



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
05.01.2011 Bulletin 2011/01

(51) Int Cl.:
A43B 3/24 (2006.01) **A43B 13/18** (2006.01)
A43B 13/30 (2006.01) **A43B 13/36** (2006.01)
A43B 21/42 (2006.01)

(21) Application number: **10251142.5**

(22) Date of filing: **24.06.2010**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
BA ME RS

(72) Inventor: **Kimura, Takaya**
Osaka-shi
Osaka 559-8510 (JP)

(74) Representative: **Brinck, David John Borchardt et al**
R.G.C. Jenkins & Co
26 Caxton Street
London SW1H 0RJ (GB)

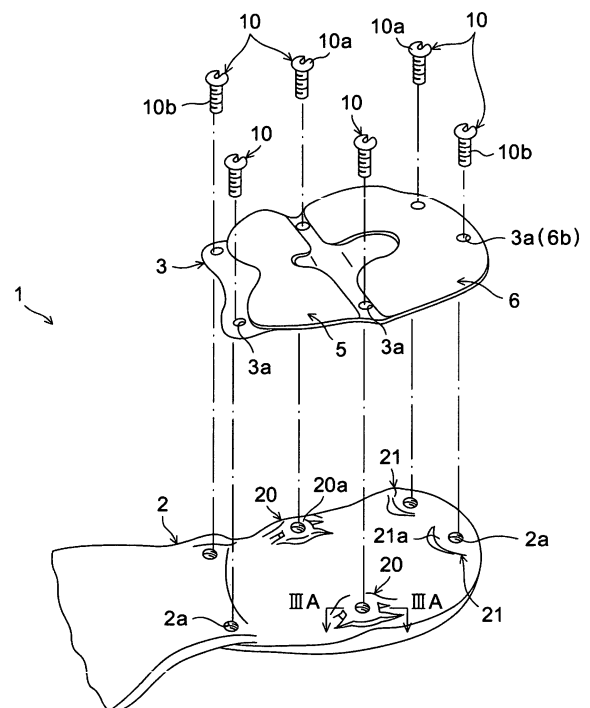
(30) Priority: **03.07.2009 JP 2009158959**

(71) Applicant: **MIZUNO CORPORATION**
Osaka-shi,
Osaka 541-8538 (JP)

(54) **Sole assembly for a shoe**

(57) A sole assembly (1) for a shoe includes an upper plate (2) disposed on an upper side of the sole assembly (1) and formed of hard elastic member, and a lower wavy plate (3) disposed on a lower side of the sole assembly (1), formed of hard elastic member and having a wavy shape that progresses in a longitudinal direction of the shoe. The lower wavy plate (3) is releasably attached to the upper plate (2) via a screw (10). An upwardly convexly curved portion (32) and upwardly convex portions (33, 34) of front and rear ends of the wavy shape are in contact with the upper plate (2) and these contact areas are coupled to each other via the screws (10). The lower wavy plate (3) is exchangeable relative to the shoe.

FIG. 3



Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a sole assembly for a shoe, especially a sports shoe, and more particularly, to a sole structure in which each user can exchange a sole inexpensively without damaging cushioning properties as a shoe.

BACKGROUND OF THE INVENTION

[0002] A sole-exchangeable shoe such as shown in Japanese patent application laying-open publication No. 7-204007 (hereinafter referred to JP reference 7-204007) has been proposed. This shoe has a fixing support that is fixed at a heel region of a sole and a heel member that is releasably attached to the fixing support via a fastening member (see figure 1 and paras. [0013] to [0014] of JP reference 7-204007).

[0003] Also, Japanese patent application laying-open publication No. 9-75107 (hereinafter referred to JP reference 9-75107) shows a shoe in which a screw that penetrates a bottom surface of the shoe is provided and a heel is releasably attached to the bottom surface of the shoe via a screw (see figures 1 to 3, and paras. [0030] and [0032]).

[0004] The sole structure described in JP reference 7-204007 needs the fixing support in order to fix the heel member to the sole, thus making the sole structure complicated and expensive. Also, since the heel member is attached to the sole through the fixing support, cushioning properties at the time of heel strike onto the ground is decreased.

[0005] The sole structure described in JP reference 9-75107 requires exchanging the entire heel when a user exchanges a heel, thus making the sole structure costly and imposing a burden on the user.

[0006] On the other hand, recently, especially in a sports shoe, request of a user has been diversified. There is a demand for a shoe that corresponds to a difference in weight, running style, running position, and motion of each user. However, preparing a subdivided lineup of shoes causes shoe makers and shoe shops to have excess stock thus resulting in an increase in costs. Also, in the event that after a user actually uses a shoe function of the shoe such as cushioning properties does not suit his/her taste, if he/she has to buy another shoe then his/her burden becomes severe.

[0007] Furthermore, recently, there are marathon or walking races in which runners run or walk tens of kilometers in a day and runners who are not fully experienced often participate such races. In these cases, runners sometimes would like to change their shoes into different shoes having different cushioning properties during races in order to lighten the burden on their feet. Under such circumstances, if runners have to carry different shoes the burden on them becomes severe.

[0008] Also, in mountain climbing, climbers can walk easily with shoes having high heels and high resilience on an uphill path, whereas on a downhill path, shoes having high shock-absorbing properties of a heel lighten the burden on feet of the climbers. Under such circumstances, if climbers have to change their shoes on an uphill path and a downhill path, they need to prepare two different shoes, thus imposing a burden on the climbers.

[0009] The present invention has been made in view of these circumstances and its object is to provide a sole assembly for a shoe in which each user can exchange a sole easily and inexpensively without damaging cushioning properties as a shoe.

SUMMARY OF THE INVENTION

[0010] The sole assembly for a shoe according to the present invention includes an upper plate disposed on an upper side of the sole assembly and formed of hard elastic member, and a lower wavy plate disposed on a lower side of the sole assembly, formed of hard elastic member and having a wavy shape that progresses in a longitudinal direction of the shoe. The lower wavy plate is releasably attached to the upper plate via a fastening element and the lower wavy plate is thus exchangeable relative to the shoe.

[0011] According to the present invention, at the time of shoe's strike onto the ground, when an impact load is imparted to the lower wavy plate from the ground, the wavy shape of the lower wavy plate deforms to be flatter or planer shape and the impact load is thus absorbed and relieved to secure cushioning properties.

[0012] In this case, the lower wavy plate is fitted to the upper plate without using a mount such as a fixing support, thereby simplifying the structure of the sole assembly, reducing the manufacturing cost, and maintaining cushioning properties. Also, in this case, at the time of exchanging the sole, a user or a shoe wearer has only to exchange only the lower wavy plate without exchanging both the upper plate and the lower wavy plate, thus further reducing the manufacturing cost and easing a burden of the user.

[0013] Moreover, in this case, by varying amplitude of the wavy shape of the lower wavy plate, and by employing material of different cushioning properties, coefficient of resilience or shock absorbance as a lower wavy plate, the user do not need to prepare different kinds of shoes and his/her burden is further relieved.

[0014] The wavy shape of the lower wavy plate may have a plurality of upwardly convex portions that are disposed in the longitudinal direction and at least a portion of the upwardly convex portions may be coupled to the upper plate via the fastening element.

[0015] In the event that the remaining upwardly convex portions are not coupled to the upper plate, when load imparts to the sole assembly, the remaining upwardly convex portions slide along a bottom surface of the upper plate without being restrained by the upper plate. As a

result, a large deformation of the lower wavy plate in the longitudinal direction as well as the upward and downward direction is facilitated to thereby improve cushioning properties. In this case, a shoe suitable for a lightweight user can be achieved.

[0016] Also, in the event that all the upwardly convex portions are coupled to the upper plate via the fastening element, the entire lower wavy plate is restrained by the upper plate and compressive hardness at the time of load action becomes high. In this case, a shoe suitable for a heavyweight user can be achieved.

[0017] The lower wavy plate may be provided at a heel region of the shoe and have at least two downwardly convexly curved portions that protrude downwardly convexly and that are adjacent to each other in the longitudinal direction. The lower wavy plate may further have an upwardly convexly curved portion that is located between the downwardly convexly curved portions. The upwardly convexly curved portion and the upwardly convex portions that are located at opposite front and rear ends of the lower wavy plate may be releasably attached to the upper plate via the fastening element.

[0018] In this case, a user can exchange the sole at the heel region easily and inexpensively that has been worn during usage. Also, in this case, since the lower wavy plate has a plurality of downwardly convexly curved portions, cushioning properties of the heel region of the shoe are improved.

[0019] The upper plate may have a wavy shape that progresses in the longitudinal direction of the shoe as with the lower wavy plate. In this case, cushioning properties or bendability of the shoe can be adjusted.

[0020] The wavy shape of the upper plate may have an inverted phase relative to the wavy shape of the lower wavy plate. At least a portion of upwardly convexly curved portions of the wavy shape of the lower wavy plate and downwardly convexly curved portions of the wavy shape of the upper plate may be fixedly attached to each other via the fastening element.

[0021] In this case, since there is formed a large lenticular shaped gap between an upwardly convexly curved portion of the upper plate and a downwardly convexly curved portion of the lower wavy plate, both the upper plate and the lower wavy plate compressively deform when shock load is imparted to the sole structure at the time of strikes onto the ground, thus improving cushioning properties of the shoe. Also, in this case, because an upward thrust from the lower wavy plate on striking onto the ground is exerted to the downwardly convexly curved portion between the longitudinally adjacent upwardly convexly curved portions of the upper plate, the upward thrust can be dispersed and relieved. Such sole structure is well suitable for a heel region of a shoe.

[0022] The wavy shape of the upper plate may be in phase with the wavy shape of the lower wavy plate. At least a portion of upwardly convexly curved portions of the wavy shape of the lower wavy plate and upwardly convexly curved portions of the wavy shape of the upper

plate may be fixedly attached to each other via the fastening element.

[0023] In this case, the upwardly convexly curved portions and downwardly convexly curved portions of the upper plate and the lower wavy plate are located at the same position in the longitudinal direction, thus improving bendability of the shoe. Such sole structure is well suited to a forefoot region of a shoe.

[0024] At least a portion of ridge lines of the upwardly convexly curved portions of the wavy shape of the lower wavy plate may be in contact with the upper plate and the contact area may be coupled to each other via the fastening element.

[0025] In the event that the ridge lines of the upwardly convexly curved portions of the wavy shape of the lower wavy plate are not in contact with the upper plate along the entire width of the sole structure, for example, the ridge lines of the upwardly convexly curved portions of the lower wavy plate are in contact with the upper plate only at a position corresponding to an outer circumference of a foot, an upward thrust to the foot by a shock load on striking onto the ground can be relieved.

[0026] The upper plate may have a wavy shape that progresses in a lateral direction of the shoe. At least a portion of a contact area of a downwardly convexly curved portion of the wavy shape of the upper plate with an upwardly convexly curved portion of the wavy shape of the lower wavy plate may be fixedly attached to each other via the fastening element.

[0027] In this case, ridge lines of the wavy shape of the upper plate and ridge lines of the wavy shape of the lower wavy plate intersect each other, thereby restricting bending of the shoe. Such sole structure is well suitable for a mid-foot region of the shoe that needs a shank-effect.

[0028] The upper plate may have a combination of a first wavy shape that progresses in the longitudinal direction and a second wavy shape that progresses in a lateral direction of the shoe.

[0029] In this case, at a region where the upper plate has a wavy shape that progresses in the longitudinal direction of the shoe, if phase of the wavy shape of the upper plate is inverted relative to phase of the wavy shape of the lower wavy plate, cushioning properties of the shoe can be improved, whereas if the wavy shape of the upper plate is in phase with the wavy shape of the lower wavy plate, bendability of the shoe can be improved. Also, at a region where the upper plate has a wavy shape that progresses in the lateral direction of the shoe, bendability of the shoe can be restricted.

[0030] The fastening element may be formed of a male screw that passes through a through hole from below formed in the lower wavy plate and a female screw provided in the upper plate which the male screw is screwed into.

[0031] In this case, when fitting the lower wavy plate to the upper plate, with the lower wavy plate disposed on the bottom surface of the upper plate, the male screw of

the fastening element is inserted into the through hole of the lower wavy plate from below and screwed and fastened into the female screw of the upper plate. On the other hand, when removing the lower wavy plate from the upper plate, the male screw of the fastening element is loosened and removed from the female screw of the upper plate.

[0032] By the way, in the above-mentioned prior-art sole structure of JP reference 9-75107, the head of the screw is disposed inside the shoe, the male screw is screwed into the female screw formed on the top surface of the heel, and the inside sole (i.e. insole) is disposed on the head of the screw inside the shoe. In this case, since the head of the screw is located directly under the insole, a shoe wearer feels the head of the screw under the sole of a foot and foot contact feeling becomes uncomfortable. Also, in this case, when exchanging the heel, the shoe wearer has to pull the insole off inside the shoe to loosen the screw, and after having exchanged the heel the shoe wearer has to return the insole to its original position, which is troublesome.

[0033] In contrast, according to the present invention, since the male screw of the fastening element is inserted into the through hole of the lower wavy plate from below, tightening and loosening of the male screw can be handled outside the shoe, and a shoe wearer does not need to pull the insole off inside the shoe to handle the male screw. Thereby, tightening and loosening of the fastening element can be handled with ease and attachment and detachment of the lower wavy plate can be facilitated. Also, since the head of the male screw is not disposed inside the shoe, a foot contact feeling of the shoe wearer is not damaged.

[0034] The fastening element may allow for a longitudinal relative movement of the upper plate and the lower wavy plate.

[0035] In this case, the lower wavy plate is movable in the longitudinal direction relative to the upper plate, thus allowing for longitudinal deformation and upward and downward deformation of the lower wavy plate to improve cushioning properties.

[0036] The fastening element may be formed of a male screw that passes through a longitudinally elongated through hole formed in the lower wavy plate and a female screw provided in the upper plate which the male screw is screwed into.

[0037] In this case, the male screw of the fastening element is slidable in the longitudinal direction along the longitudinally elongated through hole of the lower wavy plate, so that the lower wavy plate can move in the longitudinal direction relative to the upper plate.

[0038] The fastening element may be composed of an engaging protrusion formed on one of the upper plate and the lower wavy plate and an engaged groove formed on the other of the upper plate and the lower wavy plate, the engaging protrusion being engageable with the engaged groove.

[0039] In this case, since the lower wavy plate is at-

tached to the upper plate through the fastening element formed of the engaging protrusion and engaged groove, a user does not have to fasten or loosen a screw to attach the lower wavy plate to the upper plate or remove the lower wavy plate from the upper plate, thereby further simplifying attachment and removal of the lower wavy plate.

[0040] A fastened region of the upper plate and the lower wavy plate by the fastening element may be disposed on an outer circumferential side of the upper plate and the lower wavy plate.

[0041] In this case, since load from the ground acts onto the outer circumferential region, not a central region, of the upper plate, an upward thrust to the sole central portion of a shoe wearer's foot on impacting the ground can be relieved.

[0042] A contact area of at least a portion of the upwardly convex portions of the wavy shape of the lower wavy plate with the upper plate may extend in the longitudinal direction of the shoe.

[0043] In this case, when impact load from the ground is imparted to the upper plate through the lower wavy plate, the impact load can be dispersed at the longitudinally extended contact area and a thrust from the upper plate to a foot can be relieved.

[0044] An intermediate wavy plate formed of hard elastic member may be provided between the lower wavy plate and the upper plate, the intermediate wavy plate having a wavy shape that progresses in the longitudinal direction of the shoe, the wavy shape having a bottom surface that extends along an upper surface of the lower wavy plate. The intermediate wavy plate may be releasably attached to the upper plate along with the lower wavy plate via the fastening element.

[0045] In this case, by using a different material from the lower wavy plate as material of the intermediate wavy plate, or by varying thickness of the intermediate wavy plate, cushioning properties (i.e. shock absorbency and resiliency) as a sole assembly can be adjusted.

[0046] For example, in mountain-climbing, by preparing two kinds of intermediate wavy plates of different rigidity for an uphill path and a downhill path to use the different intermediate wavy plates selectively for an uphill and downhill, for example, by using the intermediate wavy plate of higher resilience for an uphill and of higher shock absorbency for a downhill, thus relieving a burden on a foot of a shoe wearer. Alternatively, by preparing two kinds of intermediate wavy plates of different thickness of a heel region for an uphill path and a downhill path to use the different intermediate wavy plates selectively for an uphill and downhill, for example, by using the intermediate wavy plate of a thicker heel region for an uphill and of a thinner heel region for a downhill, or using the intermediate wavy plate selectively in accordance with a slope of a mountain, thus easing a mountain walk of the shoe wearer.

[0047] Moreover, in this case, a user can not only exchange the intermediate wavy plate at the same time

when exchanging the lower wavy plate but also exchange the lower wavy plate or the intermediate wavy plate respectively. As a result, shoes in accordance with various tastes of users can be easily manufactured.

[0048] The intermediate wavy plate may be composed of a medial wavy plate and a lateral wavy plate that are disposed on a medial side and a lateral side of the shoe, respectively, the medial wavy plate and the lateral wavy plate being separated from each other in the lateral direction of the shoe.

[0049] In this case, the medial wavy plate and the lateral wavy plate can be made of materials of different rigidities, thereby easily altering compressive hardness on impacting onto the ground between the medial side and the lateral side of the shoe. As a result, shoes corresponding to over-pronation and over-supination of a foot of a shoe wearer can be manufactured with ease.

[0050] There may be formed a gap between the upper plate and the lower wavy plate, which holds a soft elastic member.

[0051] In this case, when the lower wavy plate deforms elastically, the soft elastic member in the gap also deforms elastically. Therefore, as the soft elastic member, by employing synthetic rubber, synthetic resin or rubber/resin foam that is superior in shock absorbance, cushioning properties can be adjusted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0052] For a more complete understanding of the invention, reference should be made to the embodiments illustrated in greater detail in the accompanying drawings and described below by way of examples of the invention. In the drawings, which are not to scale:

FIG. 1 (a) is a bottom view of a sole assembly for a shoe according to an embodiment of the present invention;

FIG. 1 (b) is a lateral side view of the sole assembly of FIG. 1 (a);

FIG. 2 is a longitudinal sectional view of FIG. 1 (a) taken along line II-II;

FIG. 3 is a blown-up perspective view of a rear foot region of the sole assembly of FIG. 1;

FIG. 3A is a cross sectional view of FIG. 3 taken along line IIIA-III A;

FIG. 4 (a) is a bottom view of a sole assembly for a shoe according to a second embodiment of the present invention;

FIG. 4 (b) is a lateral side view of the sole assembly of FIG. 4 (a);

FIG. 4 (c) is a longitudinal sectional view of FIG. 4 (a) taken along line C-C, showing an example in which an upper plate of the sole assembly is provided only at a heel region of the shoe;

FIG. 5 (a) is a bottom view of a sole assembly for a shoe according to a second embodiment of the present invention;

FIG. 5 (b) is a lateral side view of the sole assembly of FIG. 5 (a);

FIG. 5 (c) is a longitudinal sectional view of FIG. 5 (a) taken along line C-C, showing an example in which an upper plate of the sole assembly is provided only at a forefoot region of the shoe;

FIG. 6 (a) is a bottom view of a sole assembly for a shoe according to a third embodiment of the present invention;

FIG. 6 (b) is a lateral side view of the sole assembly of FIG. 6 (a);

FIG. 6 (c) is a longitudinal sectional view of FIG. 6 (a) taken along line C-C, showing an example in which a lower wavy plate of the sole assembly is provided at a heel region and a forefoot region of the shoe separately;

FIG. 7 (a) is a bottom view of a sole assembly for a shoe according to a third embodiment of the present invention;

FIG. 7 (b) is a lateral side view of the sole assembly of FIG. 7 (a);

FIG. 7 (c) is a longitudinal sectional view of FIG. 7 (a) taken along line C-C, showing an example in which a lower wavy plate of the sole assembly extends from a heel region through a mid-foot region to a forefoot region of the shoe;

FIG. 7A is a top plan view of the lower wavy plate of the sole assembly of FIG. 7;

FIG. 7B is a perspective view of the lower wavy plate of the sole assembly of FIG. 7;

FIG. 8 (a) is a bottom view of a sole assembly for a shoe according to a fourth embodiment of the present invention;

FIG. 8 (b) is a lateral side view of the sole assembly of FIG. 8 (a);

FIG. 8 (c) is a longitudinal sectional view of FIG. 8 (a) taken along line C-C, showing an example in which a lower wavy plate and an upper plate of the sole assembly are provided at a heel region and a forefoot region of the shoe separately;

FIG. 9 is a schematic side view of an upper plate and a lower wavy plate of a sole assembly for a shoe according to a fifth embodiment of the present invention, showing an example in which a phase of a wavy shape of the upper plate is inverted relative to a phase of a wavy shape of the lower wavy plate;

FIG. 10 is a schematic side view of an upper plate and a lower wavy plate of a sole assembly for a shoe according to a fifth embodiment of the present invention, showing an example in which a wavy shape of the upper plate is in phase with a wavy shape of the lower wavy plate;

FIG. 11 is a schematic side view of an upper plate and a lower wavy plate of a sole assembly for a shoe according to a fifth embodiment of the present invention, showing an example in which an upper plate is planar in shape;

FIG. 12 is a schematic perspective view of an upper

plate and a lower wavy plate of a sole assembly for a shoe according to a sixth embodiment of the present invention, showing an example in which the upper plate has a wavy shape that progresses in the lateral direction and the lower wavy plate has a wavy shape that progresses in the longitudinal direction; FIG. 13 is a longitudinal sectional view of FIG. 12 taken along line XIII-XIII;

FIG. 14 (a) is a bottom view of a sole assembly for a shoe according to a seventh embodiment of the present invention;

FIG. 14 (b) is a lateral side view of the sole assembly of FIG. 14 (a);

FIG. 14 (c) is a longitudinal sectional view of FIG. 14 (a) taken along line C-C, showing an example in which an upper plate has a composite wavy shape that progresses both in the longitudinal direction and in the lateral direction;

FIG. 15 (a) is a bottom view of the upper plate of the sole assembly of FIG. 14;

FIG. 15 (b) is a lateral side view of the upper plate of FIG. 15 (a);

FIG. 15 (c) is a longitudinal sectional view of FIG. 15 (a) taken along line C-C;

FIG. 15A is a perspective view of the upper plate of the sole assembly of FIG. 15;

FIG. 16 is a cross sectional view of FIG. 15 (a) taken along line XVI-XVI;

FIG. 17 is a schematic side view of an upper plate and a lower wavy plate of a sole assembly for a shoe according to an eighth embodiment of the present invention, showing an example in which an upper plate is planar in shape;

FIG. 18 is a schematic side view of an upper plate and a lower wavy plate of a sole assembly for a shoe according to a eighth embodiment of the present invention, showing an example in which a phase of a wavy shape of the upper plate is inverted relative to a phase of a wavy shape of the lower wavy plate;

FIG. 19 is a schematic side view of an upper plate and a lower wavy plate of a sole assembly for a shoe according to an eighth embodiment of the present invention, showing an example in which a wavy shape of the upper plate is in phase with a wavy shape of the lower wavy plate;

FIG. 20 is an enlarged sectional view of a screw fitted portion of a lower wavy plate of a sole assembly for a shoe according to a ninth embodiment of the present invention;

FIG. 21 illustrates a variant of a fastening element of an upper plate and a lower wavy plate of a sole assembly for a shoe according to a tenth embodiment of the present invention;

FIG. 22 is a blown-up perspective view of a rear foot region of a sole assembly for a shoe according to an eleventh embodiment of the present invention;

FIG. 23 is a top plan view of an intermediate wavy plate of the sole assembly of FIG. 22;

FIG. 24 is a longitudinal sectional view of a sole assembly of a shoe according to an eleventh embodiment of the present invention; and

FIG. 25 is a perspective view viewed from above of a lower wavy plate of a sole assembly for a shoe according to a twelfth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

<First Embodiment>

[0053] Turning now to the drawings, FIGS. 1 to 3A illustrate a sole assembly generally at 1 for a shoe according to a first embodiment of the present invention.

[0054] As shown in FIGS. 1 and 2, the sole assembly 1 includes an upper plate 2 extending from a heel region H through a mid-foot region M to a forefoot region F of the shoe and formed of hard elastic member, and a lower wavy plate 3 disposed under the upper plate 2 at the heel region H of the shoe and formed of hard elastic member.

[0055] The upper plate 2 is disposed on an upper side of the sole assembly at the heel region H and planar in shape. Also, the upper plate 2 is disposed on a lower side of the sole assembly at the forefoot region H, a laterally central portion being planar in shape (see FIG. 2), and a medial side portion and a lateral side portion having a wavy shape that progresses in the longitudinal direction (see FIG. 1 (b)). FIG. 1 (b) shows a wavy shape only on the lateral side portion of the upper plate 2.

[0056] The lower wavy plate 3 has a wavy shape that progresses in the longitudinal direction (i.e. in the upward to downward direction of FIGS. 1 and 2) of the shoe. Here, the lower wavy plate 3 has two downwardly convexly curved portions 30, 31 that protrude downwardly convexly and that are adjacent to each other in the longitudinal direction, and an upwardly convexly curved portion 32 that protrudes upwardly convexly and that are disposed between the adjacent two downwardly convexly curved portions 30, 31. There are also provided upwardly convex portions (or upwardly convexly curved portions) 33, 34 at a front and rear end of the lower wavy plate 3. Between the lower wavy plate 3 and the upper plate 2 is formed a void C.

[0057] At the forefoot region F of the shoe, an outsole 4 is fixedly attached via bonding or the like to a bottom surface of the upper plate 2. A number of slip-preventive grooves 4a (not shown in FIG. 1 (a)) are formed on a bottom surface of the outsole 4. At the heel region H of the shoe, outsoles 5, 6 are fixedly attached by bonding or the like to a bottom surface of the lower wavy plate 3. Similarly, a number of slip-preventive grooves 5a, 6a (not shown in FIG. 1 (a)) are formed on bottom surfaces of the outsoles 5 and 6. The outsole 5 is disposed on the front end side of the heel region H and the outsole 6 is disposed on the rear end side of the heel region H. There is formed a longitudinal gap 7 between a rear end 50 of

the outsole 5 and a front end 60 of the outsole 6. The longitudinal gap 7 is located at a position corresponding to a position of the upwardly convexly curved portion 32 of the lower wavy plate 3. Additionally, in lieu of the outsoles 4, 5 and 6 fixedly attached to the bottom surfaces of the upper plate 2 and the lower wavy plate 3, the upper plate 2 and the lower wavy plate 3 may have an outsole design formed directly on the bottom surfaces of the upper plate 2 and the lower wavy plate 3.

[0058] There is provided a midsole 8 on the top surface of the upper plate 2, which is formed of soft elastic member and extends from the heel region H through the mid-foot region M to the forefoot region F of the shoe. The upper plate 2 is fixedly attached by bonding or the like to a bottom surface of the midsole 8. The midsole 8 has a foot sole contact surface 8a that contacts a foot sole of a shoe wearer through an insole or the like (not shown) and a pair of upraised portions 8b that are formed at and upraised from laterally opposite ends of the foot sole contact surface 8a and that are attached to a bottom portion of laterally opposite side surfaces of an upper (not shown) of the shoe.

[0059] The upper plate 2 and the lower wavy plate 3 may be formed of thermoplastic resin such as thermoplastic polyurethane (TPU), polyamide elastomer (PAE) and the like, or thermosetting resin such as epoxy resin, unsaturated polyester resin and the like. Also, the upper plate 2 and the lower wavy plate 3 may be formed of ethylene-vinyl acetate copolymer (EVA), rubber and the like.

[0060] The midsole 8 may be formed of thermoplastic resin and foamed thermoplastic resin such as ethylene-vinyl acetate copolymer (EVA), thermosetting resin and foamed thermosetting resin such as polyurethane (PU), or rubber and foamed rubber such as butadiene rubber or chloroprene rubber.

[0061] As shown in FIG. 3, the lower wavy plate 3 is releasably attached to the upper plate 2 through plural (here, six) screws 10 as fastening elements. Each of the screws 10 is formed of a head 10a with a minus groove and a male screw 10b extending downwardly from the head 10a. However, different kinds of screws may be used.

[0062] The lower wavy plate 3 has plural (here, six) through holes 3a formed thereinto. A front end side, a rear end side, and a longitudinal central portion of the lower wavy plate 3 have two through holes 3a each. The through holes 3a on the front end side are located in front of the outsole 5, the through holes 3a at the longitudinal central portion are located at a gap 7 between the outsoles 5 and 6, and the through holes 3a on the rear end side are located above the outsole 6. The outsole 6 has through holes 6b on its rear end side, which are aligned with the through holes 3a of the lower wavy plate 3. Also, the through holes 3a and 6b are disposed along an outer circumference of the heel region H of the shoe.

[0063] On the bottom surface of the upper plate 2, there are provided plural (here, six) female screws 2a as fas-

tening elements which the screws 10 are screwed into and which are located at positions corresponding to positions of through holes 3a of the lower wavy plate 3. As shown in FIG. 3A, a nut 11 with a female screw 2a is embedded into the upper plate 2. The nut 11 is fitted into the upper plate 2 through, for example, an insert forming. A rivet in lieu of a nut may be fixed to the upper plate 2. Alternatively, without using a nut, the female screw 2a may be formed directly in the upper plate 2.

[0064] The female screws 2a at the longitudinally central portion of the upper plate 2 are provided in bulges 20 formed on the upper plate 2. The bulges 20 are located at a position corresponding to a position of the upwardly convexly curved portion 32 of the lower wavy plate 3. Also, the female screw 2a at the heel rear end of the upper plate 2 is provided in a bulge 21 formed on the upper plate 2. The bulge 21 is located at a position corresponding to a position of the upwardly convex portion 34 of the lower wavy plate 3. The bulges 20, 21 have contact surfaces 20a, 21a formed thereon, respectively, that the bottom surface of the upper plate 2 contacts.

[0065] The lower wavy plate 3 is coupled to the upper plate 2 through the screws 10 with the upwardly convex portions (or the upwardly convexly curved portions) 33, 34 at the front and rear end of the lower wavy plate 3 and the upwardly convexly curved portion 32 at the longitudinally central portion contacted with the bottom surface of the upper plate 2 and the bulges 20, 21.

[0066] In the above-mentioned sole assembly 1, the lower wavy plate 3 is fitted to the upper plate 2 by screwing the screws 10 without using a mount such as a fixing support, thereby simplifying the structure of the sole assembly, reducing the manufacturing cost, and maintaining cushioning properties. At the time of exchanging the sole, a user or a shoe wearer has only to exchange only the lower wavy plate 3 by loosening and removing the screws 10 without exchanging both the upper plate 2 and the lower wavy plate 3, thus further reducing the manufacturing cost and easing a burden of the user. In the event that the lower wavy plate 3 has outsole designs formed directly thereon in lieu of the outsoles 5, 6 provided on the bottom surface of the lower wavy plate 3, the number of parts of the sole structure is reduced and thus assembly of the sole structure is further facilitated.

[0067] Also, at the time of exchanging the sole, the user has only to insert the male screws 10b of the screws 10 from below the lower wavy plate 3 (i.e. from the outsole side) without pulling off an insole or the like inside the shoe and then fitting a screw, thereby facilitating exchange of the sole. Also, in this case, since the head 10a of the screw 10 is not disposed inside the shoe, foot contact feeling of the shoe wearer is not damaged.

[0068] Moreover, in this embodiment, a firm combination is achieved through a small screw with a small cross sectional area compared with a combination of the upper plate 2 with the lower wavy plate 3 using a pillar shaped elastic block member as described in Japanese patent No. 4020953. As a result, a smooth deformation of the

sole structure is achieved and cushioning properties are improved without adversely affecting deformation of the wavy shapes of the upper plate and the lower wavy plate. Also, in this case, since load is directly dispersed at a contact surface between the upper plate 2 and the lower wavy plate 3, stability of the sole structure can be improved compared with the case using elastic deformation of the pillar shaped elastic member.

[0069] Further, when forming the upper plate 2 and a lower wavy plate 3, a simplified two-piece mold structure can be employed, thus reducing a manufacturing cost. Additionally, not only in the event that either the upper plate or the lower wavy plate extends along the entire length of the shoe but also in the event that either the upper plate or the lower wavy plate does not extend along the entire length of the shoe (for example, they are divided between the front end side and the rear end side of the shoe and separated via a longitudinal gap, or they are partially overlapped with each other in the longitudinal direction), these upper and lower wavy plates can be utilized for shoes of different sizes.

[0070] Furthermore, in this embodiment, for an exchangeable lower wavy plate, by varying amplitude of the wavy shape of the lower wavy plate 3, and employing material of different cushioning properties, the coefficient of resilience or shock absorbance as a lower wavy plate, the user do not need to prepare different kinds of shoes and a burden of the user is further relieved.

[0071] Also, in this embodiment, the lower wavy plate 3 is fitted to the upper plate 2 through the bulges 20, 21 disposed around the outer circumference on the bottom surface of the upper plate 2, and lateral ridge lines of the upwardly convexly curved portion and the upwardly convex portions of the wavy shape of the lower wavy plate 3 contact the upper plate 2 only on the medial and lateral side and do not contact and spaced apart from the upper plate 2 at the heel central portion. Therefore, a shock load imparted to the lower wavy plate 3 on striking onto the ground is transmitted to the heel outer circumferential portion of the upper plate 2 via the bulges 20, 21, not to the heel central portion of the upper plate 2. In such a manner, an upward thrust to the heel central portion of the shoe wearer's foot is restrained at the time of a heel impact onto the ground.

[0072] In addition, as this first embodiment, when the lower wavy plate 3 is provided at the heel region of the shoe, a worn-out heel portion of a shoe during usage can be exchanged easily and inexpensively.

[0073] Also, in such a shoe having the sole assembly 1, when an impact load is imparted to the lower wavy plate 3 from the ground at the time of impacting onto the ground, the wavy shape of the lower wavy plate 3 deforms into a flatter or more planar shape and at this juncture the voids C function as cushion holes. Thereby, the impact load is absorbed and relieved and cushioning properties are secured.

<Second Embodiment>

[0074] The first embodiment showed that the upper plate 2 extends from the heel region H through the mid-foot region M to the forefoot region F of the shoe, but application of the present invention is not limited to such an example. The upper plate 2 may be provided only on the heel portion of the shoe as shown in FIG. 4, or only on the forefoot portion of the shoe as shown in FIG. 5. In these drawings, like reference numerals indicate identical or functionally similar elements.

[0075] In FIG. 4, the upper plate 2 has a bulge 22 having a female screw and formed on the bottom surface of the upper plate 2 at a heel front end. A lower wavy plate 3₁ has an upwardly convex portion at the heel front end, which is contacted with and coupled to the bulge 22 through a screw 10 that is screwed into the female screw.

[0076] In FIG. 5, the upper plate 2 has plural bulges 23 formed around an outer circumference of the forefoot portion of the upper plate 2. Each of these bulges 23 has a female screw that the screw 10 is screwed into. A lower wavy plate 3₂ disposed under the upper plate 2 has a wavy shape that progresses in the longitudinal direction at a forefoot portion of the lower wavy plate 3₂. The wavy shape of the lower wavy plate 3₂ has plural downwardly convexly curved portions 35 that protrudes downwardly convexly, plural upwardly convexly curved portions 36 that are disposed between the adjacent downwardly convexly curved portions 35, and upwardly convex portions (or upwardly convexly curved portions) 37, 38 that are formed at a front and rear end of the lower wavy plate 3₂.

[0077] Also, in FIGS. 4 and 5, the bulges 20-23, which the upwardly convexly curved portions 32, 36 and the upwardly convex portions 33, 34, 37, 38 of the lower wavy plate 3 contact, are arranged on the bottom surface of the upper plate 2 in the longitudinal direction. Therefore, when an impact load from the ground is imparted to the upper plate 2 through the lower wavy plate 3, the impact load can be dispersed at each of the bulges 20-23, thus relieving an upward thrust from the upper plate 2 to a shoe wearer's foot.

<Third Embodiment>

[0078] The first and second embodiment showed that the lower wavy plate 3 is disposed either at the heel portion or at the forefoot portion of the shoe. As shown in FIG. 6, the lower wavy plate 3 may be disposed at both the heel portion and the forefoot portion. Alternatively, as shown in FIG. 7, the lower wavy plate 3 may extend from the heel region H through the mid-foot region M to the forefoot region F. In these drawings, like reference numerals indicate identical or functionally similar elements.

[0079] In FIG. 6, the upper plate 2 extends from the heel portion through the mid-foot portion to the forefoot portion. At the heel portion of the shoe, a lower wavy plate 3₁ similar to one in FIG. 4 is disposed under the

upper plate 2, and at the forefoot portion of the shoe, a lower wavy plate 3₂ similar to one in FIG. 5 is disposed under the upper plate 2.

[0080] In this case, by changing hardness between the lower wavy plates 3₁ and 3₂, for example, making hardness of the lower wavy plate 3₁ greater than that of the lower wavy plate 3₂, the heel portion of the shoe becomes harder and stability of the heel portion is improved and at the same time the forefoot portion becomes softer and bendability of the forefoot portion is advanced.

[0081] In FIG. 7, the wavy lower plate 3 has a downwardly convexly curved portion 39 disposed at the mid-foot portion of the shoe. The lower wavy plate 3 disposed at the heel portion of the shoe is coupled to the lower wavy plate 3 disposed at the forefoot portion of the shoe through the downwardly convexly curved portion 39.

[0082] As shown in FIGS. 7A and 7B, on a top surface of the lower wavy plate 3, there are provided plural contact portions 32-34 and 36-38 around an outer circumference of the lower wavy plate 3. These contact portions are disposed at positions corresponding to positions of the upwardly convex portions at the front and rear end and the upwardly convexly curved portions of the wavy shape of the lower wavy plate 3. The contact portions have generally planar contact surfaces, respectively, which come into contact with the bulges 20-23 formed on the bottom surface of the upper plate 2. Also, the contact portions 32-34 and 36-38 have through holes 3a formed therein, respectively, which the male screws of the screws 10 are inserted into.

<Fourth Embodiment>

[0083] The first to third embodiment showed that the upper plate 2 extends from the heel portion through the mid-foot portion to the forefoot portion, or is disposed either at the heel portion or at the forefoot portion. As shown in FIG. 8, the upper plate 2 may be disposed at both the heel portion and the forefoot portion and separated between the heel portion and the forefoot portion. In the drawing, like reference numerals indicate identical or functionally similar elements.

[0084] In FIG. 8, the upper plate 2 has an upper plate 2₁ disposed at the heel portion and an upper plate 2₂ disposed at the forefoot portion. At the mid-foot portion, the midsole 8 has a protrusion 80 that protrudes downwardly, which is located at a gap between the upper plates 2₁ and 2₂.

[0085] In this case, by changing hardness between the upper plates 2₁ and 2₂, for example, making hardness of the upper plate 2₁ greater than that of the upper plate 2₂, the heel portion of the shoe becomes harder and stability of the heel portion is improved and at the same time the forefoot portion becomes softer and bendability of the forefoot portion is advanced.

<Fifth Embodiment>

[0086] The first embodiment showed that at the forefoot portion, the laterally central portion of the upper plate 2 is planar in shape and the medial and lateral portions of the upper plate 2 have wavy shapes that progress in the longitudinal direction. The upper plate 2 may have a wavy shape that progresses in the longitudinal direction along the entire width (thus, the entire regions) of the upper plate 2.

[0087] FIGS. 9 and 10 illustrate schematic views of the sole assembly having such an upper plate 2. In the drawing, like reference numerals indicate identical or functionally similar elements. Under the upper plate 2, the lower wavy plate 3 is disposed.

[0088] In FIG. 9, phase of a wavy shape of the upper plate 2 is inverted relative to phase of a wavy shape of the lower wavy plate 3. An upwardly convexly curved portion 2B of the wavy shape of the upper plate 2 is disposed opposite a downwardly convexly curved portion 3A of the wavy shape of the lower wavy plate 3. Also, each of downwardly convexly curved portions 2A disposed between longitudinally adjacent upwardly convexly curved portions 2B of the upper plate 2 and each of upwardly convexly curved portions 3B disposed between longitudinally adjacent downwardly convexly curved portions 3A of the lower wavy plate 3 are coupled to each other through the screws 10.

[0089] In FIG. 10, a wavy shape of the upper plate 2 is in phase with a wavy shape of the lower wavy plate 3. A downwardly convexly curved portion 2A of the wavy shape of the upper plate 2 is disposed opposite a downwardly convexly curved portion 3A of the wavy shape of the lower wavy plate 3. Also, each of upwardly convexly curved portions 2B disposed between longitudinally adjacent downwardly convexly curved portions 2A of the upper plate 2 and each of upwardly convexly curved portions 3B disposed between longitudinally adjacent downwardly convexly curved portions 3A of the lower wavy plate 3 are coupled to each other through the screws 10.

[0090] In the case of FIG. 9, there is formed a large void C of a lenticular shape between the upwardly convexly curved portion 2B of the upper plate 2 and the downwardly convexly curved portion 3A of the lower wavy plate 3. Therefore, when an impact load is imparted at the time of striking onto the ground, both the upper plate 2 and the lower wavy plate 3 deform compressively, thereby improving cushioning properties of the shoe. Also, in this case, an upward thrust from the lower wavy plate 3 at the time of striking onto the ground is imparted to the downwardly convexly curved portions 2A between the adjacent upwardly convexly curved portions 2B of the upper plate 1, and thus the upward thrust can be dispersed and relieved. Such a sole assembly is suitable especially for a heel region of the shoe.

[0091] In the case of FIG. 10, though a gap C' formed between the downwardly convexly curved portion 2A of the upper plate 2 and the downwardly convexly curved

portion 3A of the lower wavy plate 3 is small, each of the upwardly convexly curved portions 2B, 3B as well as each of the downwardly convexly curved portions 2A, 3A of the upper and lower wavy plate 2, 3 is located at the same longitudinal position. Therefore, as the load moves forward after a heel strike onto the ground, bendability of the shoe can be improved. Such a sole assembly is suitable especially for a forefoot region of the shoe.

[0092] To the contrary, in the event that the upper plate 2 is planar in shape, as shown in FIG. 11, each of the upwardly convexly curved portions 3B of the lower wavy plate 3 is coupled to the bottom surface 2C of the upper plate 2 through the screws 10. In this case, a gap C_0 formed between the upper plate 2 and the lower wavy plate 3 is smaller than the gap C of FIG. 9 and larger than the gap C' of FIG. 10. Therefore, in this sole assembly, cushioning properties at the time of impacting onto the ground are superior to the sole assembly of FIG. 10 and inferior to the sole assembly of FIG. 9. Also, bendability after impacting onto the ground is superior to the sole assembly of FIG. 9 and inferior to the sole assembly of FIG. 10.

<Sixth Embodiment>

[0093] The fifth embodiment showed that both the upper plate 2 and the lower wavy plate 3 have wavy shapes progressing in the longitudinal direction. Application of the present invention is not limited to such an example. FIGS. 12 and 13 show a sixth embodiment of the present invention. In the drawings, like reference numerals indicate identical or functionally similar elements.

[0094] As shown in FIG. 12, the upper plate 2 has a wavy shape that progresses in the lateral direction, which is formed of the downwardly convexly curved portions 2A and the upwardly convexly curved portions 2B that are disposed alternately. The lower wavy plate 3 has a wavy shape that progresses in the longitudinal direction, which is formed of the downwardly convexly curved portions 3A and the upwardly convexly curved portions 3B that are disposed alternately.

[0095] As shown in FIG. 13, ridge lines L of the downwardly convexly curved portions 2A of the upper plate 2 are in contact with the upwardly convexly curved portions 3B of the lower wavy plate 3 intermittently. These contact areas of the ridge lines L with the upwardly convexly curved portions 3B are partially coupled to each other through the screws 10. Similarly, ridge lines L' of the upwardly convexly curved portions 3B of the lower wavy plate 3 are in contact with the downwardly convexly curved portions 2A of the upper plate 2 intermittently.

[0096] In this case, the ridge lines L, L' of the wavy shapes of the upper plate 2 and the lower wavy plate 3 intersect each other between the upper plate 2 and the lower wavy plate 3, thereby restricting bending of the sole assembly for the shoe. Such a sole structure is suitable especially for a mid-foot region of the shoe that requires a shank effect as the mid-foot region.

<Seventh Embodiment>

[0097] As shown in FIGS. 14 to 16, the upper plate 2 may have a composite wavy shape that progresses in the longitudinal direction as well as in the lateral direction. In the drawings, like reference numerals indicate identical or functionally similar elements.

[0098] A sole assembly 1 shown in FIG. 14 differs from the sole assembly 1 of FIG. 7 in that the upper plate 2 in FIG. 14 has a composite wavy shape. As shown in FIGS. 14 and 15, the upper plate 2 has a wavy shape along the entire width, which progresses in the longitudinal direction from the heel portion through the mid-foot portion to the forefoot portion of the shoe. Also, as shown in FIG. 16, the upper plate 2 has a wavy shape that progresses in the lateral direction of the shoe. Therefore, in this case, the wavy shape formed in the upper plate 2 progresses not only in the longitudinal direction but also in the lateral direction.

[0099] As shown in FIGS. 15 and 15A, on a bottom surface of the upper plate 2, there are provided bulges 20-23 around an outer circumference of the upper plate 2. These bulges 20-23 are disposed at positions corresponding to positions of the upwardly convex portions of the wavy shape of the forefoot portion, and the downwardly convexly curved portions of the wavy shape of the rear-foot portion of the upper plate 2. The bulges 20-23 have generally planar contact surfaces, respectively, which come into contact with the contact portions 32-34 and 36-38 formed on the top surface of the lower wavy plate 3. Also, the bulges 20-23 have female screws 2a formed therein, respectively, which the male screws of the screws 10 are screwed into.

[0100] As shown in FIG. 14, for a wavy shape of the upper plate 2 that progresses in the longitudinal direction, the wavy shape at the heel portion is inverted relative to the wavy shape of the lower wavy plate 3, and the wavy shape at the forefoot region is in phase with the wavy shape of the lower wavy plate 3.

[0101] In this case, at the heel portion, though a large gap is formed between the upper plate 2 and the lower wavy plate 3, the wavy shape of the upper plate 2 has a composite wavy shape that progresses in the longitudinal direction as well as in the lateral direction. Therefore, the amount of compressive deformation of the upper plate 2 is restrained. As a result, at the time of striking onto the ground, cushioning properties of the heel portion becomes low compared with the case in which the wavy shape of the upper plate 2 progresses only in the longitudinal direction (see FIG. 9), but the stability is improved.

[0102] Also, at the forefoot portion, though the upper plate 2 and the lower wavy plate 3 have wavy shapes in phase with each other, the wavy shape of the upper plate 2 has a composite wavy shape that progresses in the longitudinal direction as well as in the lateral direction. Therefore, bendability of the upper plate 2 is restrained. As a result, at the time of bending and toe-off of the fore-

foot portion of the shoe, bendability of the forefoot portion is decreased compared with the case in which the wavy shape of the upper plate 2 progresses only in the longitudinal direction (see FIG. 10), but the rigidity of the forefoot portion is increased, thus improving so called "a snappy effect" during the push off motion of the foot.

[0103] The composite wavy shape of the upper plate 2 may be partially provided on the upper plate. Also, for the wavy shape of the upper plate 2, the wavy shape progressing in the longitudinal direction and the wavy shape progressing in the lateral direction may be provided separately on the upper plate 2.

[0104] In this case, at a region with the wavy shape of the upper plate 2 progressing in the longitudinal direction, if phase of the wavy shape of the upper plate 2 is inverted relative to phase of the wavy shape of the lower wavy plate 3 cushioning properties of the shoe can be improved, whereas if the wavy shape of the upper plate 2 is in phase with the wavy shape of the lower wavy plate 3 bendability of the shoe can be enhanced. Also, at a region with the wavy shape progressing in the lateral direction, bendability of the shoe can be restricted.

[0105] In FIG. 15, the bulges 20-23 may be elongated along the length of the shoe and in this case the contact portions 32-34 and 36-38 (see FIG. 7A) of the lower wavy plate 3 that correspond to the bulges 20-23 may be elongated along the width of the shoe.

[0106] The bulges 20-23 and the contact portions 32-34 and 36-38 are in contact with each other and corresponding contact areas of the bulges 20-23 and the contact portions 32-34 and 36-38 are coupled to each other through the screws 10. In this case, since the bulges 20-23 and the contact portions 32-34 and 36-38 extend in the direction that intersect each other, even in the case that some of the contact areas of the bulges 20-23 with the contact portions 32-34 and 36-38 are not coupled to each other through the screws 10, either one of the bulges or contact portions can be prevented from being slipped off from the other of the bulges or contact portions during use of the shoe. Also, in this case, since the bulges 20-23 of the upper plate 2 restricts deformation of the upper plate 2 in the longitudinal direction, and the contact portions 32-34 and 36-38 of the lower wavy plate 3 restricts deformation of the lower wavy plate 3 in the lateral direction, thus improving stability of the sole assembly.

<Eighth Embodiment>

[0107] The first to fifth embodiments and the seventh embodiment showed that all the ridge lines of the upwardly convex portions and the upwardly convexly curved portions of the lower wavy plate are fixedly attached to the upper plate 2 (see FIGS. 9-11), but application of the present invention is not limited to such an example.

[0108] FIGS. 17-19 show an eighth embodiment of the present invention. In the drawings, like reference numerals indicate identical or functionally similar elements.

[0109] FIG. 17 illustrates an example in which the upper plate 2 is planar in shape, FIG. 18 illustrates an example in which the wavy shape of the upper plate 2 is inverted relative to the wavy shape of the lower wavy plate 3, and FIG. 19 illustrates an example in which the wavy shape of the upper plate 2 is in phase with the wavy shape of the lower wavy plate 3.

[0110] As shown in FIGS. 17-19, as for the upwardly convexly curved portions 3B of the lower wavy plate 3, some are fixedly attached to the bottom surface 2C of the upper plate 2, the downwardly convexly curved portions 2A or the upwardly convexly curved portions 2B of the lower wavy plate 3 through the screws 10, but others of the upwardly convexly curved portions 3B are simply in contact with and not fixedly attached to the bottom surface 2C of the upper plate 2, the downwardly convexly curved portions 2A or the upwardly convexly curved portions 2B of the lower wavy plate 3 through the screws 10.

[0111] In this case, when an impact load is imparted to the sole assembly, the upwardly convexly curved portions 3B of the lower wavy plate 3 that are not fixedly attached to the upper plate 2 slide along the bottom surface 2C of the upper plate 2, the downwardly convexly curved portions 2A or the upwardly convexly curved portions 2B of the lower wavy plate 3. Thereby, a large deformation of the lower wavy plate 3 in the longitudinal direction and upward and downward direction is facilitated, thus enhancing cushioning properties. In this case, a shoe suitable for a lightweight user can be achieved.

[0112] In contrast, as shown in FIGS. 9-11, in the event that all the upwardly convexly curved portions 3B of the lower wavy plate 3 are fixedly attached to the upper plate 2 through the screws 10, compressive hardness at the time of load action becomes high. In this case, a shoe suitable for a heavyweight user can be achieved.

<Ninth Embodiment>

[0113] The eighth embodiment showed that some of the upwardly convexly curved portions 3B of the lower wavy plate 3 are not coupled to the upper plate 2 through the screws 10 and these upwardly convexly curved portions 3B slide along the bottom surface of the upper plate 2, but application of the present invention is not limited to such an example.

[0114] FIG. 20 shows a ninth embodiment of the present invention. In the drawing, like reference numerals indicate identical or functionally similar elements.

[0115] As shown in FIG. 20, the lower wavy plate 3 has an elongated through hole 3e formed therein, which extends in the longitudinal direction (or to the left to right direction in FIG. 20). The head 10a of the screw 10 contacts an opening edge portion of the through hole 3e. The male screw 10b of the screw 10 is inserted into the through hole 3e of the lower wavy plate 3 and screwed into the female screw 2a of a nut member 11 embedded in the upper plate 2. Between the male screw 10b of the screw 10 and the through hole 3e is formed a longitudinal

gap.

[0116] In this case, the upper plate 2 and the lower wavy plate 3 are coupled to each other through the screw 10 in such a way that the upper plate 2 and the lower wavy plate 3 are allowed to move relatively in the longitudinal direction. Therefore, when an impact load is imparted to the sole assembly, the upper plate 2 and/or the lower wavy plate 3 can slide in the longitudinal direction, thereby facilitating longitudinal deformation as well as upward and downward deformation of the upper plate 2 and/or the lower wavy plate 3 to improve cushioning properties

<Tenth Embodiment>

[0117] The first to ninth embodiment showed that as a fastening element to fasten the lower wavy plate 3 to the upper plate 2 the screws 10 and the female screws 2a which the screws 10 are screwed into are used, but application of the present invention is not limited to such an example.

[0118] FIG. 21 illustrates a tenth embodiment of the present invention, showing another example of the fastening element. In the drawing, like reference numerals indicate identical or functionally similar elements.

[0119] As shown in FIG. 21, this fastening element is composed of an engaging protrusion 3p of T-shaped cross section formed on the upwardly convexly curved protrusion 3B of the lower wavy plate 3 and an engaged groove 2g which is formed on the bottom surface of the upper plate 2 and which the engaging protrusion 3p is engageable with.

[0120] When fitting the lower wavy plate 3 to the upper plate 2, the engaging protrusion 3p of the lower wavy plate 3 is inserted into and engaged with the engaged groove 2g of the upper plate 2. When removing the lower wavy plate 3 from the upper plate 2, the engaging protrusion 3p of the lower wavy plate 3 is pulled out and removed from the engaged groove 2g of the upper plate 2. In this case, since screw-fastening/-loosening work is not necessary, the lower wavy plate 3 is easy to be fastened and removed.

<Eleventh Embodiment>

[0121] FIGS. 22-24 show an eleventh embodiment of the present invention. In these drawings, like reference numerals indicate identical or functionally similar elements. The sole assembly of this embodiment differs from the first embodiment in that an intermediate wavy plate 100 is interposed between the lower wavy plate 3 and the upper plate 2.

[0122] As shown in FIGS. 22 and 24, the intermediate wavy plate 100 is a thin plate formed of hard elastic member similar to the lower wavy plate 3 and has a wavy shape that progresses in the longitudinal direction. Here, the intermediate wavy plate 100 is formed of a medial wavy plate 101 having a wavy shape and disposed along

the medial side of the shoe and a lateral wavy plate 102 having a wavy shape and disposed along the lateral side of the shoe.

[0123] As is clearly seen from FIG. 23, the medial wavy plate 101 and the lateral wavy plate 102 are separated in the lateral direction (or to the upward to downward direction in FIG. 23). The medial wavy plate 101 and the lateral wavy plate 102 have through holes 101a, 102a, respectively, which the male screws 10b of the screws 10 are inserted into, and ribs 101b, 102b, respectively, which extends substantially longitudinally.

[0124] The wavy shapes of the medial wavy plate 101 and the lateral wavy plate 102 extend along the top surface of the lower wavy plate 3. The entire bottom surface of the medial and lateral wavy plates 101, 102 contacts the top surface of the lower wavy plate 3. The medial and lateral wavy plates 101, 102 are releasably coupled to the upper plate 2 along with the lower wavy plate 3 through the screws 10.

[0125] In this case, since the intermediate wavy plate 100 is interposed between the upper plate 2 and the lower wavy plate 3, by using different material for the intermediate wavy plate 100 from that for the wavy lower plate 3, or varying thickness of the intermediate wavy plate 100, cushioning properties (i.e. shock absorbing properties and resilience) of the entire sole assembly can be adjusted.

[0126] For example, in mountain-climbing, by preparing two kinds of intermediate wavy plates 100 of different rigidity for an uphill path and a downhill path to use the different intermediate wavy plates 100 selectively for an uphill and downhill, e.g. by using the intermediate wavy plate 100 of higher resilience for an uphill and of higher shock absorbency for a downhill, a burden on a foot of a shoe wearer can be relieved. Alternatively, by preparing two kinds of intermediate wavy plates 100 of different thickness of a heel region for an uphill path and a downhill path to use the different intermediate wavy plates 100 selectively for an uphill and downhill, e.g. by using the intermediate wavy plate 100 of a thicker heel region for an uphill and of a thinner heel region for a downhill, or using the intermediate wavy plate 100 selectively in accordance with a slope of a mountain, a mountain walk of the shoe wearer can thus be eased.

[0127] Moreover, in this case, when exchanging the lower wavy plate 3, a user can also exchange the intermediate wavy plate 100 at the same time. Also, the user can exchange either the lower wavy plate 3 or the intermediate wavy plate 100, independently. As a result, shoes in accordance with various tastes of users can be easily manufactured.

[0128] Furthermore, in this case, the medial wavy plate 101 and the lateral wavy plate 102 can be made of materials of different rigidities, thereby altering compressive hardness easily between the medial side and the lateral side of the shoe when impacting onto the ground. As a result, shoes corresponding to over-pronation and over-supination of a shoe wearer's foot can be easily manu-

factured.

<Twelfth Embodiment>

[0129] FIG. 25 shows a sole assembly according to a twelfth embodiment of the present invention. In the drawing, like reference numerals indicate identical or functionally similar elements. This sole assembly has a soft elastic member 9 disposed at the heel portion of the shoe and inserted into a void C formed between the upper plate 2 and the lower wavy plate 3. As soft elastic member 9, for example, synthetic rubber or synthetic resin of superior shock absorbency, and foamed rubber and resin of superior shock absorbency (i.e. low resilient foam material) are preferable. Resiliency of the soft elastic member 9 itself can be adjusted by altering the kind of rubber and resin, or changing the foaming ratio.

[0130] The soft elastic member 9 has a pair of cutouts 9n on opposite sides of the longitudinally central portion. The positions of the cutouts 9n correspond to the position of the gap 7 between the outsoles 5 and 6 of the above-mentioned first embodiment. In each of the cutouts 9n, a screw 10 is provided. There are also provided screws 10 in front of and at the rear of the soft elastic member 9.

[0131] In this case, when the upper plate 2 is placed on the soft elastic member 9 shown in FIG. 25 and the screws 10 are fastened, the soft elastic member 9 is compressed and filled up in the void C between the upper plate 2 and the lower wavy plate 3. At this juncture, since the screws 10 are provided in front of, at the rear of and on opposite sides of the soft elastic member 9, the soft elastic member will not fall off from the void C.

[0132] When the lower wavy plate 3 elastically deforms, the soft elastic member 9 in the void C also deforms elastically. Therefore, insertion of the soft elastic member 9 allows for ease of adjustment of cushioning properties. Also, insertion of the soft elastic member 9 prevents the lower wavy plate 3 from being crushed in a flattened shape when an excessive compressive load is imparted to the lower wavy plate 3. Moreover, insertion of the soft elastic member 9 prevents mud or water from entering the void C and splashes of mud or water during running can be prevented.

[0133] As shown in FIG. 25, the soft elastic member 9 has plural grooves 9g for cooling. In the event that plural protrusions engageable with the grooves 9g are formed on the upper plate 2, with the upper plate 2 fitted onto the soft elastic member 9, fall-off of the soft elastic member 9 from the void C between the upper plate 2 and the lower wavy plate 3 can be securely prevented through the engagement of the protrusions of the upper plate 2 with the grooves 9g of the soft elastic member 9.

[0134] Each of the above-noted first to fifth embodiments and seventh to twelfth embodiments showed that the upper plate 2 is linear in cross sectional shape, but the present invention is applicable to an example in which the upper plate 2 has upraised wall portions on the medial and lateral side.

[0135] In this case, when the upraised wall portions of the upper plate 2 are fixedly attached to side surfaces of the midsole or upper of the shoe, the upraised wall portions act as a stabilizer to improve running stability, enhance fittability, and restrain deformation of the upper.

Claims

1. A sole assembly (1) for a shoe comprising:
 - an upper plate (2) disposed on an upper side of the sole assembly (1) and formed of hard elastic member; and
 - a lower wavy plate (3) disposed on a lower side of the sole assembly (1), formed of hard elastic member, and having a wavy shape that progresses in a longitudinal direction of the shoe, said lower wavy plate (3) being releasably attached to said upper plate (2) via a fastening element and said lower wavy plate (3) being thus exchangeable relative to the shoe.
2. The sole assembly (1) according to claim 1, wherein said wavy shape of said lower wavy plate (3) has a plurality of upwardly convex portions (33, 34) that are disposed in the longitudinal direction, at least a portion of said plurality of upwardly convex portions (33, 34) being coupled to said upper plate (2) via said fastening element.
3. The sole assembly (1) according to claim 1, wherein said lower wavy plate (3) is provided at a heel region (H) of the shoe, said lower wavy plate (3) having at least two downwardly convexly curved portions (30, 31) that protrude downwardly convexly and that are adjacent to each other in the longitudinal direction, said lower wavy plate (3) further having an upwardly convexly curved portion (32) that is located between said downwardly convexly curved portions (30, 31), said upwardly convexly curved portion (32) and upwardly convex portions (33, 34) that are located at opposite front and rear ends of said lower wavy plate (3) being releasably attached to said upper plate (2) via said fastening element.
4. The sole assembly (1) according to claim 1, wherein said upper plate (2) has a wavy shape that progresses in the longitudinal direction of the shoe.
5. The sole assembly (1) according to claim 4, wherein said wavy shape of said upper plate (2) has an inverted phase relative to said wavy shape of said lower wavy plate (3), at least a portion of upwardly convexly curved portions (3B) of said wavy shape of said lower wavy plate (3) and downwardly convexly curved portions (2A) of said wavy shape of said upper plate (2) are fixedly attached to each other via

said fastening element.

6. The sole assembly (1) according to claim 4, wherein said wavy shape of said upper plate (2) is in phase with said wavy shape of said lower wavy plate (3), at least a portion of upwardly convexly curved portions (3B) of said wavy shape of said lower wavy plate (3) and upwardly convexly curved portions (2B) of said wavy shape of said upper plate (2) are fixedly attached to each other via said fastening element.
7. The sole assembly (1) according to claim 1, wherein at least a portion of ridge lines of said upwardly convex portions (33, 34) of said wavy shape of said lower wavy plate (3) is in contact with said upper plate (2) and the contact area is coupled to each other via said fastening element.
8. The sole assembly (1) according to claim 1, wherein said upper plate (2) has a wavy shape that progresses in a lateral direction of the shoe, at least a portion of a contact area of a downwardly convex portion (2A) of said wavy shape of said upper plate (2) with an upwardly convex portion (3B) of said wavy shape of said lower wavy plate (3) is fixedly attached to each other via said fastening element.
9. The sole assembly (1) according to claim 1, wherein said upper plate (2) has a combination of a first wavy shape that progresses in the longitudinal direction and a second wavy shape that progresses in a lateral direction of the shoe.
10. The sole assembly (1) according to claim 1, wherein said fastening element is formed of a male screw (10b) that passes through a through hole (3a) formed in said lower wavy plate (3) from below and a female screw (2a) provided in said upper plate (2) which said male screw (10b) is screwed into.
11. The sole assembly (1) according to claim 1, wherein said fastening element allows for a longitudinal relative movement of said upper plate (2) and said lower wavy plate (3).
12. The sole assembly (1) according to claim 11, wherein said fastening element is formed of a male screw (10b) that passes through a longitudinally elongated through hole (3e) formed in said lower wavy plate (3) and a female screw (2a) which is provided in said upper plate (2) and which said male screw (10b) is screwed into.
13. The sole assembly (1) according to claim 1, wherein said fastening element is composed of an engaging protrusion formed on one of said upper plate (2) and said lower wavy plate (3) and an engaged groove formed on the other of said upper plate (2) and said

lower wavy plate (3), said engaging protrusion being engageable with said engaged groove.

14. The sole assembly (1) according to claim 1, wherein a fastened region of said upper plate (2) and said lower wavy plate (3) by said fastening element is disposed on an outer circumferential side of said upper plate (2) and said lower wavy plate (3).
15. The sole assembly (1) according to claim 2, wherein a contact area of said at least a portion of said upwardly convex portions (33, 34) of said wavy shape of said lower wavy plate (3) with said upper plate (2) extends in the longitudinal direction of the shoe.
16. The sole assembly (1) according to claim 1, wherein an intermediate wavy plate (100) formed of hard elastic member is provided between said lower wavy plate (3) and said upper plate (2), said intermediate wavy plate (100) having a wavy shape that progresses in the longitudinal direction of the shoe, said wavy shape having a bottom surface that extends along a top surface of said lower wavy plate (3), said intermediate wavy plate (100) being releasably attached to said upper plate (2) along with said lower wavy plate (3) via said fastening element.
17. The sole assembly (1) according to claim 16, wherein said intermediate wavy plate (110) is composed of a medial wavy plate (101) and a lateral wavy plate (102) that are disposed on a medial side and a lateral side of the shoe, respectively, said medial wavy plate (101) and said lateral wavy plate (102) are separated from each other in the lateral direction of the shoe.
18. The sole assembly (1) according to claim 16, wherein there is formed a gap between said upper plate (2) and said lower wavy plate (3), said gap holding a soft elastic member (9).

FIG. 1

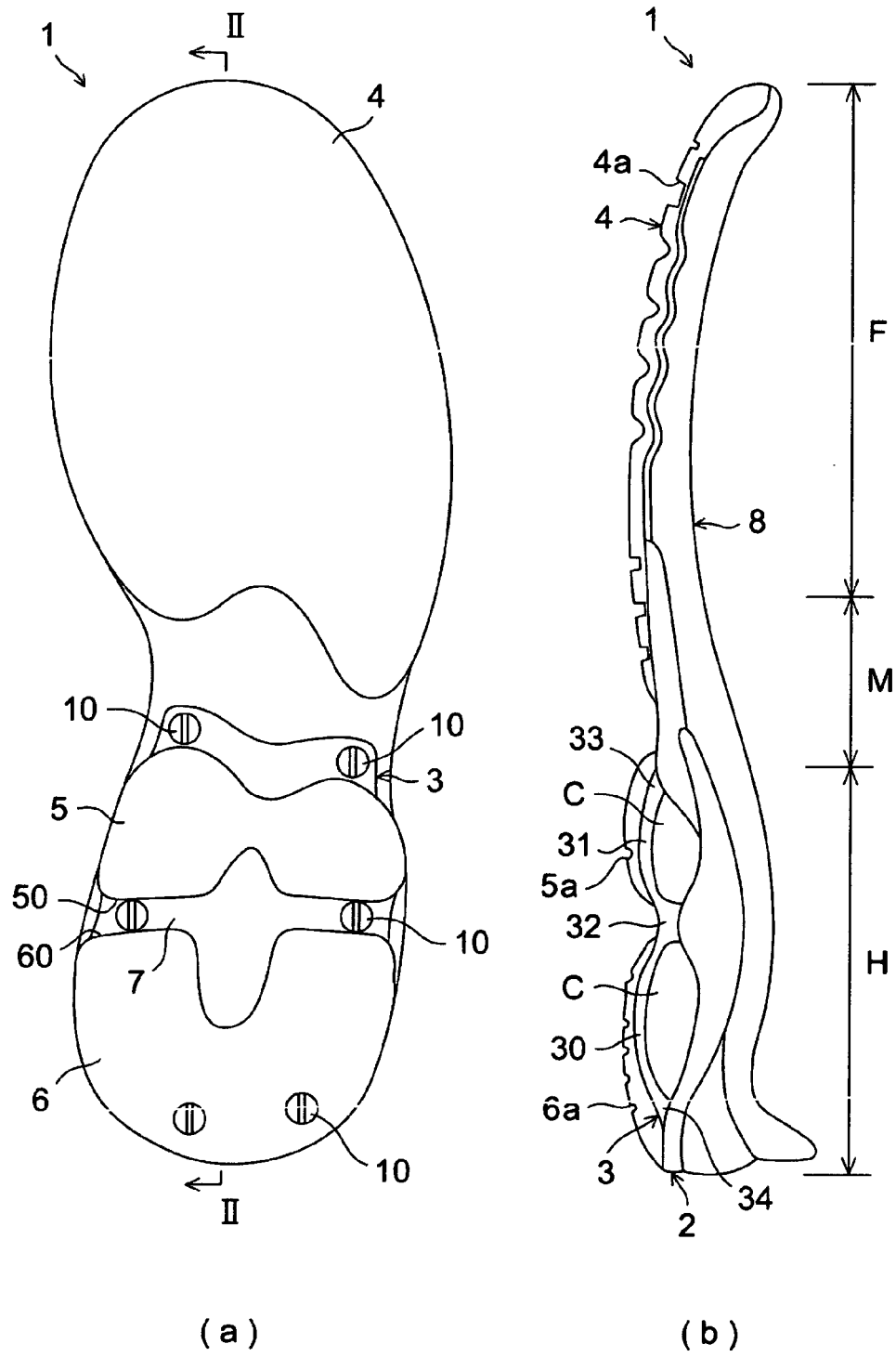


FIG. 2

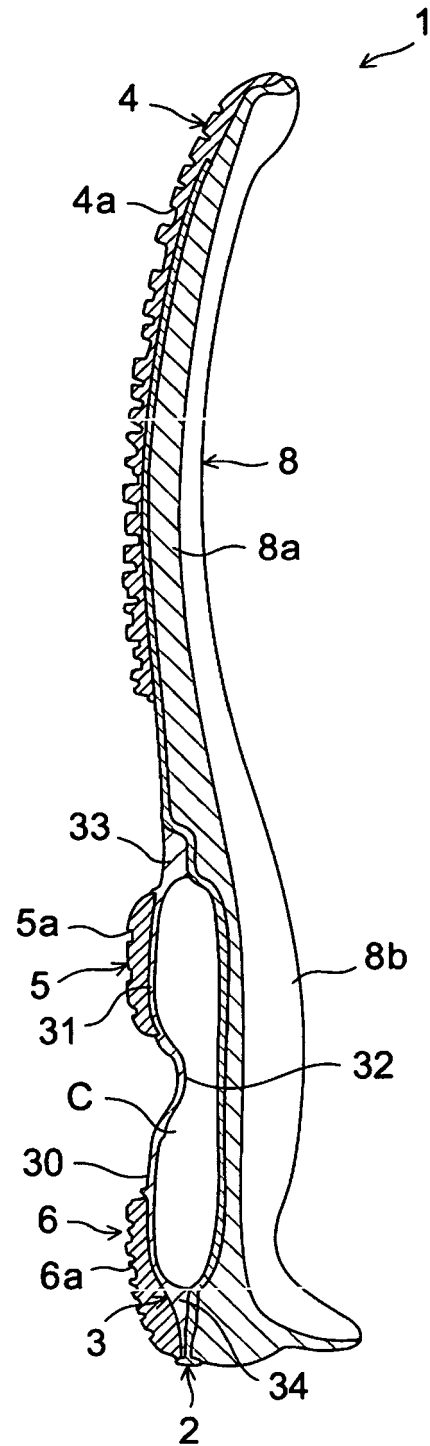


FIG. 3

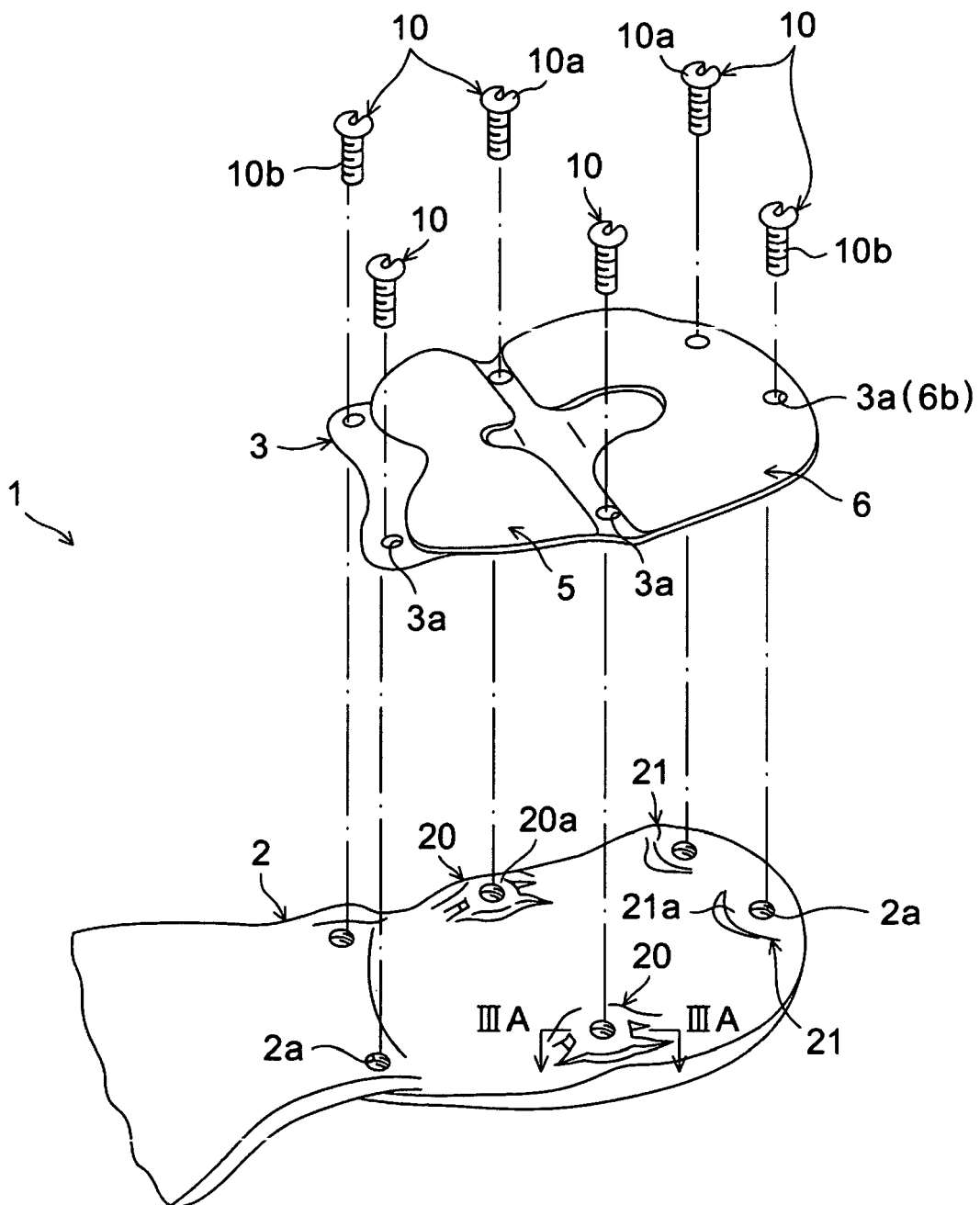


FIG. 3A

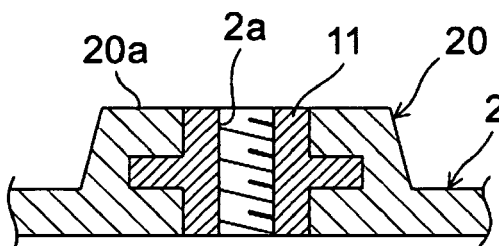


FIG. 4

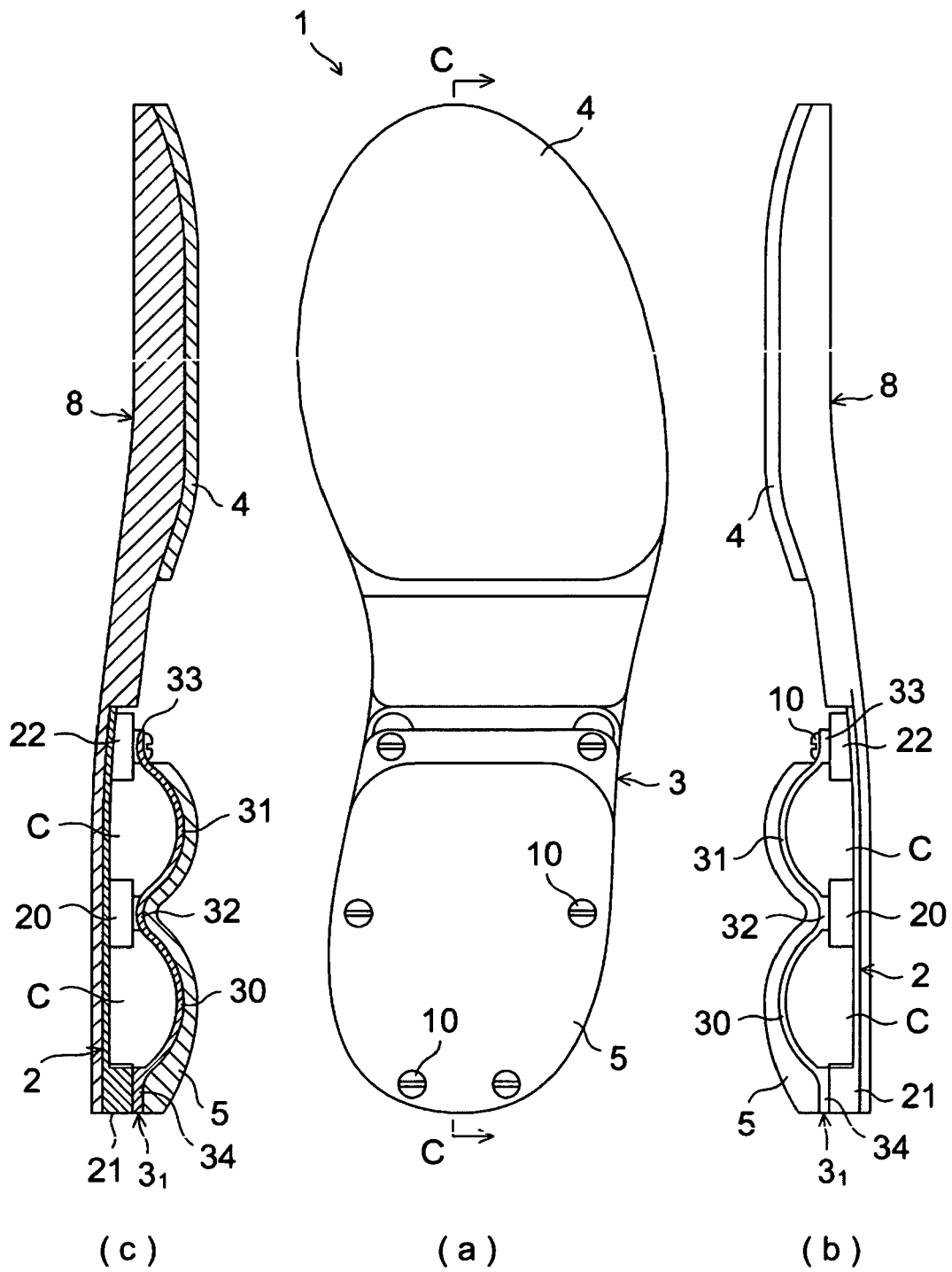


FIG. 5

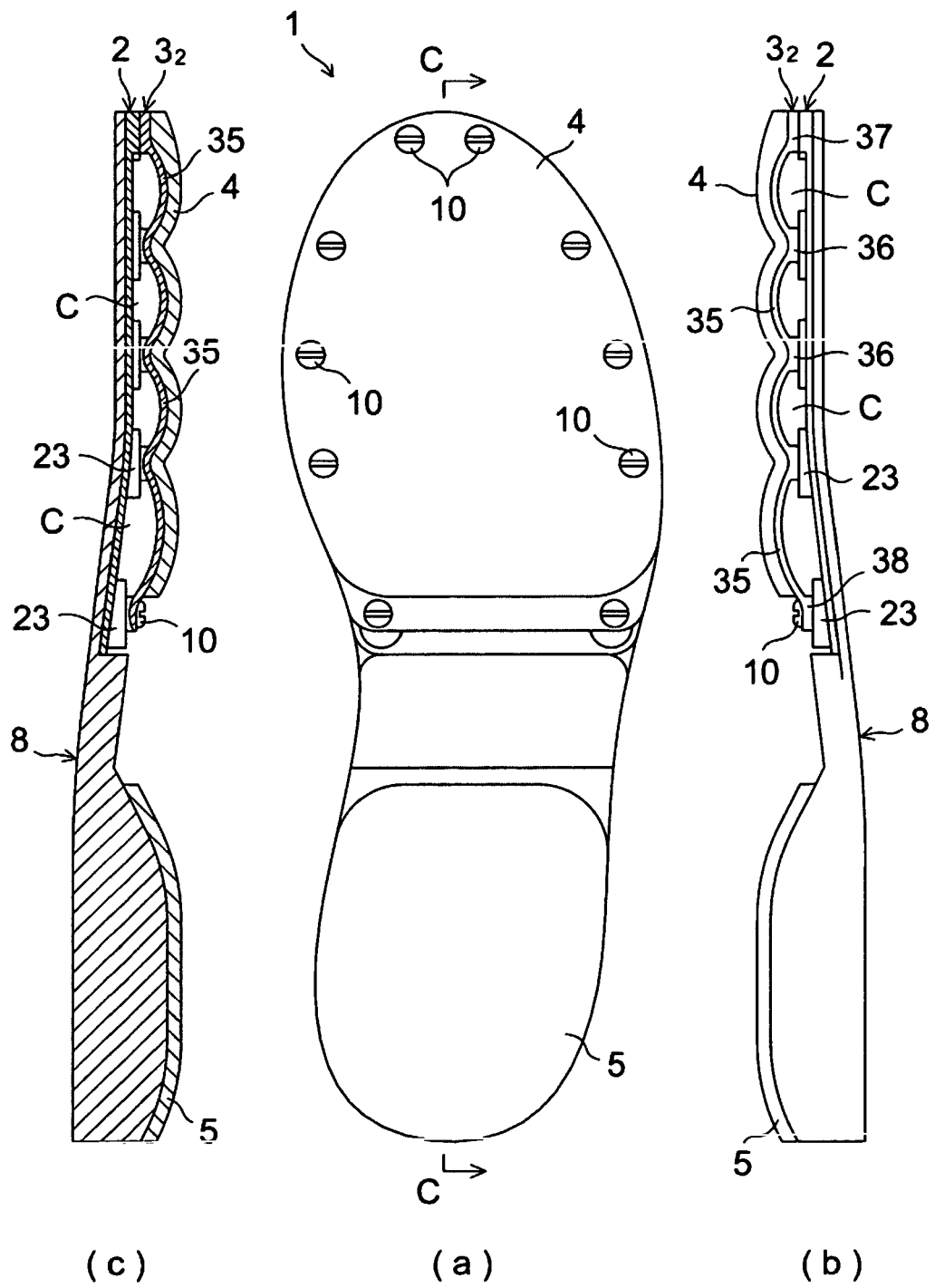


FIG. 6

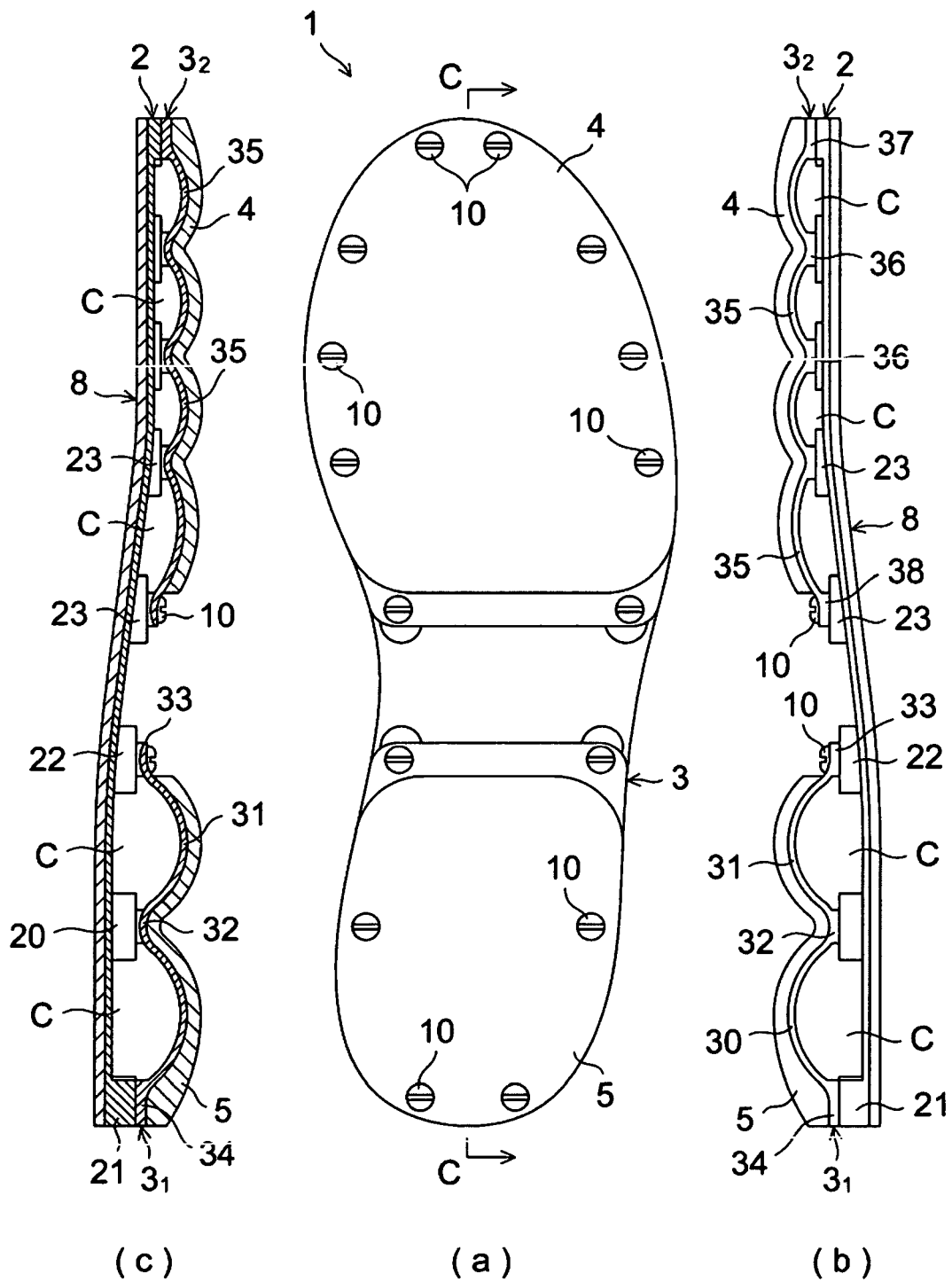


FIG. 7

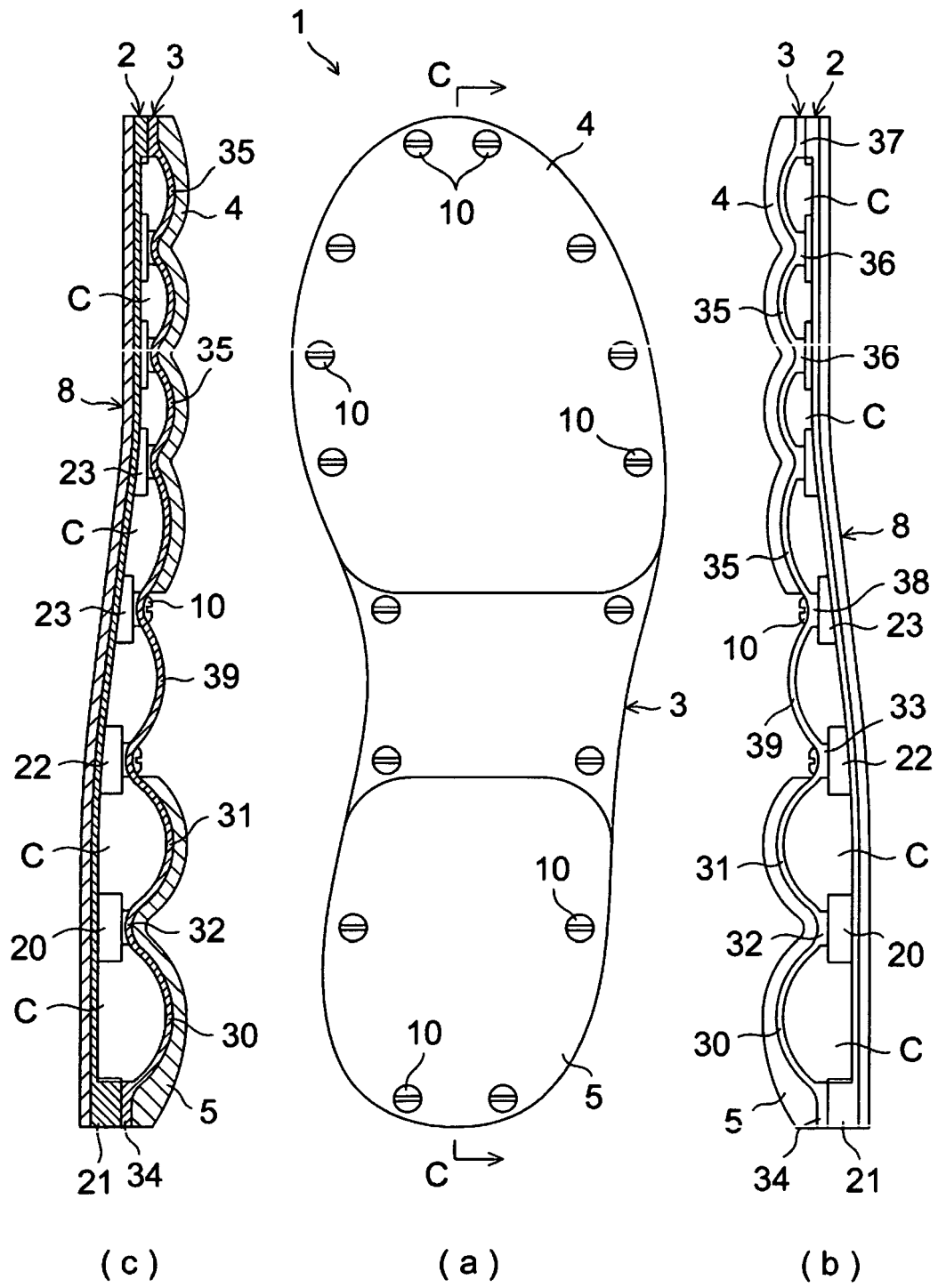


FIG. 7A

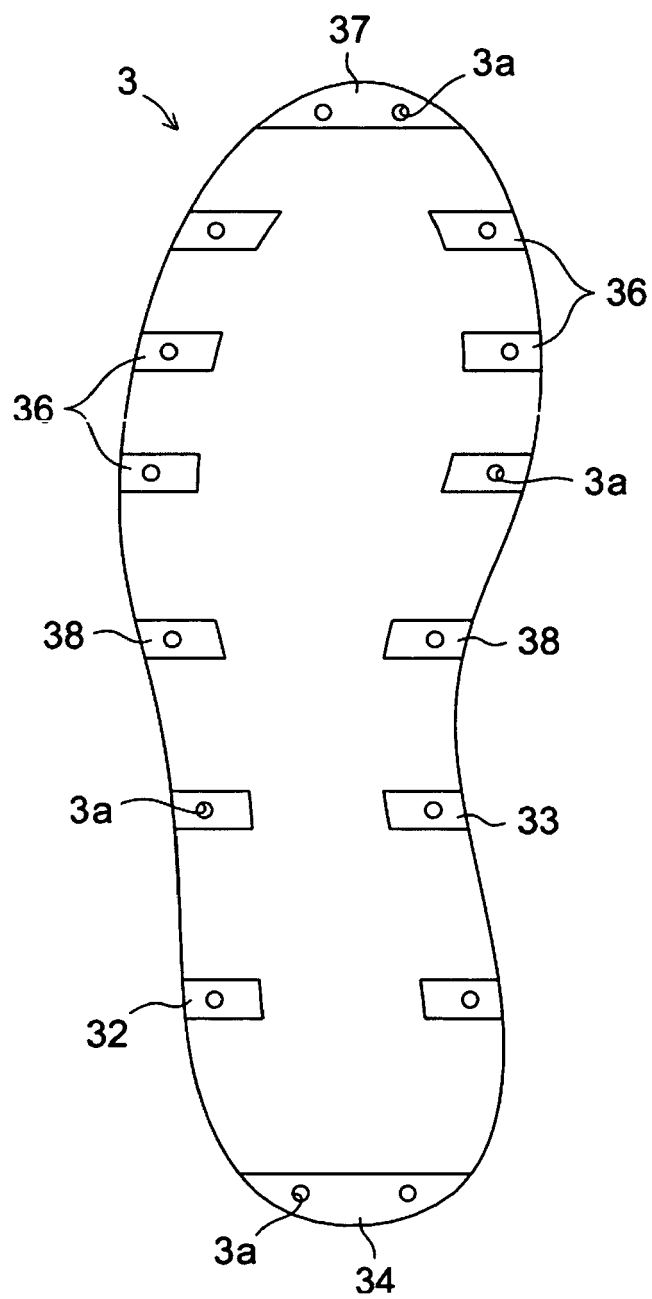


FIG. 7B

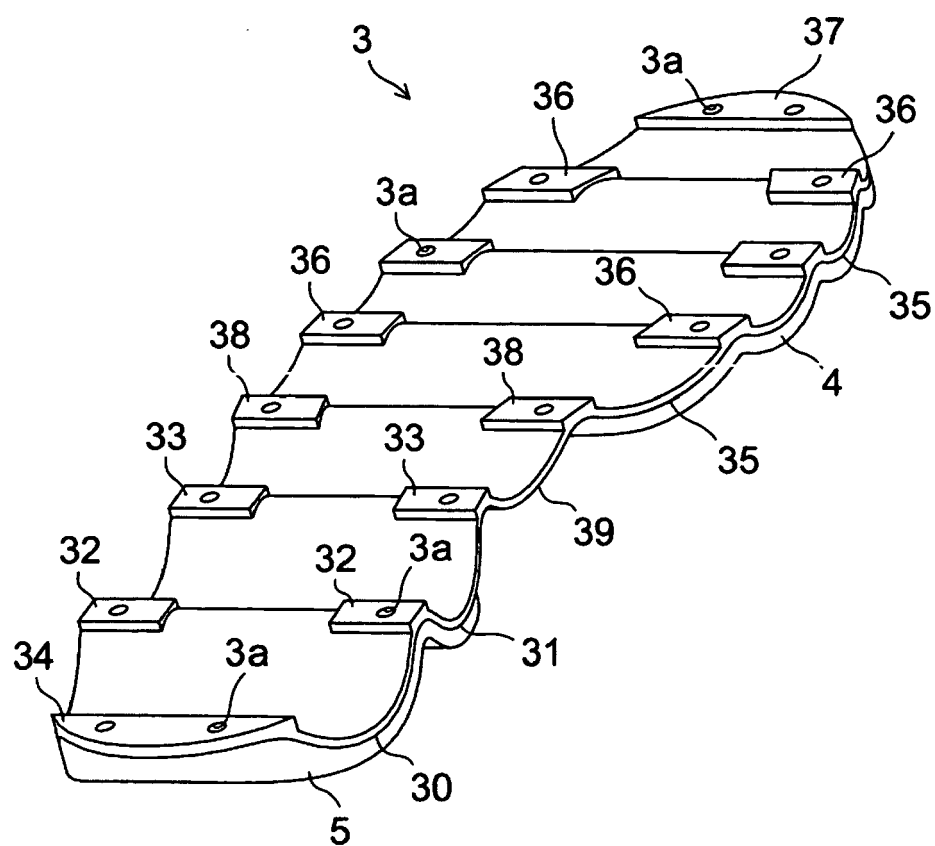


FIG. 8

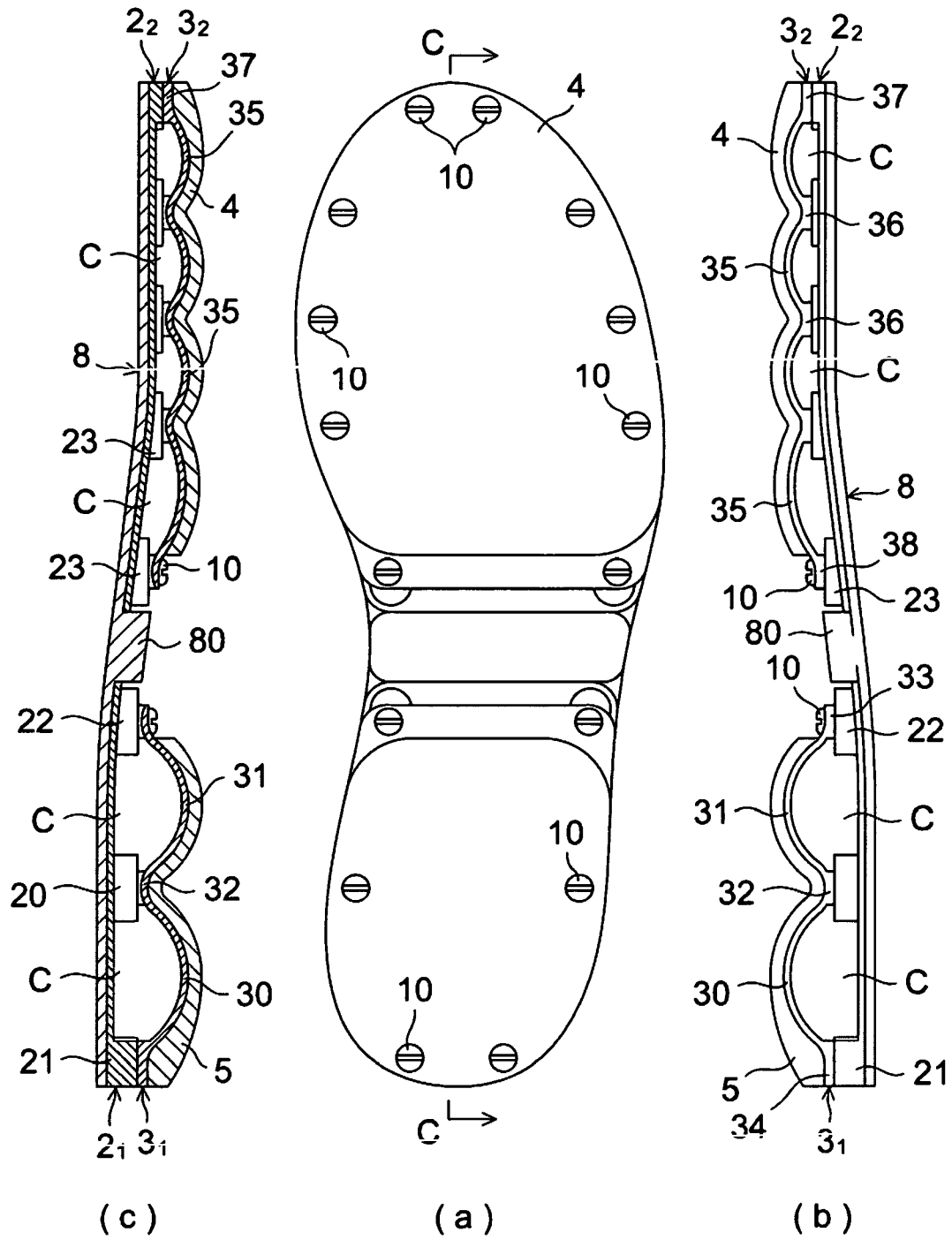


FIG. 9

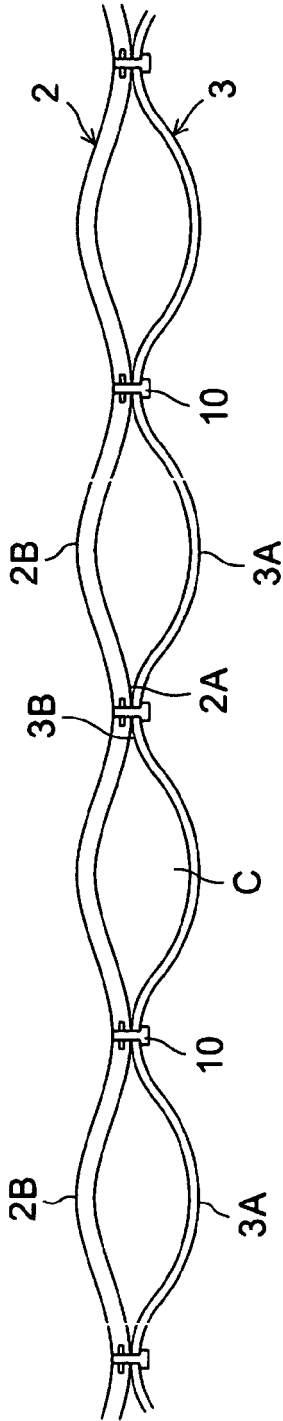


FIG. 10

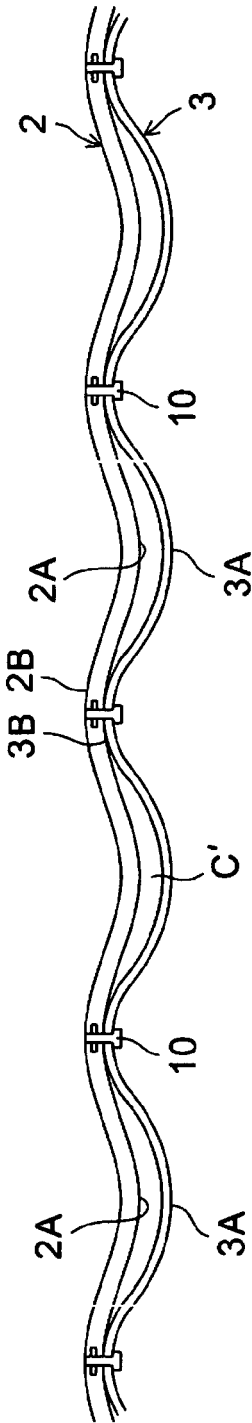


FIG. 11

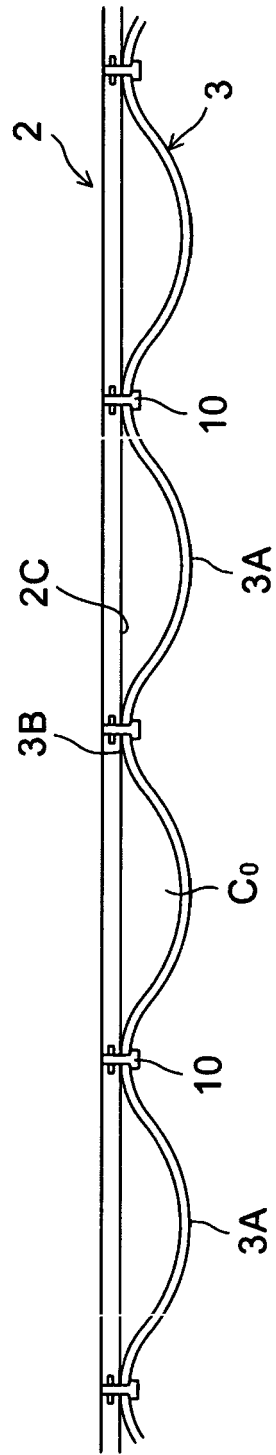


FIG. 17

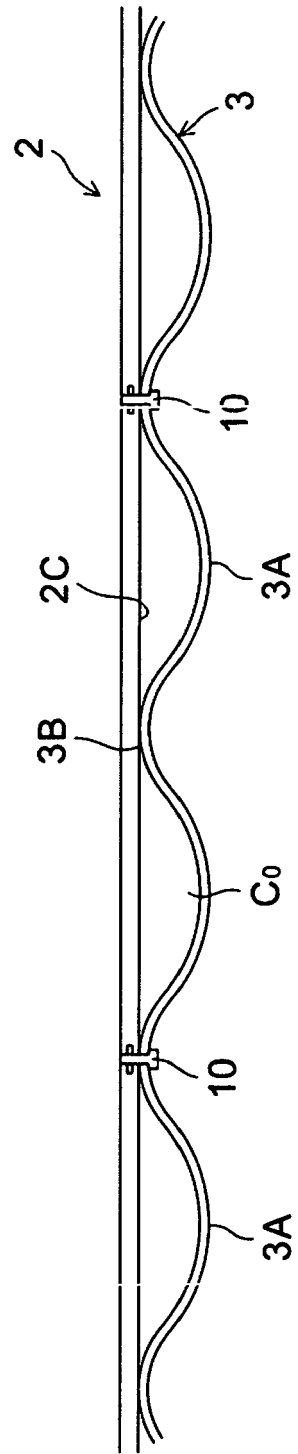


FIG. 12

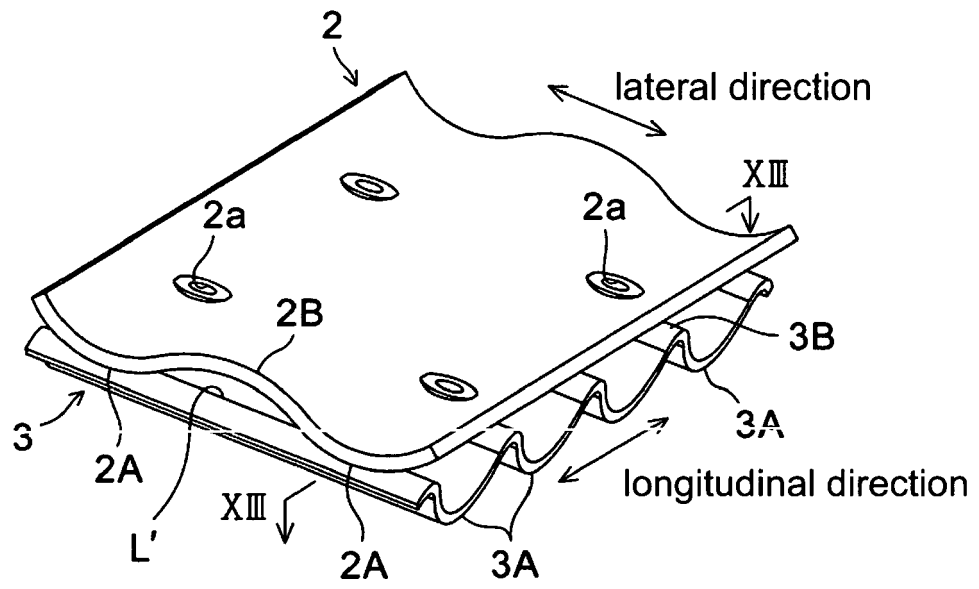


FIG. 13

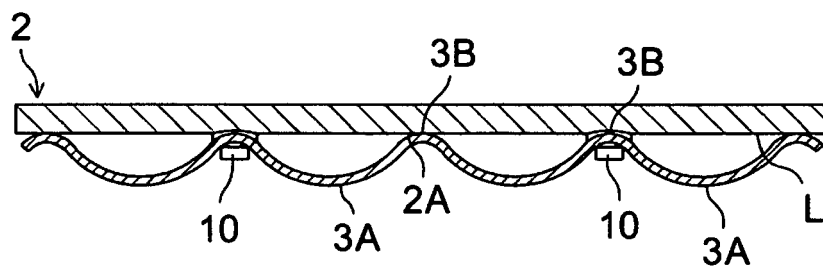


FIG. 14

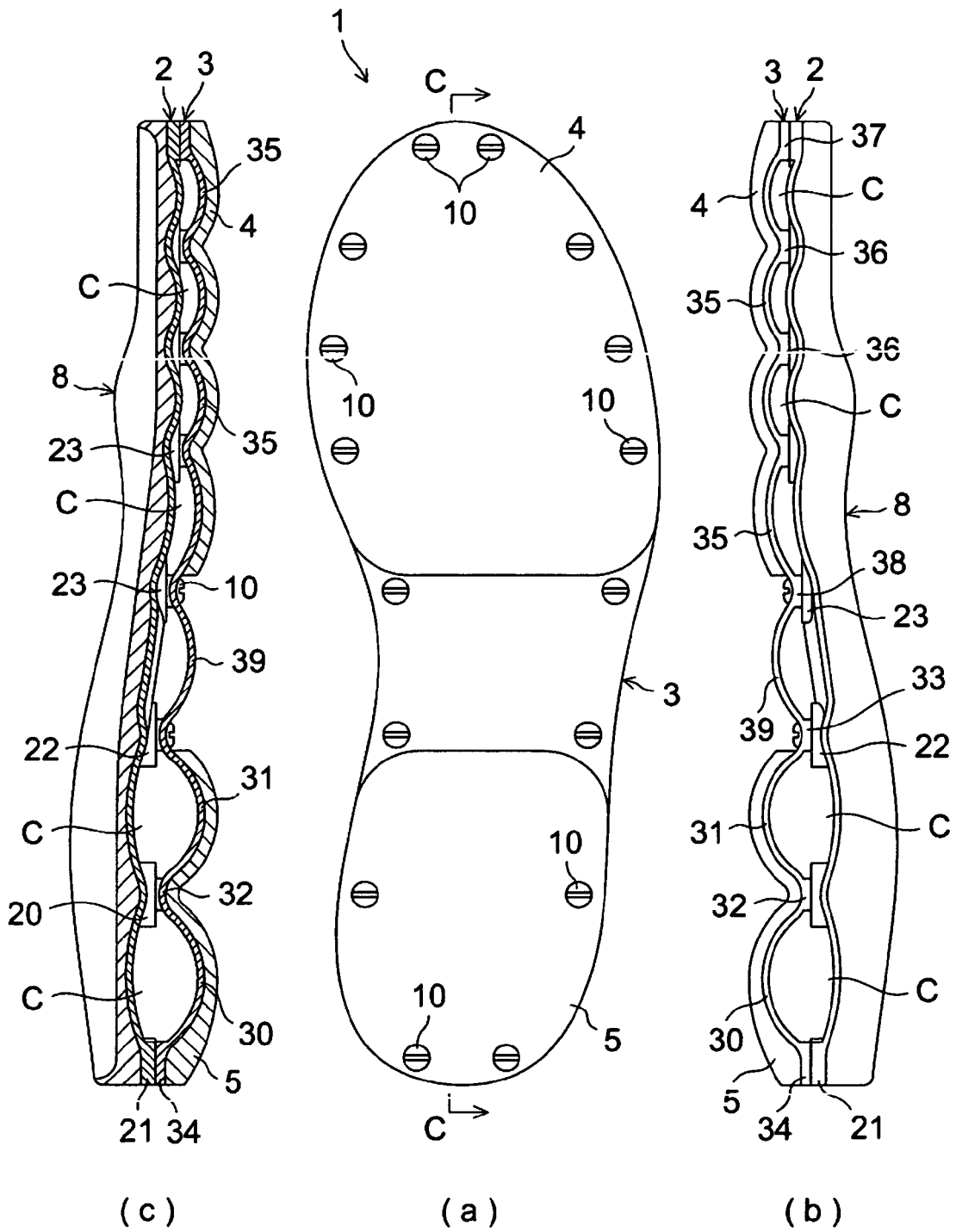


FIG. 15

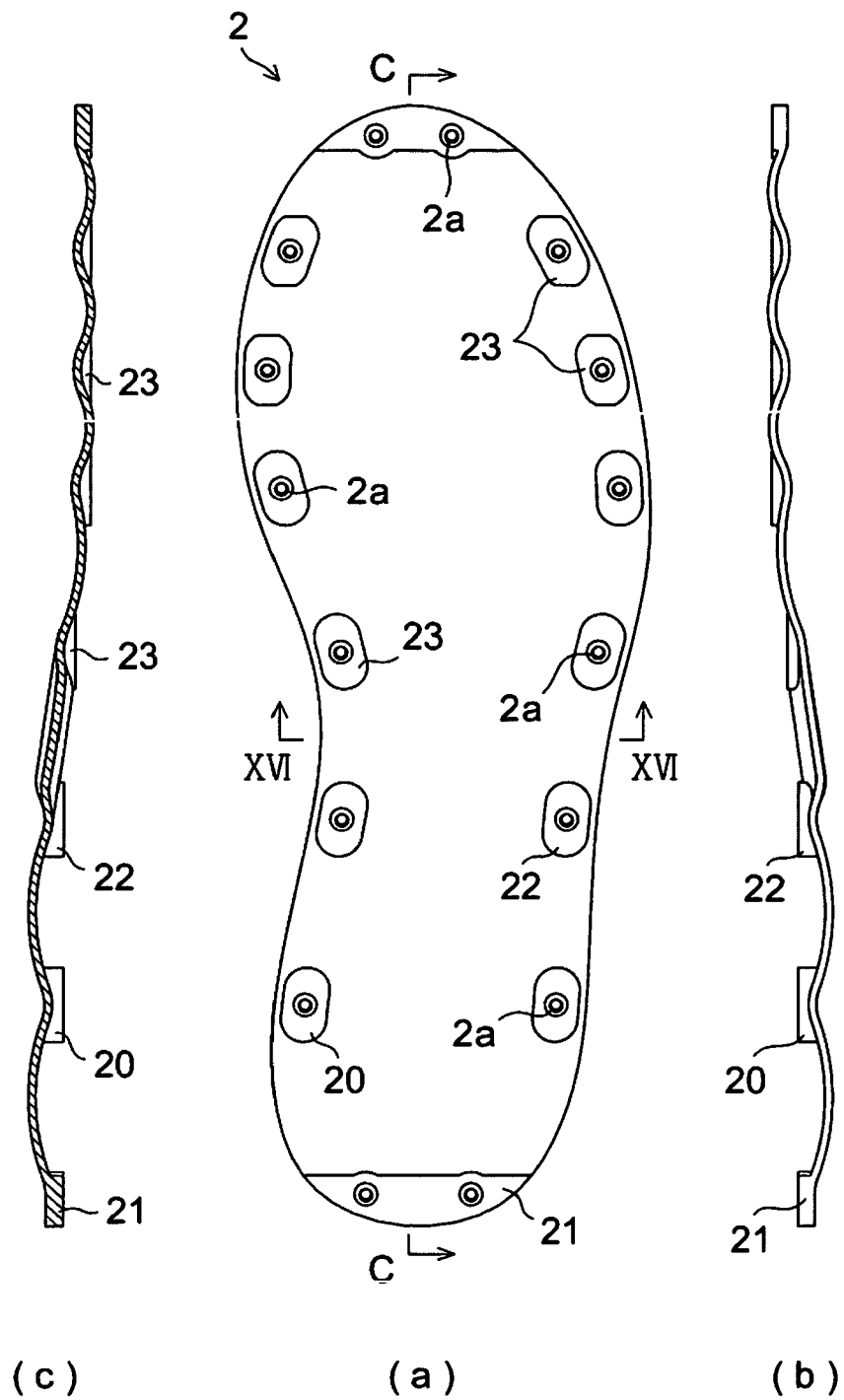


FIG. 15A

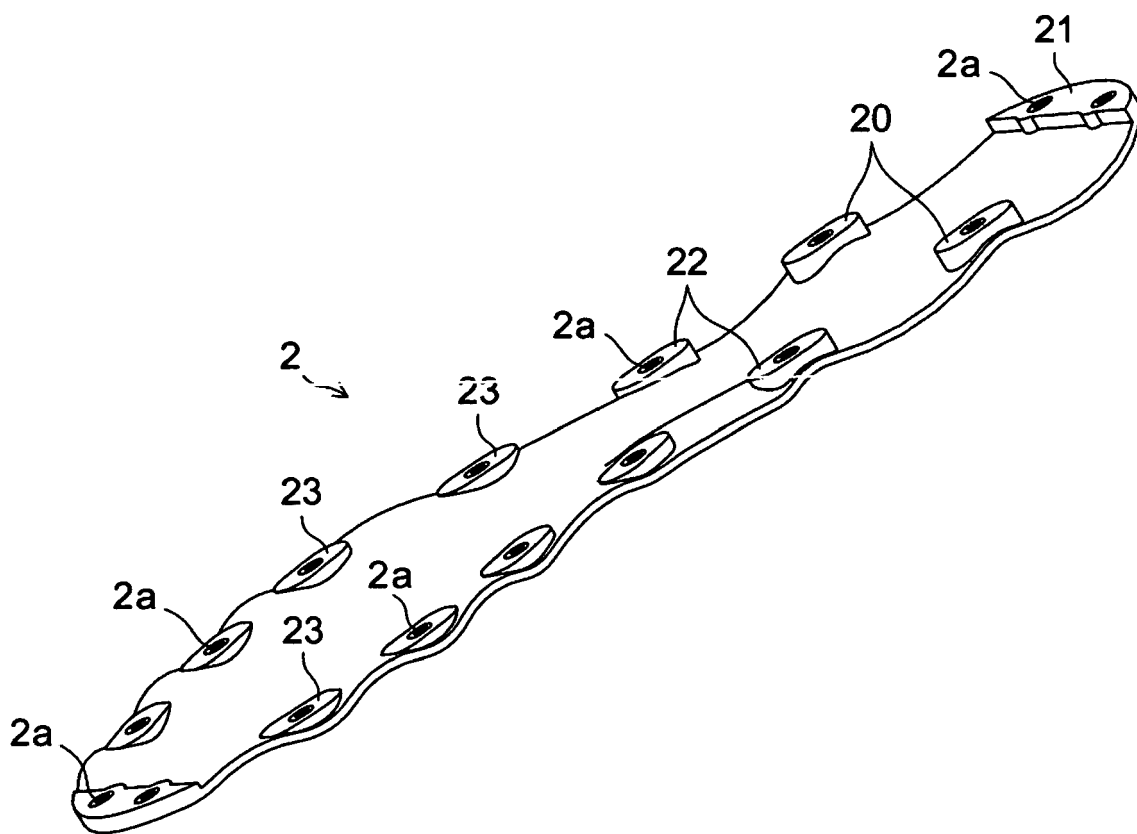


FIG. 16

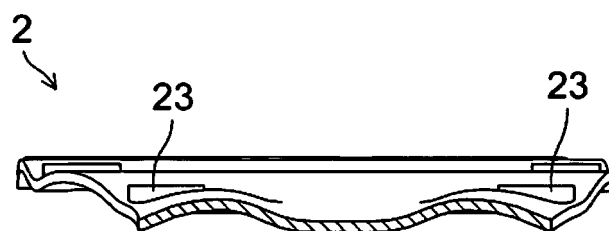


FIG. 18

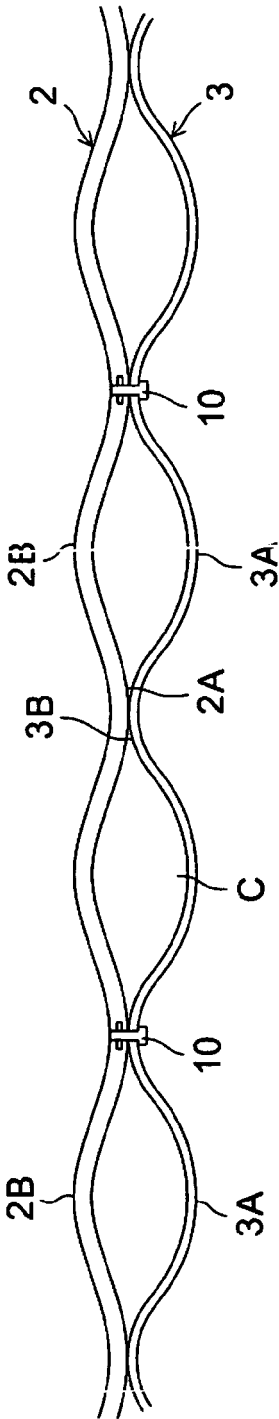


FIG. 19

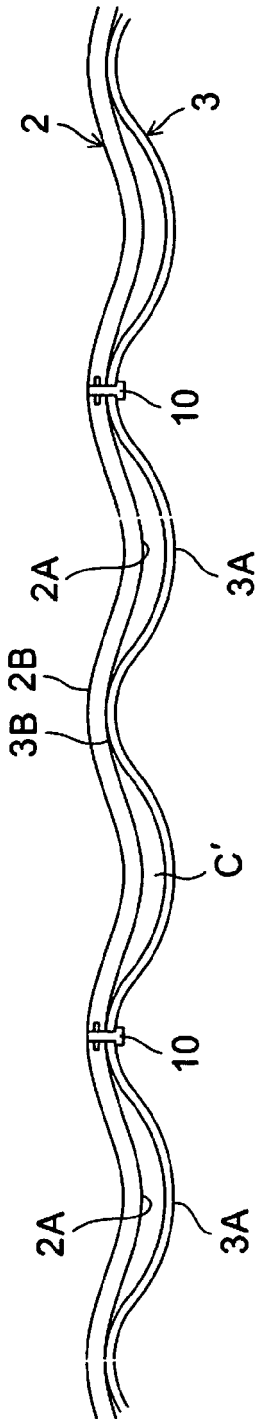


FIG. 20

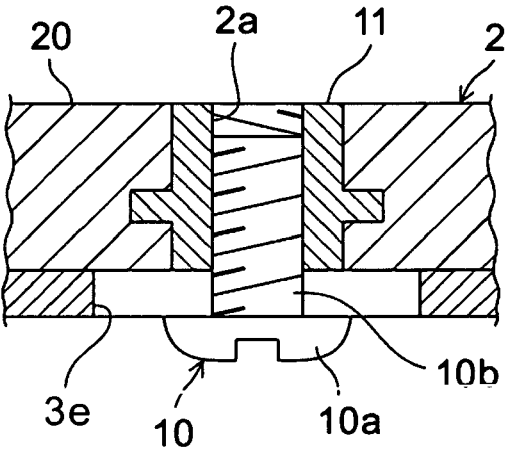


FIG. 21

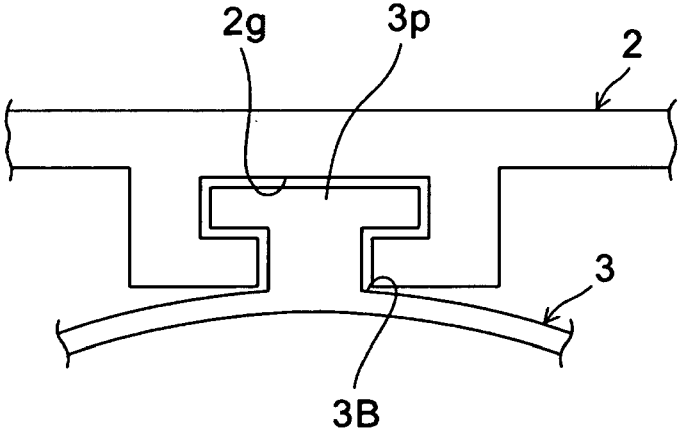


FIG. 22

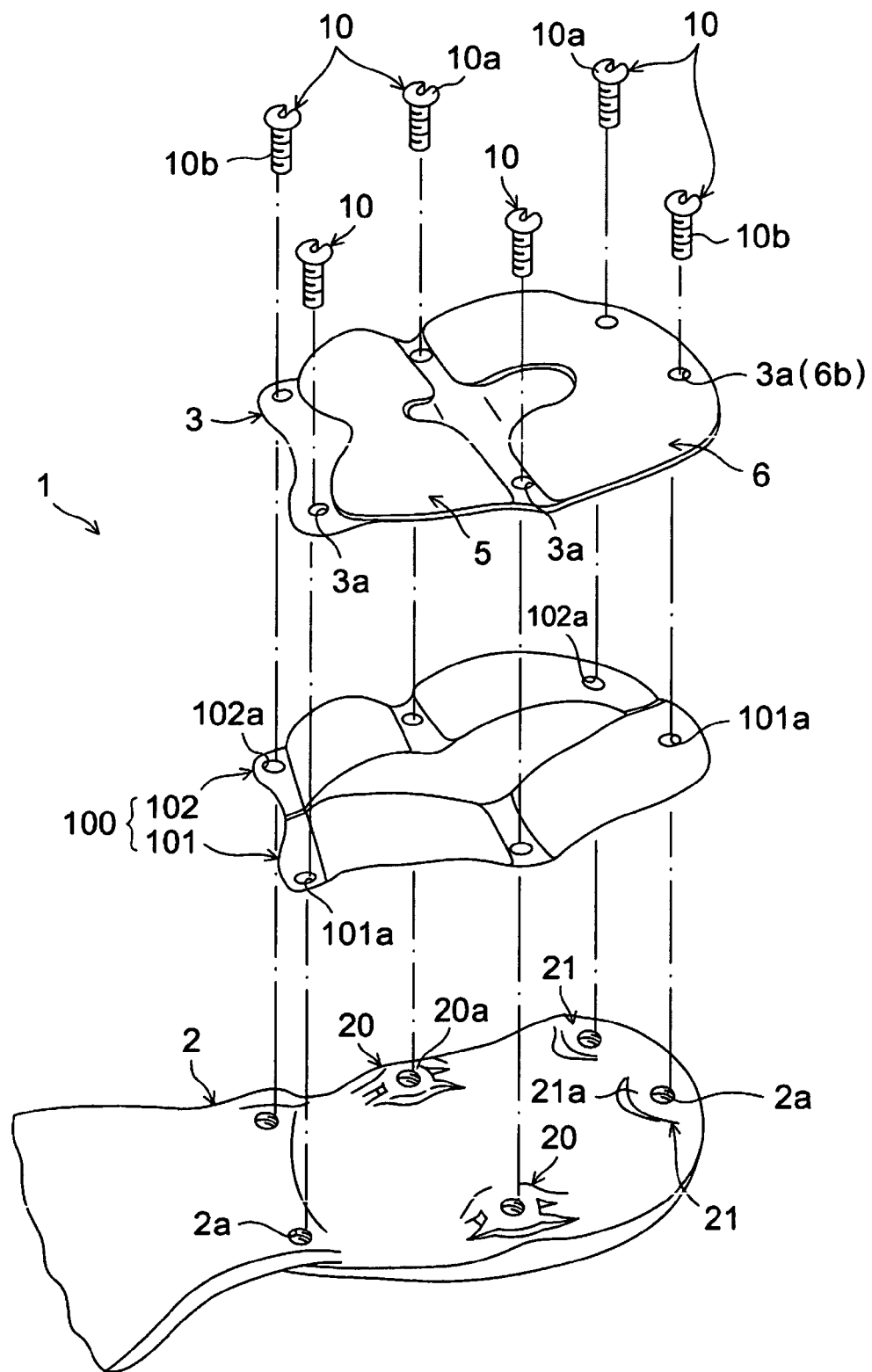


FIG. 23

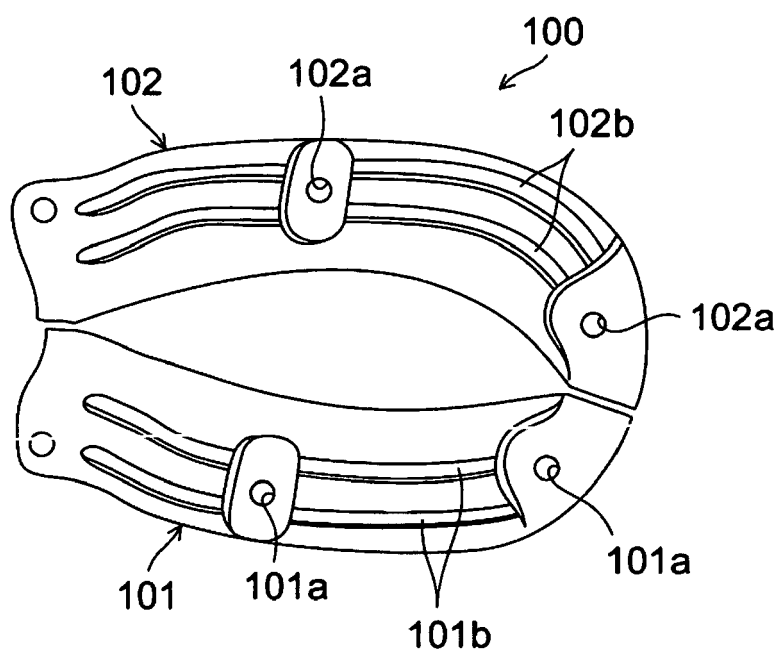


FIG. 24

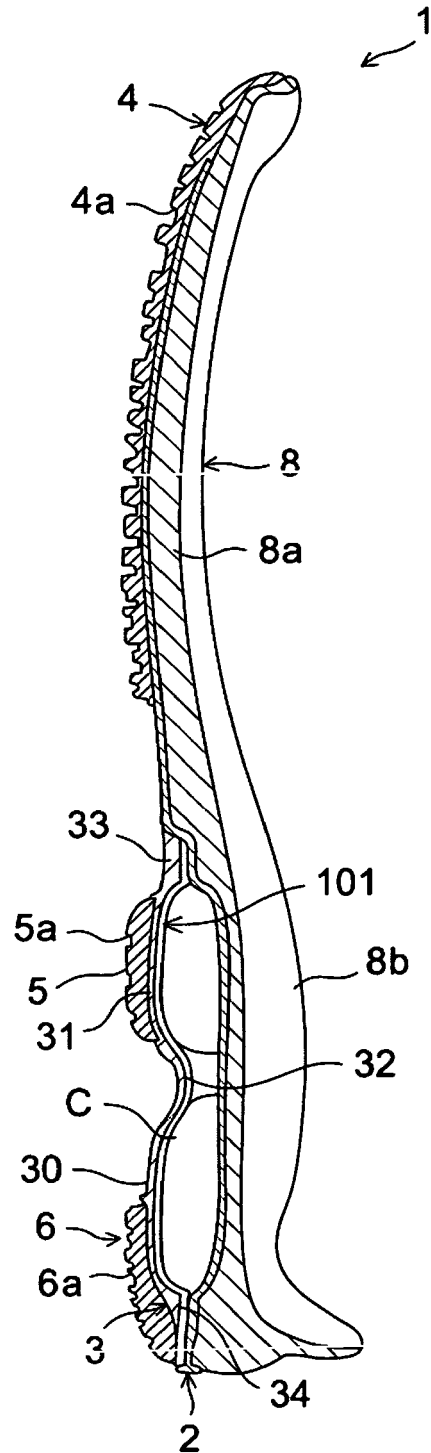
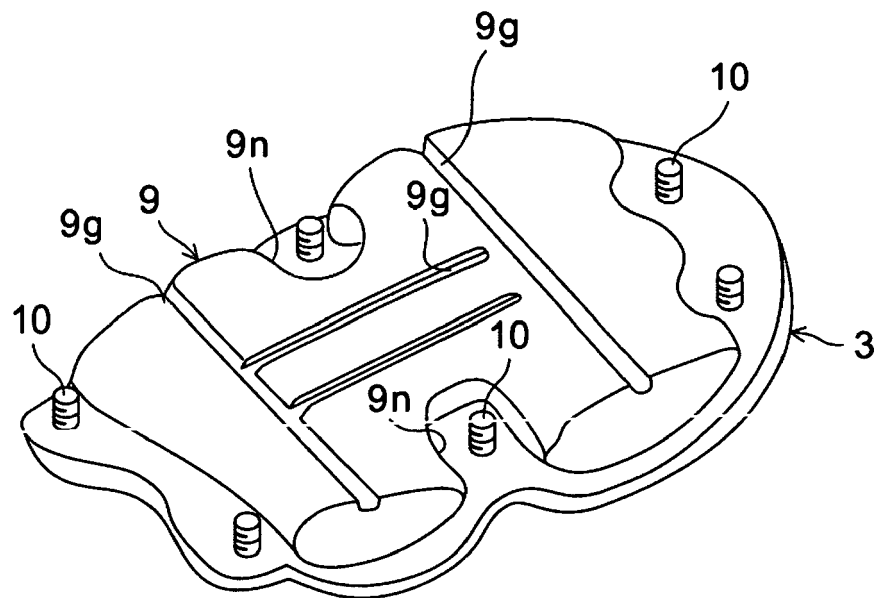


FIG. 25





EUROPEAN SEARCH REPORT

Application Number
EP 10 25 1142

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 839 511 A2 (TIMBERLAND CO [US]) 3 October 2007 (2007-10-03)	1,10,13,14	INV. A43B3/24
A	* paragraphs [0056] - [0058], [0 73], [0 75]; figures 26-27 *	2-9,15-18	A43B13/18 A43B13/30 A43B13/36 A43B21/42
X	US 5 970 630 A (GALLEGOS ALVARO Z [US]) 26 October 1999 (1999-10-26)	1,10,13	
A	* column 3, lines 1-50; figures 3-4 *	2,3,5-9,11,12,14-18	
X	FR 1 288 897 A (LISSAYOU AUGUSTE) 30 March 1962 (1962-03-30)	1-3,7,10,13-15	
A	* page 1, column 2 - page 2, column 1; figure *	4-6,8,9,11,12,16-18	
A	JP 2003 339405 A (MIZUNO KK) 2 December 2003 (2003-12-02)	1-18	
A	US 2003/000109 A1 (KITA KENJIRO [JP]) 2 January 2003 (2003-01-02)	1-18	TECHNICAL FIELDS SEARCHED (IPC) A43B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 October 2010	Examiner Herry, Manuel
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1
EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 10 25 1142

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-10-2010

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1839511 A2	03-10-2007	US 2007209230 A1	13-09-2007
		US 2009282700 A1	19-11-2009
		WO 2007103476 A2	13-09-2007

US 5970630 A	26-10-1999	NONE	

FR 1288897 A	30-03-1962	NONE	

JP 2003339405 A	02-12-2003	JP 4038391 B2	23-01-2008

US 2003000109 A1	02-01-2003	BR 0201518 A	29-04-2003
		JP 3947658 B2	25-07-2007
		JP 2003009906 A	14-01-2003

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 7204007 A [0002] [0004]
- JP 9075107 A [0003] [0005] [0032]
- JP 4020953 B [0068]