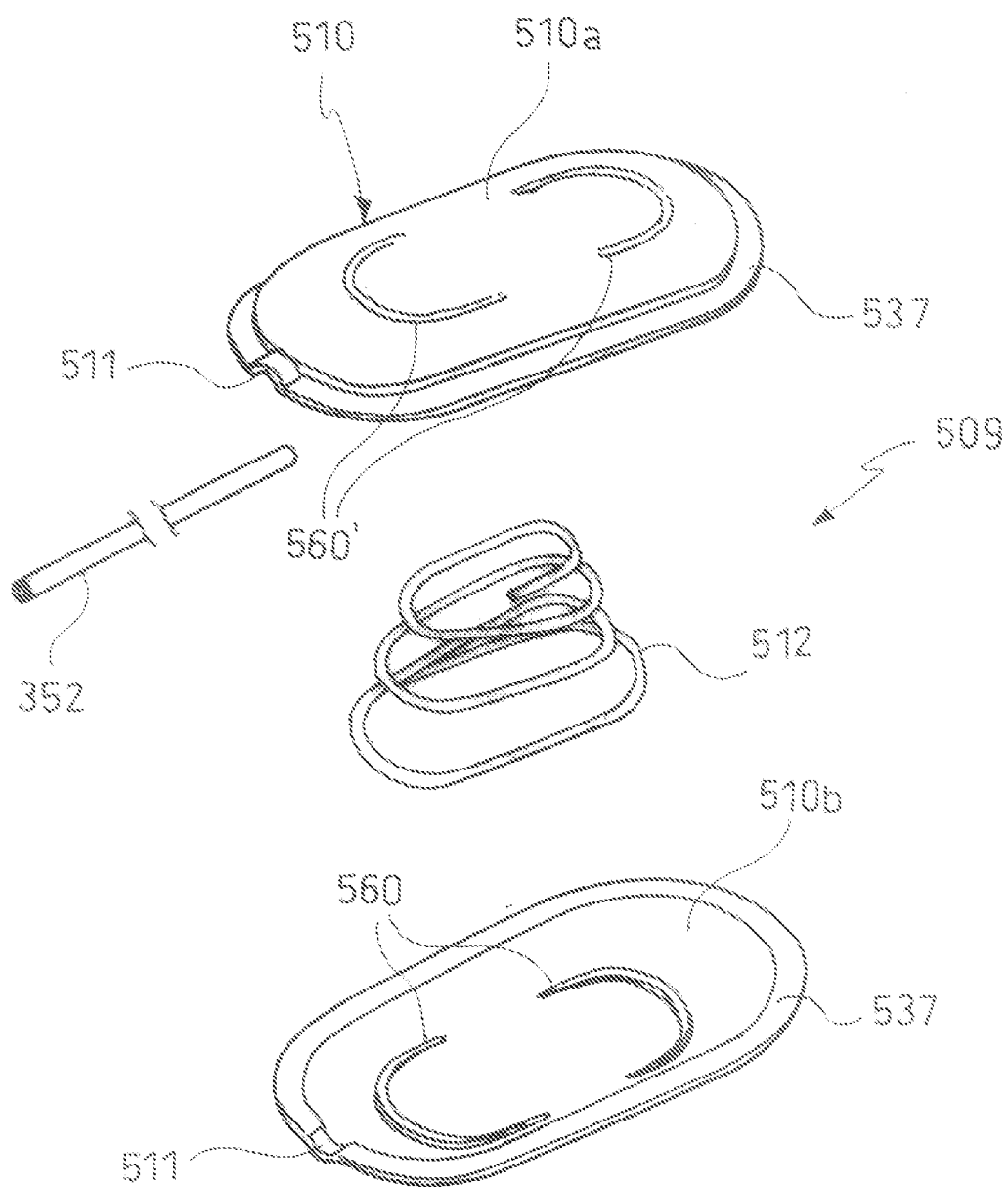


FIG. 17

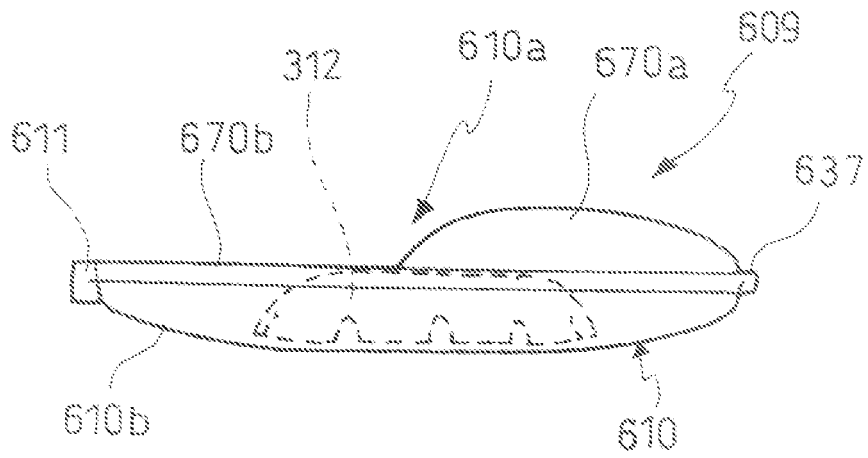


FIG. 18

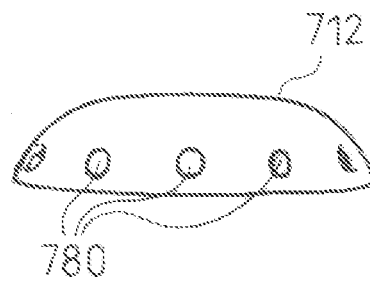


FIG. 19

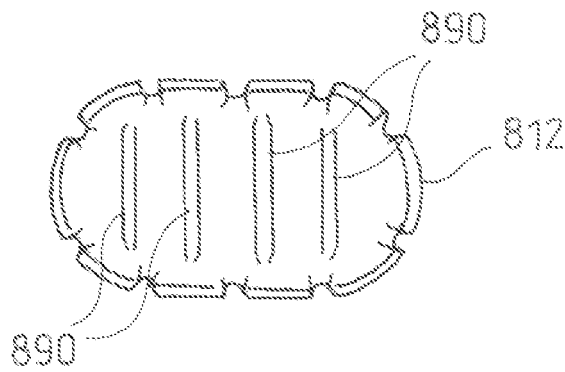


FIG. 20

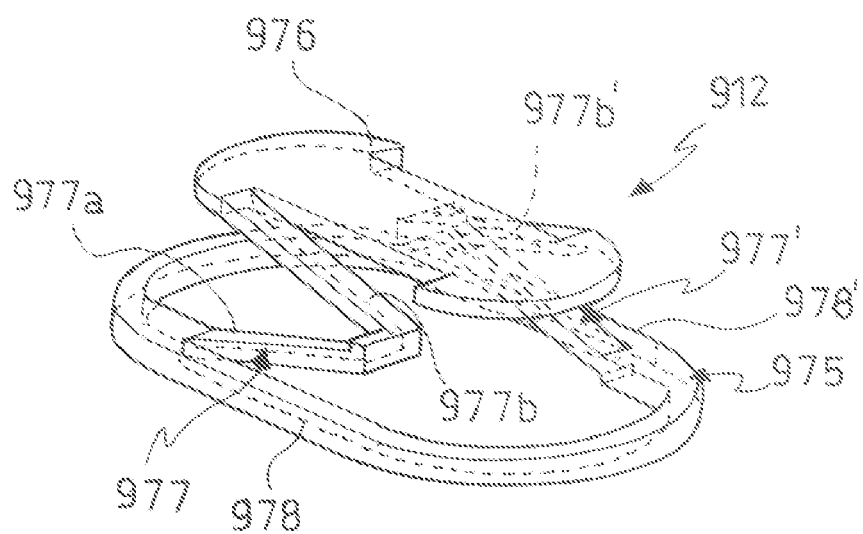


FIG. 21

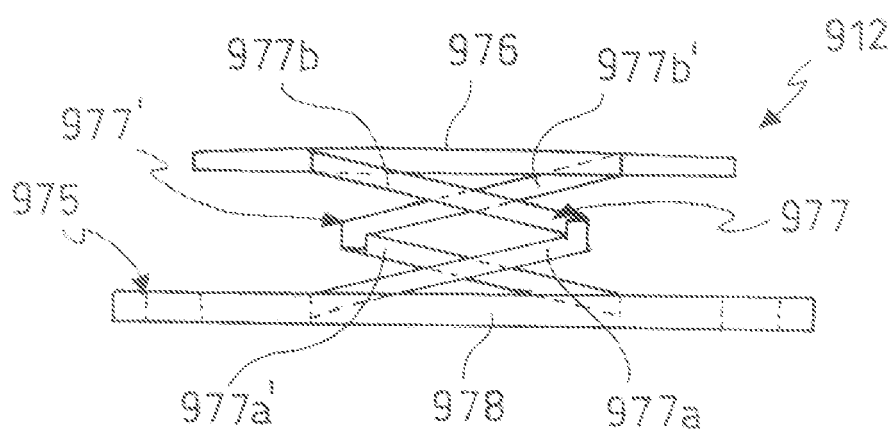


FIG. 22

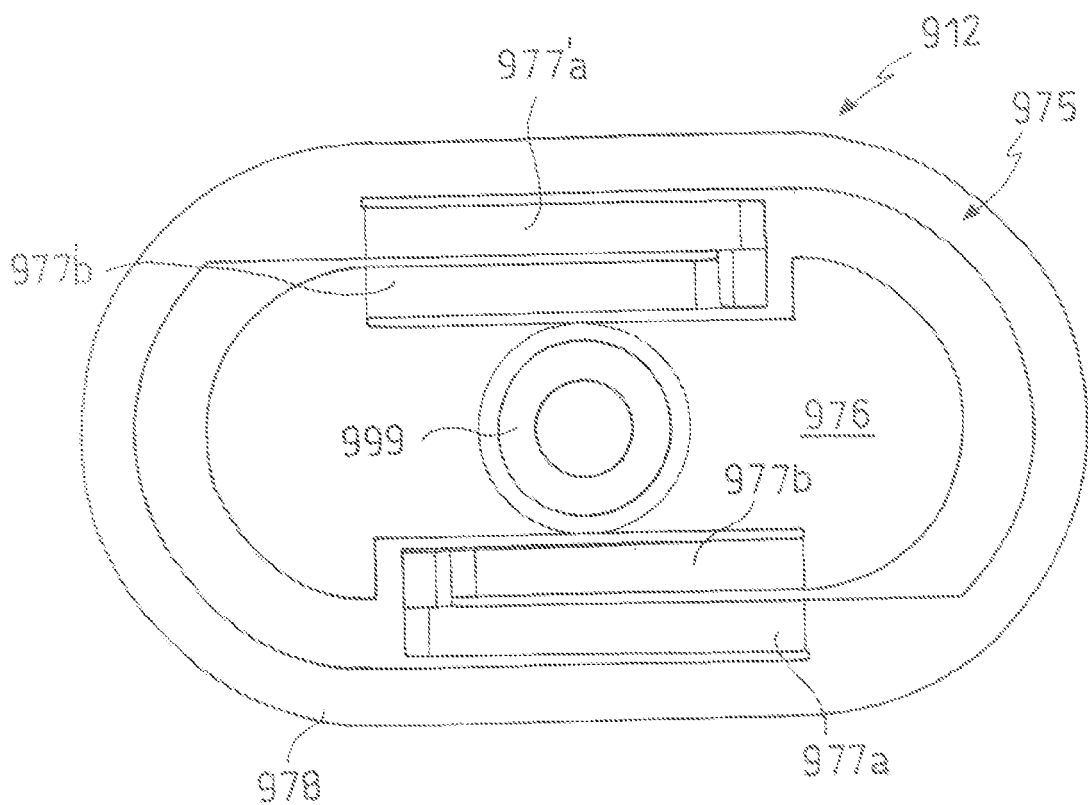


FIG. 24

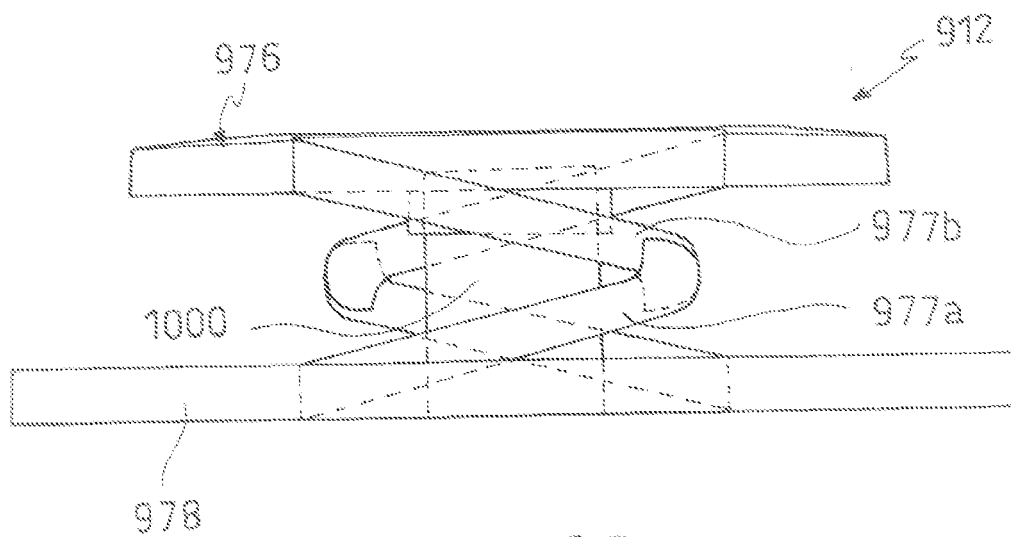


FIG. 23