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(54) **SHOCK-ABSORBING STRUCTURE AND SHOES IMPLEMENTING SAME**

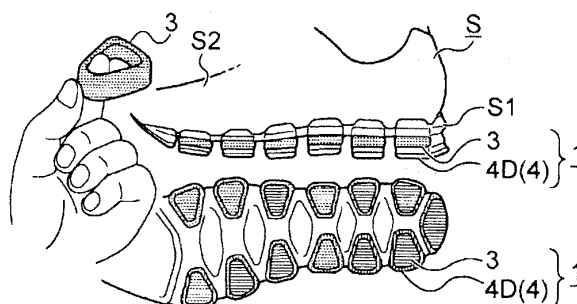
(57) The present invention addresses a problem to develop a novel shock absorbing structure which enables a repulsive force to shift to a kick-out motion of a wearer smoothly while enabling impact to be absorbed stepwise when incorporated into a sole of a shoe or the like, for example, and a shoe to which the shock absorbing structure is applied.

[Solution]

A shock absorbing structure of the present invention is formed by including a column member, an elastic ring member that is provided by being fitted onto the column member, and upper and lower pressure receiving por-

tions that are connected by the column member, wherein the column member is capable of being deformed and restored at least in a pressure receiving direction, the ring member has an effective working height set to be lower than the column member, and is formed to be in a non-bonded state with the upper and lower pressure receiving portions, and at a time of pressure reception, the column member undergoes compression deformation in the pressure receiving direction first, and thereafter, the ring member undergoes compression deformation in the pressure receiving direction next, whereby multi-stage shock absorbing performance is exhibited.

FIG. 1



Description

Technical Field

[0001] The present invention relates to a shock absorbing structure that is incorporated into a sole of a sports shoe, or a running shoe, for example, so as to be easily observed visually from outside and absorbs impact applied to a foot of a wearer at a time of landing on the ground, and particularly relates to a novel shock absorbing structure that enables a repulsive force to shift smoothly to a kick-out motion of the wearer while enabling the impact to be absorbed in a stepwise manner, and a shoe to which the shock absorbing structure is applied.

Background Art

[0002] In many sports shoes, running shoes and the like, shock absorbing members (shock absorbing structures) are incorporated in order to absorb an impact which is applied to legs (feet, knees and the like) of those who wear the shoes. A number of research and development activities have been earnestly carried out, and various proposals have been made as the shock absorbing structures like this.

[0003] The present applicant has also kept studying the structures adopting gels and rubbers (soft materials) with low hardness, as the shock absorbing materials having excellent shock absorbing performance as described above, and has filed various patent applications (refer to Patent Literatures 1 to 10, for example).

[0004] Since it is important to design the structure that can absorb impact to the greatest extent possible with respect to extremely large impact at a time of running and at a time of jumping, these soft materials are especially provided directly under and in vicinities of regions directly under heels, thenars and hypothenars, and therefore, most of the soft materials have been hidden inside the shoes in general. It has been one of problems that although the materials themselves have high shock absorbing performance, the states of the soft materials cannot be observed from the outside, that is, the ability to attract attention as a product is low.

[0005] Further, as the shock absorbing member which practically performs a shock absorbing action is made softer in order to enhance a shock absorbing characteristic, shock absorbing performance (impact absorbing performance) is enhanced more, but when the shock absorbing member is too soft, the shock absorbing member is compressed at a maximum level at a time of pressure reception, so that bottoming occurs. Even when bottoming does not occur, a repulsion characteristic is small, so that in the process from landing to kicking-out with toes, reduction of a so-called repulsion characteristic occurs, such as excessive turning of an ankle and a deviation of a center of the gravity (landing stability), and reduction in a propulsion force by a repulsive force at the time of kicking out, and therefore, there has been the problem

to make a shock absorbing characteristic and performance of facilitating running and jumping compatible.

[0006] For the above reason, shock absorbing structures and shoes have been pursued, which can expose a soft material to outside, in particular, expose most of the outer circumferential face to outside to a maximum extent so that presence of the soft material can call attention of users, and can keep performance of easily running and jumping while exhibiting high shock absorbing performance, at the same time. Further, there has been an increasing need for customizing shock absorbing performance on site in accordance with the feet conditions over time of a wearer (change in a running characteristic and a walking characteristic following foot podedema and fatigue).

[0007] Meanwhile, as the prior art of the structure in which a shock absorbing material is exposed outside, there is proposed a shoe in which a pillar-shaped (columnar) shock absorbing material is fixedly disposed in a sole, and a periphery of the shock absorbing material is opened (refer to Patent Literature 11, for example).

[0008] However, it is not sufficient to simply expose a shock absorbing material to outside. That is, when a columnar shock absorbing material is vertically fixed between a midsole and an outer sole as in Patent Literature 11 described above, the shock absorbing material easily causes "unsteadiness" with the column bends and tilts by compression deformation, and therefore, use of a rigid resin material for the columnar member, or another support member for a periphery is required. In this way, a shock absorbing characteristic against impact in the vertical direction can be ensured more or less, but shock absorbing characteristics against a number of impacts and deformations from diagonal directions, which occur in actual use are lost.

[0009] If the columnar shock absorbing member is made of a softer material, the shock absorbing material (soft material) which is fixed between the midsole and the outer sole has deformation restricted (arrested) by the upper and lower junction faces, and therefore, there is no change in the fact that high impact absorbing performance itself which is peculiar to the soft material is significantly restricted (in particular, at a time of start of deformation).

Citation List

Patent Literature

[0010]

Patent Literature 1: Japanese Patent Laid-Open No. 08-38211 (Japanese Patent No. 3425630)

Patent Literature 2: Japanese Patent Laid-Open No. 2009-56007

Patent Literature 3: Japanese Patent Laid-Open No. 03-170104 (Japanese Patent No. 1981297)

Patent Literature 4: Japanese Patent Laid-Open No.

2007-144211

Patent Literature 5: U. S. Patent No. 7877899

Patent Literature 6: Japanese Patent Laid-Open No. 2003-79402 (Japanese Patent No. 4020664)

Patent Literature 7: Japanese Patent Laid-Open No. 2003-9904

Patent Literature 8: Japanese Patent No. 4704429

Patent Literature 9: Japanese Patent Laid-Open No. 2009-142705 (Japanese Patent No. 4923081)

Patent Literature 10: Japanese Patent Laid-Open No. 03-170102

Patent Literature 11: U. S. Patent No. 5343639

Summary of Invention

Technical Problem

[0011] The present invention is made by recognizing the background like this, and in order to realize exhibition of high impact absorbing performance (shock absorbing performance) peculiar to a sort material and a repulsion characteristic at the same time while exposing most of at least an outer circumference of the soft material, the present invention has an object to develop a novel shock absorbing structure that adopts a structure in which an inside is a columnar member and a ring-shaped soft material is provided on an outer periphery of the columnar member, does not depend on a peripheral support member, further does not restrict deformation at a time of the ring-shaped soft material starting to receive impact and is suitable for running and jumping, and a shoe to which the shock absorbing structure is applied.

Solution to Problem

[0012] A shock absorbing structure of the present invention includes a column member, an elastic ring member that is provided by being fitted onto the column member, and upper and lower pressure receiving portions that are connected by the column member, wherein the column member is capable of being deformed and restored at least in a pressure receiving direction, the ring member has an effective working height set to be lower than the column member, and is formed to be in a non-bonded state with the upper and lower pressure receiving portions, and at a time of pressure reception, the column member undergoes compression deformation in the pressure receiving direction first, and thereafter, the ring member undergoes compression deformation in the pressure receiving direction next, whereby multi-stage shock absorbing performance is exhibited.

[0013] Further, a ratio of the effective working height of the ring member is preferably 0.2 to 0.95 with respect to the column member.

[0014] Further, at least one of the column member and the ring member is preferably formed in such a manner that an effective working height is not constant throughout an entire circumference.

[0015] Further, the column member is preferably formed of a foam, and the ring member is preferably formed from a solid material.

[0016] Further, a hardness of the column member is preferably an Asker C hardness of 30 to 100 or a JIS A hardness of 40 to 120, and a hardness of the ring member preferably is a JIS A hardness of 30 or less.

[0017] Further, a ring bulging space in a depressed concave shape is preferably formed in at least either one of contact faces of the ring member and the column member.

[0018] Further, a bulging restriction portion that restricts bulging deformation of the ring member is preferably provided in at least a part of an outside of the ring member.

[0019] Further, at least one of the ring member and the column member is preferably configured by parts having a plurality of different materials or different repulsive forces.

[0020] Further, the column member is preferably formed by combining a plurality of members, and the members are preferably configured to deform movably in the pressure receiving direction.

[0021] Further, the ring member is preferably attached to the column member detachably and attachably.

[0022] Further, a shoe of the present invention is formed by incorporating a shock absorbing structure that absorbs impact that is applied to a leg of a wearer at a time of landing on the ground, into a sole, wherein the above described shock absorbing structure is applied to the shock absorbing structure.

[0023] Further, the shock absorbing structure is preferably provided on a bottom face of the sole.

Advantageous Effects of Invention

[0024] The shock absorbing structure exhibits multi-stage shock absorbing performance by at a time of pressure reception, the column member undergoing compression deformation in the pressure receiving direction first, and thereafter, the ring member undergoing compression deformation in the pressure receiving direction with the column member, while accompanied by an action of restricting bulging deformation of the column member by the ring member, next. Therefore, while the shock absorbing performance (impact absorbing characteristic) is enhanced, the repulsive force can be enhanced intentionally and in a stepwise manner in accordance with a shock absorbing stage, so that bottoming can be prevented, and a repulsion characteristic can be further given. Further, when the ring member is made deformable in an entire circumferential direction (since deformation is not restricted), the shock absorbing characteristic of the ring member can be exhibited to the greatest extent possible, and an excellent shock absorbing characteristic can be realized.

[0025] Further, if the effective working height of the ring member is set at a ratio of 0.2 to 0.95 of the column

member (the height), favorable multi-stage shock absorbing deformation can be realized. That is, if the above described ratio is less than 0.2, the height dimension of the ring member is too small to realize favorable multi-stage shock absorbing deformation, and since a strength support action of the column member by the ring member decreases, load flexibility of the column member becomes large, so that when the shock absorbing structure is provided in a shoe, for example, stability at a time of running and at a time of walking is reduced.

[0026] Further, when the above described ratio exceeds 0.95, the height dimension of the ring member is so large (so high) this time that the distance between the pressure receiving portion and the ring member is so short (a clearance is too small) that effective multi-stage shock absorbing deformation is lost.

[0027] Further, if the effective working height of at least one of the column member and the ring member is formed not to be constant throughout the entire circumference (formed to differ partially), the pressure receiving portion inclines toward a side with a low effective working height when the load is applied, and when the shock absorbing structure is provided in a shoe, for example, a tilting action of tilting a leg of a wearer to a specific direction at the time of landing, or a load guiding action of guiding the load applied to a foot to a proper direction can be generated.

[0028] Further, if the column member is formed of a foam, and the ring member is formed from a solid material, at the initial stage of impact absorption, soft shock absorbing performance is obtained, and from here, the repulsion characteristic is gradually enhanced to realize the shock absorbing characteristic at the same time. That is, since a foam deforms accompanied by volume contraction (compression characteristic is high), bulging deformation in the radial direction at the time of compression deformation is smaller than that of a solid material, so that if the column member is formed of a foam, the column member undergoes deformation that contracts substantially only a volume and exhibits a soft shock absorbing characteristic, at the initial time of pressure reception when only the column member is substantially compressed. Thereafter, pressure reception advances to reach the stage accompanied by deformation of the ring member, compression deformation of the ring member is added to the compression deformation of the column member this time, but the ring member has a larger non-compression characteristic (volume change at the time of deformation is extremely small) than the column member since the ring member is formed from a solid material, and therefore has an action of restricting compression deformation of the column member relatively strongly, and with the shock absorbing performance of the ring member itself also added, the repulsion characteristic is enhanced. If the column member is formed of a foam, and the ring member is formed from a solid material in this way, the shock absorbing characteristic and the repulsion characteristic can be realized at the same time.

[0029] Further, since the sole of a shoe is generally formed of a foam, the configuration in which the column member is formed of a foam is also preferable in the case of adopting the structure in which the column member and the sole are integrated, and is also advantageous in terms of productivity and cost of the shoe. Since a foam itself is light, the configuration also contributes to reduction in weight of the shoe, as a matter of course.

[0030] Further, by embodying the hardnesses of the column member and the ring member, the preferable hardnesses of them become obvious, and the shock absorbing structure which prevents bottoming while realizing high shock absorbing performance, and brings about a repulsion characteristic can be realized.

[0031] That is, generally, in the case where both the ring member and the column member have a low hardness (in the case of being soft), the impact absorbing characteristic increases, but the repulsion characteristic reduces, so that bottoming occurs depending on the case, and stability at the time of walking and at the time of running cannot be maintained. Conversely, in the case where the hardness is high (in the case of being hard), the ring member and the column member become difficult to deform at the time of pressure reception, and hardly express impact absorbing characteristics. Accordingly, selection and setting of a proper hardness is required, and thereby suitable multi-stage shock absorbing performance can be exhibited.

[0032] Further, if the ring bulging space is formed in either one or both of the ring member and the column member, the ring bulging space functions as the deformation space or an allowance space for the ring member when the ring member undergoes bulging deformation by pressure reception, and can promote bulging deformation of the ring member. Consequently, the shock absorbing performance as the shock absorbing structure can be enhanced.

[0033] Further, if the bulging restriction portion is provided at the outside of the ring member, bulging deformation of the ring member at the time of pressure reception is restricted in a proper site, and bulging deformation of the ring member, and the shock absorbing performance (two-stage shock absorbing performance) of the shock absorbing structure by extension, can be controlled and adjusted.

[0034] The material, the shape, the dimension, the number and the like of the bulging restriction portion can be properly set depending on how the ring member is deformed or the like at the time of pressure reception.

[0035] Further, if at least one of the ring member and the column member is configured of the part having a plurality of different materials or different repulsive forces, development of variations having more various kinds of multi-stage shock absorbing performance can be realized.

[0036] Further, if the column member is formed by combining a plurality of members, and the members are configured to deform movably in the pressure receiving

direction, development of variations having more various kinds of multi-stage shock absorbing performance can be realized.

[0037] Further, if the ring member is enabled to be attached to the column member detachably and attachably, when the shock absorbing structures are provided in the shoes, for example, a user can select the ring members that are to his or her taste and can replace the ring members with the selected ring members after purchasing the shoes, so that a new way of enjoyment of finding out a multi-stage shock absorbing characteristic suitable to unique arrangement and his or her own running form and the like can be provided to the user. That is, by making the ring members attachable and detachable, the ring members can be replaced with the ring members with different hardness, shapes, colors and the like to customize the ring members in accordance with preference and an object of a wearer (a user).

[0038] Further, if the shock absorbing structures as described above are applied to shoes, the shoes that prevent bottoming while enhancing an impact absorbing characteristic, and is given a repulsion characteristic can be provided.

[0039] Further, if the shock absorbing structures are provided on the bottom faces of the soles, it is more easily recognized visually from outside that the shock absorbing structures are provided in the shoes, and it can be more strongly expressed that the shoes have excellent shock absorbing performance.

Brief Description of Drawings

[0040]

[Figure 1] Figure 1 shows an explanatory view showing an example of a shoe to which a shock absorbing structure of the present invention is applied, and sectional views each skeletally showing a primary shock absorbing stroke and a secondary shock absorbing stroke of the shock absorbing structure, Figure 1(a) is a case where a column member and a ring member are both formed from solid materials, Figure 1(b) is a case where a column member is formed of a foam and a ring member is formed from a solid material, Figure 1(c) is a case where a column member is formed from a solid material, and a ring member is formed of a foam, and Figure 1(d) is a case where a column member and a ring member are both formed of foams.

[Figure 2] Figure 2 shows sectional views of a shock absorbing structure with an entire circumference of an upper end of a ring member being formed into a sharp-pointed shape and the entire circumference of the upper end being made as an action wait portion, and skeletally showing a primary shock absorbing stroke and a secondary shock absorbing stroke at a time of pressure reception (a), a partial perspective view showing a ring member in which a plurality

of partial protrusions are formed on an upper end edge of the ring member as another action wait portion (b), a partial perspective view showing a ring member in which a plurality of partial recesses are formed on an upper end edge of the ring member as still another action wait portion (c), a perspective view showing a ring member in which concentric corrugated recesses and protrusions are formed on an entire circumference of an upper end of the ring member as yet another action wait portion (d), a sectional view showing a ring member in which the concentric corrugated recesses and protrusions are formed so as to be located at a higher position toward an outer circumferential side (e), a perspective view showing a ring member in which corrugated recesses and protrusions in a radial direction (radial shape) are formed on an entire circumference of an upper end of the ring member as still another action wait portion (f), and a perspective view showing a ring member in which a plurality of cutouts are formed in a radial direction (a radial shape) after a model of the corrugated recesses and protrusions (g).

[Figure 3] Figure 3 shows a side view (an elevation view) and a sectional view of a shock absorbing structure in which an action wait portion is formed on an upper side pressure receiving portion (a), a sectional view showing a shock absorbing structure in which an action wait portion is formed by bringing a ring member formed by diagonally cutting a cylindrical member into partial contact with the upper side pressure receiving portion on an upper end portion thereof (b), and a perspective view showing a ring member in a case where the diagonal cylindrical ring member is formed to be eccentric (c).

[Figure 4] Figure 4 shows several kinds of shock absorbing structures having multi-stage shock absorbing characteristics (three-stage shock absorbing characteristics), Figure 4(a) is a sectional view skeletally showing a primary shock absorbing stroke to a tertiary shock absorbing stroke in a case where ring members are provided to be doubly fitted onto a column member, Figure 4(b) is a sectional view skeletally showing a primary shock absorbing stroke to a tertiary shock absorbing stroke in a case where a size in plan view of the column member is varied in a vertical direction, and Figure 4(c) is a sectional view showing a shock absorbing structure in which ring members with different properties are provided to be fitted onto the column member in series to be in a line vertically.

[Figure 5] Figure 5 shows sectional views of a shock absorbing structure in which a ring member having upper and lower end edges inclined and forming a taper shape seen from a side face is provided by being fitted, which skeletally show a primary shock absorbing stroke and a secondary shock absorbing stroke of the shock absorbing structure (a), a sectional view showing a shock absorbing structure in

which a ring member forming a slope shape seen from a side face is provided by being fitted (b), a perspective view and a sectional view showing a shock absorbing structure in which cutouts are formed at both upper and lower end edges of a ring member (c), a sectional view showing a shock absorbing structure in which formation positions of the cutouts are shifted somewhat in a circumferential direction from each other (d), a perspective view and a plan view each showing a column member and a ring member in which the ring member is provided eccentrically from the column member in a column shape (e), and a plan view showing a state where the ring member formed into an eccentric state is rotated by approximately 90 degrees with respect to the column member (f).

[Figure 6] Figure 6 shows sectional views of a shock absorbing structure, in which a ring bulging space that allows bulging deformation of a ring member is formed in an outer side portion (a contact portion with the ring member) of a column member, the sectional views skeletally showing a primary shock absorbing stroke and a secondary shock absorbing stroke of the shock absorbing structure (a), and sectional views skeletally showing a primary shock absorbing stroke and a secondary shock absorbing stroke of a shock absorbing structure in which the ring bulging space is formed in an inner side of the ring member (b).

[Figure 7] Figure 7 shows modes in which bulging restriction portions that restrict bulging deformation of ring members are formed outside the ring members, Figure 7(a) shows sectional views skeletally showing a primary shock absorbing stroke and a secondary shock absorbing stroke of a shock absorbing structure in a case where a bulging restriction portion is provided at a part of an outside of a ring member like a standing wall, Figure 7(b) shows sectional views skeletally showing a primary shock absorbing stroke and a secondary shock absorbing stroke in a case where while an upper side pressure receiving portion is formed as a part of a sole, an annular (ring-shaped) bulging restriction portion is provided in the sole, and Figure 7(c) is a sectional view showing a shock absorbing structure in which a ring-shaped bulging restriction portion is provided to be fitted onto an outer circumferential side of a ring member in a close contact state.

[Figure 8] Figure 8(a) shows sectional views of a shock absorbing structure in which properties of a column member are caused to differ between upper and lower sides, which skeletally shows an initial state (a no-load state) where no load is applied, and a state after a secondary shock absorbing stroke, Figure 8(b) shows a shock absorbing structure in which properties of a column member are caused to differ between a left and right sides, which skeletally shows an initial state and a state after a secondary

shock absorbing stroke, Figure 8(c) is a sectional view of a shock absorbing structure in which properties of a ring member are caused to differ between upper and lower sides, Figure 8(d) is a sectional view of a shock absorbing structure in which properties are caused to differ at a lower side and an inner circumferential side of a ring member, Figure 8(e) is a side view showing only a ring member in which properties are partially caused to differ by opening a number of small holes in only a lower portion while the single ring member is formed of a member of the same properties, Figure 8(f) is a sectional view of a shock absorbing structure in which only a column member is formed into three layers of materials having different properties, Figure 8(g) is a sectional view of a shock absorbing structure in which only a ring member is formed into three layers of materials having different properties, and Figure 8(h) to Figure 8(j) are sectional views of shock absorbing structures in which both column members and ring members are formed of materials having different properties.

[Figure 9] Figure 9(a) shows a sectional view of a shock absorbing structure in which while a column member is formed into a column shape, a ring member is formed into a cylinder shape with a wall thickness dimension in a radial direction becoming larger toward a lower side, and a perspective view of only the ring member, Figure 9(b) shows a sectional view of a shock absorbing structure in which while a column member is formed into a truncated cone shape which is narrowed toward a lower side, a ring member is formed into a cylinder shape with a wall thickness dimension in a radial direction substantially the same throughout the upper and lower sides, and a perspective view of only the ring member, Figure 9(c) is an explanatory view showing a shock absorbing structure in which a sectional size (a radial dimension) of a ring member is varied stepwise in a height direction by partially breaking the shock absorbing structure, and Figure 9(d) is an explanatory view showing a shock absorbing structure in which a ring member is formed into a spiral shape in addition to the stepwise variation in the radial dimension like the above by partially breaking the shock absorbing structure.

[Figure 10] Figure 10 is a sectional view of a shock absorbing structure in which an upper side pressure receiving portion and a lower side pressure receiving portion are formed to continue to each other.

[Figure 11] Figure 11 shows modes showing shock absorbing structures each provided with a plurality of column members, Figure 11(a) shows a perspective view, a sectional view and a plan view of a case where a single ring member is fitted to outer sides of a plurality of column members, Figure 11(b) shows a plan view and a sectional view of a case where a ring member is provided to be fitted onto each of a plurality of column members, and Figure 11(c) is a

plan view of a case where a plurality of column members are divided into a few groups, and a ring member is provided to be fitted onto each of the groups. [Figure 12] Figure 12 shows another mode showing a shock absorbing structure in which a plurality of column members are provided, and shows sectional views skeletally showing a primary shock absorbing stroke and a secondary shock absorbing stroke in a case where a plurality of column members themselves are positively bulged and deformed at a time of pressure reception, and a perspective view mainly showing the column members in an initial state. [Figure 13] Figure 13 shows a perspective view (an initial state) showing a shock absorbing structure having a column member formed by combining a plurality of members, and a sectional view skeletally showing a primary shock absorbing stroke and a secondary shock absorbing stroke of the shock absorbing structure.

[Figure 14] Figure 14 shows an embodiment in which shock absorbing structures each having an upper column member and a lower column member brought into a nested state to make a ring member attachable and detachable are incorporated into a shoe, Figure 14(a) is an explanatory view showing a state in which ring members are attached to the column members (shoe), and Figure 14(b) is an explanatory view showing a state of detachment of the ring member from the column member (shoe).

[Figure 15] Figure 15 shows a perspective view (an initial state) showing still another shock absorbing structure having a column member formed by combining a plurality of members, an exploded perspective view of an upper part and a lower part except for a ring member, and sectional views skeletally showing a primary shock absorbing stroke and a secondary shock absorbing stroke of the shock absorbing structure.

[Figure 16] Figure 16 shows disposition examples of a case where a plurality of shock absorbing structures are provided on a bottom face of a shoe (a sole), Figure 16(a) is an explanatory view in which the shock absorbing structures are disposed in three spots that are a thenar, a hypothenar and a heel portion, and Figure 16(b) shows an explanatory view in which shock absorbing structures with low shock absorbing characteristics are provided at an inner side (IN side) of a foot, and shock absorbing structures with high shock absorbing characteristics are provided at an outer side (OUT side), and an explanatory view showing a proper pronation line (a moving line of the center of the gravity that prevents excessive inward roll) for this case.

[Figure 17] Figure 17 is an explanatory diagram showing shock absorbing characteristics, that is, an impact absorbing characteristic and a repulsion characteristic according to the shock absorbing structure of the present invention.

[Figure 18] Figure 18 shows disposition examples of shock absorbing structures differing in repulsion characteristic (hardness) in a case where a plurality of shock absorbing structures are provided on a bottom face of a shoe (a sole), Figure 18(a) is an explanatory view showing a disposition example in which a repulsion characteristic (hardness) of an inner side of a foot is enhanced so as to be suitable for mid foot strike, and Figure 18(b) is an explanatory view showing a disposition example in which a repulsion characteristic (hardness) of an outer side of a foot is enhanced so that movement which quickly strikes back in a transverse direction can be realized.

Reference Signs List

[0041]

20	S	Shoe
	S1	Sole
	S2	Upper
	1	Shock absorbing structure
	2	Column member
25	3	Ring member
	4	Pressure receiving portion
	5	Action wait portion
	10U	Upper part
	10D	Lower part
30	2	Column member
	2U	Upper column member
	2D	Lower column member
	21	Column element
	21U	Upper column element
35	21D	Lower column element
	22	Flange element
	22U	Upper flange element
	22D	Lower flange element
	3	Ring member
40	3I	Inner side ring member
	3O	Outer side ring member
	3U	Upper side ring member
	3D	Lower side ring member
	31	Cutout
45	32	Small hole
	33	Groove
	4	Pressure receiving portion
	4U	Upper side pressure receiving portion
	4D	Lower side pressure receiving portion
50	5	Action wait portion
	C	Clearance
	NS	Unfilled space
	51	Protrusion
	52	Recess
55	53	Corrugated recesses and projections
	54	Cutout
	55	Protrusion
	AS	Ring bulging space

ER Bulging restriction portion

Description of Embodiments

[0042] Modes for carrying out the present invention include what will be described in the following embodiments as some of the modes, and also further include various methods that can be improved within the technical idea of the present invention.

Embodiments

[0043] A shock absorbing structure 1 of the present invention is provided in footwear such as a shoe S, for example, as shown in Figure 1 as an example, and the shock absorbing structure 1 absorbs impact that is applied to a leg of a person wearing (a wearer) the shoe S, and also enables a repulsive force to be smoothly converted into a kicking-out motion of a foot. Here, in the present embodiment, as a product in which the shock absorbing structure 1 is provided, a shoe (sport shoe) S is mainly shown, but as footwear other than this sandals and the like are cited, for example. The shock absorbing structure 1 of the present invention can be, as a matter of course, applied to products other than footwear, and are also applicable to supporters, protectors and the like which athletes wear to protect joints and the like, for example.

[0044] Hereinafter, the shoe S in which the shock absorbing structure 1 is provided will be described first.

[0045] The shoe S is formed by joining an upper S2 which covers an instep of a foot or the like to a sole S1 to be a ground contact part as shown in Figure 1 described above. A single or a plurality of the above described shock absorbing structures 1 is or are provided on a bottom face or the like of the sole S1, for example.

[0046] Note that when the shock absorbing structure 1 is provided in the shoe S, it is desired that the shock absorbing structure 1 itself is installed so as to be visible from outside as much as possible for the purpose of causing shock absorbing performance to call attention strongly, and from a viewpoint of improvement in design or the like, and for this purpose, Figure 1 described above illustrates a mode in which the shock absorbing structures 1 are attached to a substantially entire outer peripheral edge of the bottom face of the sole S1 (the shoe S). However, when the shock absorbing structures 1 are provided on the sole 1, it is also possible to form a reception space that accommodates the shock absorbing structures 1, inside the sole S1 in advance, for example, (not illustrated), and after accommodating the shock absorbing structures 1 in the reception space, close the reception space with a translucent member (a transparent member) to make the shock absorbing structures 1 visible from outside.

[0047] Hereinafter, the shock absorbing structure 1 of the present invention will be described. Note that in the present description, a case where the shock absorbing

structures 1 are provided in the shoe S is basically assumed and explained.

[0048] While the shock absorbing structure 1 of the present invention has a main object to absorb impact when an impact compression load is applied (a time of pressure reception), the shock absorbing structure 1 is configured to smoothly shift a repulsive force to a kicking-out motion of a foot of a wearer (a so-called repulsion characteristic), at a proper stage in which the shock absorption advances (before the shock absorbing material causes a bottoming phenomenon).

[0049] The shock absorbing structure 1 like this is formed by a column member 2 and a ring member 3 that is provided to be fitted onto the column member 2 as main components as shown in Figure 1 (a) to (d) as an example, and pressure receiving portions 4 are further provided at both upper and lower ends of the column member 2. Consequently, upper and lower pressure receiving portions 4U and 4D have a structure connected by the column member 2.

[0050] Note that respective drawings shown in Figures 1(a) to (d) described above are drawings skeletally showing shock absorption of a first stage (a primary shock absorbing stroke) to shock absorption of a second stage (a secondary shock absorbing stroke). That is, the primary shock absorbing stroke shows a deformation stage (compression deformation) in which only the column member 2 decreases a height dimension by the received pressure load, and the secondary shock absorbing stroke shows a deformation stage (compression deformation) in which the column member 2 and the ring member 3 both decrease height dimensions after compression deformation of only the column member 2 advances.

[0051] Next, an estimated shock absorbing mechanism of the shock absorbing structure 1 of the present invention will be described with the shock absorbing deformation strokes shown in Figures 1(a) to (d) as an example.

[0052] The shock absorbing deformation stroke in Figure 1 is a deformation stroke which occurs after a runner (a wearer) lands feet on the ground until the runner kicks out, and a relationship between a deformation amount generated in the shock absorbing structure 1 and a force forms a hysteresis loop illustrated in Figure 17. More specifically, the aforementioned hysteresis loop is made of deformation strokes of the shock absorbing structure 1 of the following 1) to 4):

- 1) a first deformation stroke ("a deformation stroke A" in the drawing) in which a bottom face lands on the ground, the pressure receiving portion 4 receives an impact compression load and only the column member 2 independently deforms,
- 2) a second deformation stroke ("a deformation stroke B" in the drawing) in which the pressure receiving portion 4 simultaneously deforms the column member 2 and the ring member 3,
- 3) a third deformation stroke ("a deformation stroke

C" in the drawing) in which deformation of the shock absorbing structure 1 is restricted by bulging restriction of the ring member 3, and bottoming of the landed foot is prevented, and

4) a fourth deformation stroke ("a deformation stroke D" in the drawing) in which load decreases as the foot moves away from the ground, and the shape of the shock absorbing structure 1 is to be restored. Deformation of the shock absorbing structure 1 is thus restored.

[0053] Here, an area E1 surrounded by the deformation strokes A, B, C and D in Figure 17 is energy absorbed by the shock absorbing structure 1, and an area E2 surrounded by the deformation stroke D and a deformation axis represents energy which is not absorbed completely by the shock absorbing structure 1, that is, repulsion energy. The shock absorbing structure 1 having the large area E1 has a large shock absorbing characteristic, but hardly exhibits a repulsion characteristic, and is easily bottomed. Further, the shock absorbing structure 1 having the large area E2 is favorable for a countermeasure against bottoming, but has a large repulsion characteristic, and therefore, a shock absorbing effect cannot be expected. That is, the shock absorbing structure 1 that expresses the areas E1 and E2 in a well-balanced manner is preferable as a shoe part.

[0054] Next, a formation process of the aforementioned hysteresis in two-stage shock absorption of the shock absorbing structure 1 of the present invention will be described. First, in the primary shock absorbing stroke, only the column member 2 independently deforms (the first deformation stroke), and a gradient of the deformation stroke A to a magnitude of a generated repulsive force, i.e. a displacement, changes in accordance with physical properties of a material, a shape and a dimension of the column member 2. When the process shifts to the secondary shock absorbing stroke (the second deformation stroke) subsequently, the column member 2 and the ring member 3 compositely generate a repulsive force by the pressure receiving portion 4, and a gradient of the deformation stroke B to a displacement changes in accordance with the physical properties of materials, shapes and dimensions of the column member 2 and the ring member 3. Subsequently, in the third deformation stroke, the ring member 3 generates relatively large bulging deformation in a radial direction so that apparent rigidity of the ring material 3 itself increases, and deformation resistance is generated. In addition, in order to restrict bulging in the radial direction of the column member 2, deformation resistance of the column member 2 also increases, and a gradient of the deformation stroke C to a displacement compositely changes in accordance with the physical properties of the materials, shapes and dimensions of the column member 2 and the ring member 3. When the force which deforms the shock absorbing structure 1 is removed subsequently, a repulsive force response to an apparent increase amount of modulus of

elasticity by shape deformation or deformation restriction of the column member 2 and the ring member 3, and a displacement corresponding to the physical properties of the materials, shapes and dimensions of the column member 2 and the ring member 3, that is, a route of the deformation stroke D is determined, and a shock absorbing characteristic and a repulsion characteristic corresponding to the areas E1 and E2 of the hysteresis loop in the relationship between the deformation amount generated in the shock absorbing structure 1 and a force are exhibited.

[0055] The shock absorbing structure 1 of the present invention is configured as described above, whereby in the shock absorbing process, suppression of the compression deformation amount and adjustment of timing for increasing the repulsive force (adjustment of the shapes and the gradients in the loop of the deformation strokes B and C in Figure 17) can be achieved while keeping balance with the shock absorbing characteristic (E1), and therefore, coexistence of an excellent shock absorbing characteristic and repulsion characteristic is realized while bottoming is prevented. Note that as will be described later, the primary shock absorbing stroke and the secondary shock absorbing stroke can further give a multi-stage shock absorbing characteristic by changing configuration conditions.

[0056] Hereinafter, the column member 2, the ring member 3 and the pressure receiving portion 4 which configure the shock absorbing structure 1 will be further described.

[0057] First, the column member 2 will be described.

[0058] The column member 2 can be deformable and restorable at least along a pressure receiving direction in which load acts, and although a material is not specially limited, a rubber, gel and foams of them can be illustrated, for example. Among them, foams are more preferable in particular from the viewpoints of a lightweight property and a shock absorbing characteristic. Note that as specific kinds of foams, a thermoplastic resin such as an ethylene-vinyl acetate copolymer (EVA), a thermosetting resin such as a polyurethane, and a rubber material such as a butadiene rubber and a chloroprene rubber are cited.

[0059] When the column member 2 is formed of a foam, the column member 2 behaves in such a manner that internal foam spaces are substantially directly crushed by compression load at the time of pressure reception, and therefore, deformation (this will be referred to as bulging deformation) in a bulging direction substantially orthogonal to the pressure receiving direction is extremely small or hardly occurs, as shown in Figures 1(b) and (d) described above, for example. That is, when the column member 2 is a foam, the column member 2 directly performs compression deformation so as to substantially decrease a volume.

[0060] In contrast, when the column member 2 is formed from a solid material such as a rubber or gel, the column member 2 also easily causes bulging deformation in a direction (a transverse direction) substantially

orthogonal to the pressure receiving direction, with compression deformation, at the time of pressure reception, and causes bulging deformation so as to keep a volume constant as a behavior of deformation, as shown in Figures 1(a) and (c) described above, for example.

[0061] In this connection, respective drawings shown in Figures 1(a) to (d) described above are views skeletally showing shock absorption of the first stage (the primary shock absorbing stroke) to shock absorption of the second stage (the secondary shock absorbing stroke). That is, the primary shock absorbing stroke shows a deformation stage (compression deformation) in which only the column member 2 decreases a height dimension by received pressure load, and the secondary shock absorbing stroke shows a deformation stage (compression deformation) in which after compression deformation of only the column member 2 advances, the column member 2 and the ring member 3 both decrease height dimensions.

[0062] Here, in the secondary shock absorbing stroke shown in Figure 1(b), a side portion of the column member 2 formed of a foam is illustrated so as to be recessed inward by receiving bulging deformation of the ring member 3 (assumed as a solid material, here), but this is only an example showing a deformation behavior, and it is assumed that an actual deformation situation does not always become the illustrated deformation situation, depending on hardnesses of the ring member 3 and the column member 2, and the like.

[0063] Note that although in the present description, many column members 2 are assumed to be in columnar shapes (shapes in columns and obliquely cut columns), the shape of the column member 2 is not always limited to a columnar shape.

[0064] Next, the ring member 3 will be described.

[0065] The ring member 3 is formed to be smaller than the height dimension (a length dimension) of the column member 2 in the initial state (no-load state) where a load is not applied, forms a so-called short cylinder shape, and is provided by being fitted to an outer side of the column member 2. As described above, the ring member 3 causes compression deformation for itself to perform a shock absorbing action with advance of pressure reception as described above, and also performs an action of restricting deformation, in particular, bulging deformation of the column member 2 which is located inside of the ring member 3.

[0066] Further, as a material of the ring member 3, various rubber materials and gel materials, or foams of these materials are applicable, and depending on hardness or the like of the material, not only the shock absorbing action of itself but also a restriction force that restricts deformation of the column member 2 changes.

[0067] Note that on the assumption that the ring member 3 which is once fitted onto the column member 2 is not detached, that is, in a case where replacement of the ring member 3 is not performed (on the assumption of non-replacement), the ring member 3 can be bonded and fixed to the column member 2.

[0068] Meanwhile, when the ring member 3 is not bonded to the column member 2, and is made replaceable, an inside diameter of the ring member 3 is not specially limited with respect to an outside diameter of the column member 2 in a range in which the multi-stage shock absorbing action of the present invention can be exhibited, and by combination of the inside diameter of the ring member 3 and the outside diameter of the column member 2, a multi-stage shock absorbing characteristic can be adjusted. For example, the inside diameter of the ring member 3 is made smaller than the outside diameter of the column member 2 (a so-called "close fit"), and the ring member 3 may be firmly held by the column member 2 by using a fastening force of the ring member 3 itself at the time of the ring member 3 being fitted onto the column member 2. This state is a state in which stress bias is applied to both the ring member 3 and the column member 2, and the state can be properly adjusted by an inside diameter dimension of the ring member 3, for example, whereby various shock absorbing characteristics can be obtained. Further, when the inside diameter of the ring member 3 is made larger than the outside diameter of the column member 2, multi-stage shock absorbing performance in accordance with the size of a gap between an inner circumferential face of the ring member 3 and an outer circumferential face of the column member 2 is obtained. The inside diameter of the ring member 3 and the outside diameter of the column member 2 may be made the same as a matter of course.

[0069] Note that by making the ring member 3 replaceable, performance such as a shock absorbing characteristic, a repulsion characteristic, and a pronation characteristic can be adjusted on site in accordance with a change in condition of feet over time by running and walking for a long time, such as a long distance marathon, for example. Further, new development, interest and the like can be also provided to a user, such as enjoyment of unique arrangement by a user selecting the ring member 3 which meets a taste of the user (a sense of enjoying fashion) after purchase, and enjoyment of finding out multi-stage shock absorbing characteristics unique to the user.

[0070] Next, the pressure receiving portion 4 will be described.

[0071] The pressure receiving portion 4 is a part that transmits the load (load) at the time of pressure reception to the column member 2 and the ring member 3, and is capable of being provided as a member totally different from the sole S1 such as a midsole and an outer sole in the shoe S, or a part of the sole S1 can be used as the pressure receiving portion 4. When the pressure receiving portion 4 is formed as a part of the sole S1, the material of it becomes the same as the sole S1 as a matter of course, and even when the pressure receiving portion 4 is formed as the totally different member from the sole S1 as the member, the same material as the sole S1 can be applied. Note that when the pressure receiving portion 4 is formed from a material totally different from the sole

S1, a resin material or the like that is more rigid than the sole S1 can be applied, for example.

[0072] Further, in the present embodiment, as shown in Figures 1(a) to (d), for example, a clearance C is formed between the ring member 3 and the pressure receiving portion 4 in an initial state where no load is applied. When compression load is applied (at the time of pressure reception), only the column member 2 firstly starts compression deformation that decreases the height dimension (the length dimension), and after the column member 2 is compressed by a length dimension of the clearance C, the ring member 3 causes compression deformation. In this way, the ring member 3 does not undergo compression deformation as soon as impact compression load is applied, but since the above described clearance C is present in the present embodiment, the ring member 3 is in a state where the ring member 3 waits until start of compression deformation correspondingly to the clearance C. Consequently, a deformation wait region of the ring member 3 like this is used as an action wait portion 5, and in the present embodiment, the clearance C corresponds to the action wait portion 5. In other words, the action wait portion 5 (the clearance C in this case) like this is present, and thereby a multi-stage shock absorbing action sequentially deforming the column member 2 and the ring member 3 manifests.

[0073] Note that when the action wait portion 5 is configured, the action wait portion 5 is not necessarily limited to the clearance C which is provided between the ring member 3 and the pressure receiving portion 4, and the action wait portion 5 other than the clearance C will be described later.

[0074] Here, essence of the above described action wait portion 5 includes the two-stage shock absorbing action (multi-stage shock absorbing action) by causing a time difference between timings for starting deformation in the height direction of the column member 2 and the ring member 3, and a shock absorbing action in an oblique direction by the ring member 3 and the pressure receiving portion 4 being not bonded and fixed, and therefore, if the two actions are not lost, the action wait portion 5 is not limited to the mode of providing the clearance C. That is, even if the clearance C is not present, it is possible to form the action wait portion 5, in other words, provide a time difference in compression deformation of the column member 2 and the ring member 3, and this will be described hereinafter.

[0075] As the action wait portion 5 other than the clearance C, as shown in Figure 2(a), for example, a mode of forming a contact tip end portion to the pressure receiving portion 4 (an upper side pressure receiving portion 4U in this case) in the ring member 3 into an acute-angle shape on an entire circumference, and forming an unfilled space NS where no thickness (material) of the ring member 3 is present in that site is cited (since the ring member 3 contacts the pressure receiving portion 4, the unfilled space is not present as the clearance C). In this case, if load is applied, not only the column member 2 inside

causes compression deformation, but also the ring member 3 outside deforms (compression deformation) to decrease the height dimension (the length dimension) substantially simultaneously as shown in Figure 2(a) in combination. However, the deformation (compression deformation) of the ring member 3 in the primary shock absorbing stroke is a deformation behavior which is considered as the thickness (the material) of the ring member 3 which should originally perform bulging deformation moving to fill the above described unfilled space NS, and therefore, bulging deformation hardly occurs as external bulging deformation. Accordingly, a certain time difference occurs after start of pressure reception until the ring member 3 causes substantial bulging deformation, and therefore, the unfilled space NS like this becomes one of the action wait portions 5.

[0076] In this connection, in Figure 2(a) described above, the secondary shock absorbing stroke is illustrated by assuming that the ring member 3 is formed from a solid material, that is, the ring member 3 is drawn to bulge and deform after the unfilled space NS is substantially filled with the ring member 3 (the material), but when the ring member 3 is formed of a foam, bulging deformation like this is difficult to cause in many cases as described above. However, even if the ring member 3 is formed of a foam, a stepwise shock absorbing action occurs although the shock absorbing action is not so remarkable as in a case where the ring member 3 is formed from a solid material. That is, when the unfilled space NS is present, the unfilled space NS functions as the primary shock absorbing stroke until the unfilled space NS is filled, or until the ring member 3 bulges and deforms.

[0077] In this way, the action wait portion 5 is not always limited to the clearance C, but when the unfilled space NS is formed in the initial state, the unfilled space NS can be the action wait portion 5.

[0078] Further, as shown in Figure 2(a) described above, when the unfilled space NS as the action wait portion 5 is formed in the ring member 3, an effective working height where the ring member 3 performs substantial deformation is a height dimension obtained by subtracting "the length dimension of the action wait portion 5 (until the unfilled space NS is filled, or until the ring member 3 bulges and deforms)" from "a maximum height (in the initial state)".

[0079] When the clearance C is formed as the action wait portion 5 between the ring member 3 and the pressure receiving portion 4 (the upper side pressure receiving portion 4U) as shown in Figures 1(a) to (d) described above, the effective working height (the effective working height of the ring member 3) corresponds to the height dimension of the ring member 3 in the initial state, and becomes a dimension obtained by subtracting "the length dimension of the clearance C" from "the height dimension of the column member 2", as a matter of course.

[0080] Hereinafter, another mode of forming the unfilled space NS as the action wait portion 5 in the ring member 3 will be described. For this, recesses and pro-

trusions can be formed on a contact end edge to the pressure receiving portion 4 in the ring member 3, and as shown in Figure 2(b), for example, a plurality of partial protrusions 51 can be provided throughout an entire circumference on an upper end edge of the ring member 3. In more detail, only a top face of the protrusion 51 is brought into contact with the upper side pressure receiving portion 4U, and spaces among the protrusions 51 are used as the unfilled spaces NS (the action wait portions 5). Alternatively, as shown in Figure 2(c), for example, the unfilled spaces can be also realized by providing a plurality of partial recesses 52 throughout the entire circumference on the upper end edge of the ring member 3. More specifically, the recess 52 itself is made the unfilled space NS, and a site (the upper end edge of the ring member 3) where the recesses 52 are not formed is brought into contact with the upper side pressure receiving portion 4U.

[0081] Further, an embodiment shown in Figure 2(d) is a mode where concentric corrugated recesses and protrusions 53 along a circumferential direction are formed in multiple layers on the upper end edge of the ring member 3, and the unfilled spaces NS as the action wait portions 5 can be also formed in this way. That is, in this case, top portions (the highest portions) of the corrugated recesses and protrusions 53 contact the upper side pressure receiving portion 4U, and the other non-contact portions (spaces formed among the individual waves) correspond to the unfilled spaces NS (the action wait portions 5). Here, as shown in Figure 2(e) as an example, the corrugated recesses and protrusions 53 may be formed to be located at a higher position toward an outer circumferential side of the ring member 3. That is, in this case, the upper end edge of the ring member 3 on which the corrugated recesses and protrusions 53 are formed has a difference of elevation, and is formed into an inclined shape (a so-called "mortar-shape") which is lower toward an inner side and higher toward an outer side as a whole.

[0082] Furthermore, an embodiment shown in Figure 2(f) is a mode in which the corrugated recesses and protrusions 53 on the upper end edge of the ring member 3 are formed to roll (rises and falls) along a circumferential direction (not in a concentric shape). As a matter of course, the recessed-and-protruded shape in this case does not necessarily have to be in a corrugated shape, but as shown in Figure 2(g), for example, the upper end edge of the ring member 3 is cut into a plurality of semicircular shapes seen in the radial direction (these parts are referred to as cutouts 54), and can be brought into a substantially same state as the corrugated recesses and protrusions 53 shown in Figure 2(f), for example.

[0083] Although in the above described explanation, the unfilled space NS as the action wait portion 5 is described as being exclusively formed in the ring member 3, the action wait portions 5 like this can be provided not only in the ring member 3 but also in the pressure receiving portion 4, the column member 2 and the like. More

specifically, as shown in Figure 3(a), for example, a plurality of protrusions 55 that partially contact the ring member 3 can be provided at a substantially entire circumference of a lower end edge of the upper side pressure receiving portion 4U. In this case, the ring member 3 partially contacts the upper side pressure receiving portion 4U in the initial state, and therefore, shows a same deformation behavior as described above, and the protrusions 55 of the upper side pressure receiving portion 4U form the unfilled spaces NS as the action wait portion 5.

[0084] Further, when the unfilled space NS (the action wait portion 5) is formed between the ring member 3 and the upper side pressure receiving portion 4U, a partial contact region to the upper side pressure receiving portion 4U does not necessarily have to be formed throughout an entire circumference of the ring member 3 as shown in Figure 2 described above, but as shown in Figure 3(b), for example, what is obtained by obliquely cutting a member in a short cylindrical shape can be made the ring member 3. That is, in this case, only an uppermost end portion of the ring member 3 contacts the upper side pressure receiving portion 4U in the initial state, and non-contact parts correspond to the unfilled spaces NS (the action wait portions 5).

[0085] Further, a wall thickness dimension in the radial direction in the ring member 3 in this case does not have to be constant throughout the entire circumference, as shown in Figure 3(c), for example, and in this case, an example is illustrated, in which the column member 2 is provided in an eccentric state with respect to the ring member 3 and axes of both of them do not correspond to each other.

[0086] Next, a relationship between "the height (the effective working height) of the column member 2" and "the effective working height of the ring member 3" will be described.

[0087] In multi-stage shock absorption in the shock absorbing structure 1 of the present invention, one of large features is a deformation behavior such that after the column member 2 undergoes compression deformation first at the time of pressure reception, the ring member 3 subsequently undergoes compression deformation. That is, the ring member 3 undergoes compression deformation with a time difference (a time lag) from the compression deformation of the column member 2.

[0088] To put it plainly, "the height dimension of the column member 2" > "the effective working height dimension of the ring member 3" is satisfied.

[0089] A ratio as a specific numeric value of this, that is, a ratio of "the effective working height dimension of the ring member 3" to "the height dimension of the column member 2" is preferably 0.2 to 0.95, and is more preferably 0.5 to 0.85.

[0090] The reason why "(the effective working height)" in parentheses is also written alongside the height of the column member 2 is that the member in which the unfilled space NS as the action wait portion 5 is formed is not

always limited to the ring member 3 as described above.

[0091] Next, a technical meaning of the above described height ratio will be described.

[0092] First of all, when the above described height ratio is less than 0.2 (a lower limit), favorable multi-stage shock absorbing deformation cannot be realized, and a strength support action for the column member 2 by the ring member 3 further decreases, so that the load flexibility of the column member 2 increases (the column member 2 easily causes buckling at the time of pressure reception), and stability at a time of running and at a time of walking is reduced.

[0093] Further, if the above described height ratio exceeds 0.95 (an upper limit), a distance between the pressure receiving portion 4 and the ring member 3 is too short (for example, the clearance C which is the action wait portion 5 is too small), and effective multi-stage shock absorbing deformation is lost.

[0094] Note that materials (combination) of the column member 2 and the pressure receiving portion 4 are properly selected in accordance with an object, and these components may be formed from the same material, or may be formed from different materials.

[0095] When the column member 2 and the pressure receiving portion 4 are formed as separate members, regardless of whether they are formed from different kinds of materials, or the same kind of material, the column member 2 and the pressure receiving portion 4 can be bonded after formation. As a matter of course, when the column member 2 and the pressure receiving portion 4 are integrally formed from the beginning, productivity can be enhanced, and possibility of separation in a case where these components are formed as separate members and bonded also can be eliminated (in other words, ensuring adhesive strength).

[0096] When the column member 2 and the pressure receiving portion 4 are integrally formed, multicolor injection molding or the like can be applied, and is further preferable when the column member 2 and the pressure receiving portion 4 are desired to be integrated with the sole S1.

[0097] Further, as combinations of materials of the column member 2 and the ring member 3, as respectively shown in Figures 1(a) to (d) as examples, in sequence of the column member 2/the ring member 3, combinations of a solid material/a solid material, a foam/a solid material, a solid material/a foam, and a foam/a foam are possible, and since the multi-stage deformation characteristics (deformation behaviors) differ in accordance with the respective combinations, the combination can be properly selected in accordance with intended shock absorbing performance.

[0098] Hereinafter, deformation behaviors (shock absorbing characteristics) of the shock absorbing structure 1 in the respective combinations will be described.

(1) Case of solid material/solid material: Figure 1(a)

[0099] In this combination, a behavior is such that the column member 2 also bulges (bulging deformation) in the radial direction with compression deformation at the time of pressure reception, and the ring member 3 restricts the bulging deformation. Therefore, the shock absorbing structure 1 of the present combination shows a multi-stage shock absorbing characteristic with relatively high elasticity.

(2) Case of foam/solid material: Figure 1(b)

[0100] In this combination, the column member 2 is easily crushed directly in the pressure receiving direction at the time of pressure reception, and a volume is easily reduced, so that bulging deformation of the column member 2 becomes smaller as compared with Figure 1(a) described above, and switch of the repulsion characteristic by deformation of the ring member 3 from the compression deformation of the column member 2 becomes more remarkable as compared with Figure 1(a) described above. Therefore, the present combination is a combination which is suitable for a design that exhibits a soft shock absorbing characteristic at an initial stage of the time of pressure reception, gradually enhances a repulsion characteristic, and causes the shock absorbing characteristic and the repulsion characteristic to coexist with each other.

[0101] Since the sole S1 is often formed of a foam, the present combination is also preferable when the column member 2 is desired to be integrated with the sole S1, and also contributes to reduction in a weight of the shoe S.

(3) Case of solid material/foam: Figure 1(c)

[0102] In this combination, the column member 2 causes bulging deformation at the time of pressure reception, but since the ring member 3 is made of a foam, the restriction effect which is given to the column member 2 by the ring member 3 becomes small, and the compression deformation repulsive force of the ring member 3 itself also becomes small. Consequently, the present combination is a combination that is suitable for a case where a multi-stage shock absorbing effect is desirably designed to be small.

(4) Case of foam/foam: Figure 1(d)

[0103] Since in this combination, the column member 2 and the ring member 3 are both formed of foams, the compression deformation repulsive forces of the respective members themselves are small, and the restriction effect on the column member 2 by the ring member 3 is small, so that this combination is a combination suitable for a case where the multi-stage shock absorbing performance as the shock absorbing structure 1 is desirably designed to be smaller than that in Figure 1(c) described

above.

[0104] In the case of the present combination, a repulsion characteristic exhibited by the shock absorbing structure 1 after absorbing impact (after compression) cannot be expected so much, but the present combination is a combination that is suitable for a case where the shock absorbing structure 1 is provided in a site on which a body weight and impact are not exerted so much, such as a substantially central portion on a bottom face in the sole S1. That is, this is because even though an impact absorbing characteristic and a multi-stage shock absorbing characteristic as actual actions are low, when the shock absorbing structures 1 are provided on an entire bottom face of a sole, the shock absorbing structures 1 sufficiently have feelings of satisfaction and fulfillment given to the user. In connection to this, when the user purchases the shoes S, the user often actually touches the shock absorbing structure 1 like this, in particular, the ring member 3 with hands and fingers (refer to Figure 1), and even when the shock absorbing structures 1 may be provided at only sites which functionally require the shock absorbing structures 1, a product in which the shock absorbing structures 1 are provided on an entire bottom face of the sole further encourages the user to buy the product.

[0105] Next, hardnesses of the column member 2 and the ring member 3 will be described.

[0106] A hardness of the column member 2 is preferably an Asker C hardness of 30 to 100 or a JIS A hardness of 40 to 120, whereas a hardness of the ring member 3 is preferably a JIS A hardness of 30 or less, and with the combination within the range, the multi-stage shock absorbing performance of the shock absorbing structure 1 is desirably adjusted properly.

[0107] Hereinafter, a technical meaning of setting the hardnesses of the column member 2 and the ring member 3 at the above described hardnesses will be described.

[0108] This is because if the hardness of the column member 2 is less than the lower limit value (assumption of being soft), the repulsion characteristic is worsened irrespective of the hardness of the ring member 3, and stability at the time of walking and at the time of running is sometimes reduced, whereas when the hardness of the column member 2 exceeds the upper limit value (assumption of being hard), compression deformation of the column member 2 is difficult to cause, and the multi-stage shock absorbing action is sometimes difficult to exhibit, irrespective of the hardness of the ring member 3.

[0109] Further, the hardness of the ring member 3 affects a multi-stage shock absorbing behavior by synergy of easiness of compression deformation of the ring member 3 itself and a restriction action of bulging deformation of the column member 2 at the time of pressure reception, and if the same column member 2 is used, for example, the shock absorbing performance becomes higher as the hardness of the ring member 3 becomes smaller (softer), but the repulsion characteristic tends to reduce, whereas

as the hardness of the ring member 3 becomes larger (harder), the multi-stage shock absorbing characteristic is reduced, but the repulsion characteristic tends to increase. However, if the hardness of the ring member 3 is less than the lower limit value, the repulsion characteristic as the entire shoe S is significantly reduced, and stability in running and walking is not obtained in some cases. Meanwhile, if the hardness of the ring member 3 exceeds the upper limit value (assumed to be hard), the repulsion characteristic can be ensured, but shock absorbing characteristic is reduced in some cases, and therefore, the hardness of the ring member 3 is set to be in the above described hardness range.

[0110] Although the deformation behavior of the shock absorbing structure 1 of the present invention is in such a manner that the column member 2 causes compression deformation first, and thereafter the ring member 3 performs compression deformation with a time difference left as described above, the deformation behavior of the shock absorbing structure 1 is not always limited to two stages, but multi-stage shock absorption with three stages or more is also possible, and other various kinds of shock absorbing performance are further obtained. Hereinafter, modes like them will be described.

[0111] First, an embodiment shown in Figure 4(a) is a mode that can exhibit shock absorbing performance of three stages, and a configuration is on the basis of a configuration in which the ring members 3 with different heights are provided in two layers by being fitted onto the column member 2. Here, properties of the ring member 3 in the two layers may be of the same kind or different kinds. Note that reference sign 31 in the drawing denotes an inner side ring member, and reference sign 30 in the drawing denotes an outer side ring member.

[0112] In this case, a primary shock absorbing stroke is compression deformation of only the column member 2, and if the column member 2 is formed of a foam, the column member 2 is assumed to hardly undergo bulging deformation. The present drawing is illustrated on the basis of the assumption.

[0113] Further, a secondary shock absorbing stroke is a composite stroke in which deformation (compression and bulging) of the inner side ring member 31 is added to the compression deformation of the column member 2, and if the inner side ring member 31 is formed from a solid material, the inner side ring member 31 is assumed to cause (or easily cause) bulging deformation, following compression deformation. The present drawing is illustrated on the basis of the assumption. In this way, deformation of the inner side ring member 31 is added in the present stroke, so that the shock absorbing structure becomes more difficult to crush than in the primary shock absorbing stroke as a matter of course (the shock absorbing characteristic is reduced), and a repulsion characteristic becomes larger than in the primary shock absorbing stroke.

[0114] Thereafter, deformation (compression and bulging) of the outer side ring member 30 is further added

to the compression deformation of the column member 2 and deformation (compression and bulging) of the inner side ring member 3I, and this stage corresponds to a tertiary shock absorbing stroke. Here, in the tertiary shock absorbing stroke, the shock absorbing structure is more difficult to crush than in the secondary shock absorbing stroke (the shock absorbing characteristic is reduced) as deformation (compression and bulging) of the outer side ring member 3O is added, and the repulsion characteristic further becomes larger than in the secondary shock absorbing stroke.

[0115] By providing the ring members 3 by being fitted onto the column member 2 in multiple layers, multi-stage shock absorbing performance is obtained.

[0116] Although in the present drawing, the height dimension of the inner side ring member 3I is formed to be larger than that of the outer side ring member 3O, the height dimension is not necessarily limited to this, and the inner side ring member 3I may be formed to be taller. In this case, a deformation behavior different from the above description is performed, and shock absorbing performance is obtained.

[0117] Further, an embodiment shown in Figure 4(b) is a mode in which a sectional size in plan view of the column member 2 is not constant, that is, a size of a section varies in the pressure receiving direction, and in this case, a mode in which an upper side of the column member 2 is formed into a truncated cone shape, and a lower side is formed into a columnar shape is illustrated.

[0118] In this case, a primary shock absorbing stroke is a stage in which only the truncated cone portion of the upper portion of the column member 2 causes deformation (compression deformation), and if the column member 2 is formed of a foam, the column member 2 is assumed to hardly undergo bulging deformation. The present drawing is illustrated on the basis of the assumption.

[0119] Further, a secondary shock absorbing stroke is a stage in which the column member 2 (a column portion) after the primary shock absorbing stroke undergoes compression deformation until the column member 2 has a substantially same height as the ring member 3, and in this case, the shock absorbing structure in the present secondary shock absorbing stroke becomes somewhat more difficult to crush than that in the primary shock absorbing stroke, so that repulsion characteristic becomes large. This is because in the secondary shock absorbing stroke, the sectional area of the column member 2 which is compressed is larger, and the column member 2 itself is gradually closer to a crushing limit (compression limit), and the like. Further, from a point of view like this, in the case shown in Figure 4(b), crushing difficulty also increases gradually in the primary shock absorbing stroke.

[0120] A tertiary shock absorbing stroke is a composite stroke in which deformation (compression and bulging) of the ring member 3 is added to compression deformation of the column member 2 (the column portion) like this, and if the ring member 3 is formed from a solid ma-

terial, the ring member 3 is assumed to cause bulging deformation (or easily cause), with compression deformation. The present drawing is illustrated on the basis of the assumption. As a matter of course, crushing difficulty is more significantly enhanced than in the primary shock absorbing stroke and the secondary shock absorbing stroke, and in the tertiary shock absorbing stroke, a repulsion characteristic abruptly occurs.

[0121] Further, an embodiment shown in Figure 4(c) is a mode in which the ring members 3 with different properties are provided by being fitted to be in a line in series in the vertical direction. Here, reference sign 3U in the drawing denotes a ring member which is fitted to an upper side, and reference sign 3D in the drawing denotes a ring member fitted to a lower side. Although in the present drawing, the clearance C is provided by being divided to a plurality of spots, various modes can be adopted as a way of taking the clearance C.

[0122] Although specific illustration of multi-stage shock absorbing deformation in the shock absorbing structure 1 of the present embodiment is omitted, a primary shock absorbing stroke is a stage in which only the column member 2 causes compression deformation by length dimensions of the clearances C (a sum total), and if the column member 2 is formed of a foam, the column member 2 hardly undergoes bulging deformation.

[0123] Further, a secondary shock absorbing stroke is a composite stroke in which deformation (compression and bulging) of the ring member 3 is added to the compression deformation of the column member 2, and at this time, the ring member 3 (for example, the upper side ring member 3U) which is softer in properties and is more easily bulged, for example, undergoes compression or bulging deformation first. Further, as pressure reception to the shock absorbing structure 1 advances, a deformation degree is larger in the ring member 3 (for example, the upper side ring member 3U) which is more easily bulged. Accordingly, when the ring members 3 with different properties are provided by being fitted in series like this, various shock absorbing characteristics are obtained, or at least a shock absorbing property, which is different from the case where the single ring member 3 is provided by being fitted onto the column member 2, is obtained.

[0124] Although in the aforementioned embodiment, the height (effective working height) of the ring member 3 which is constant throughout the entire circumference is basically illustrated, the height dimension of the ring member 3 does not always have to be constant throughout the entire circumference, but can be made to differ partially.

[0125] More specifically, as shown in Figure 5(a), for example, the ring member 3 can be formed so that an upper end edge and a lower end edge of the ring member 3 forming a short cylinder shape are inclined to form a taper shape in a side view state. Here, in the present drawing, a side with a smaller height dimension of the ring member 3 (a shorter side as the length dimension)

is illustrated as a right side, and a side with a larger height dimension of the ring member 3 (a longer side as the length dimension) is illustrated as a left side.

[0126] A primary shock absorbing stroke in the present embodiment is a stage in which only the column member 2 causes deformation (compression deformation) until the upper and lower pressure receiving portions 4U and 4D contact the ring member 3 (the side with a larger working height dimension), and if the column member 2 is formed of a foam, the column member 2 is assumed to hardly undergo bulging deformation as shown in Figure 5(a) in combination. The present drawing is illustrated on the basis of the assumption.

[0127] Further, a secondary shock absorbing stroke is a composite stroke in which deformation (compression and bulging) of the ring member 3 is added to the compression deformation of the column member 2 like this, and if the ring member 3 is formed from a solid material, the ring member 3 is assumed to cause (or easily cause) bulging deformation, with compression deformation. The present drawing is illustrated on the basis of the assumption.

[0128] Since in the present secondary shock absorbing stroke, the ring member 3 is originally in a taper shape in side view, and the side with the larger height dimension is more difficult to deform than the side with the smaller height dimension (difficult to compress and bulge) or the like, the upper and lower pressure receiving portions 4 become nonparallel, and the pressure receiving portions incline toward the smaller height side of the ring member 3 as illustrated.

[0129] When the shock absorbing structure 1 like this (the shock absorbing structure 1 that tilts while exhibiting a shock absorbing action at the time of pressure reception) is provided in the shoe S, leaning directions of feet of a wearer can be controlled while impact which is applied to the foot (the shoe S) is absorbed, in a period from a landing motion of the foot to a kicking-out motion, for example. That is, human feet are generally equipped with an action called "pronation (inward roll)" that alleviates impact by ankles leaning inward when receiving impact at a time of landing. However, when the leaning of ankles becomes excessively large due to a physical constitution, fatigue or the like, such leaning is said to become "overpronation (excessive inward roll)", and cause troubles in the knees and back, and in such a case, the shock absorbing structure 1 as described above is provided (for example, the side with the larger height dimension of the ring member 3 is disposed to face an inner side (IN side) of the foot), whereby the inward roll speed is decreased, and overpronation can be prevented.

[0130] In this way, the shock absorbing structure 1 of the present invention can not only simply absorb and alleviate the applied impact, but also can have an action of guiding the impact to a specific direction in addition.

[0131] Further, an embodiment shown in Figure 5(b) is a mode in which only an upper end edge is inclined while a lower end edge of the ring member 3 is formed

in a substantially horizontal state, and the ring member 3 is formed to form a slope shape in a side view state.

[0132] Although it is difficult to illustrate specific multi-stage shock absorbing deformation in the present embodiment, a primary shock absorbing stroke is also a stage in which only the column member 2 causes compression deformation until the upper side pressure receiving portion 4U contacts a tip end of the ring member 3, and if the column member 2 is formed of a foam, the column member 2 hardly undergoes bulging deformation.

[0133] Further, a secondary shock absorbing stroke is a composite stroke in which deformation (compression and bulging) of the ring member 3 is added to the compression deformation of the column member 2, and if the ring member 3 is formed from a solid material, the ring member 3 causes (easily causes) bulging deformation.

[0134] Consequently, in the secondary shock absorbing stroke, the upper side pressure receiving portion 4U inclines toward the smaller height side of the ring member 3, and can prevent the foot of the wearer from overpronating, for example, as described above.

[0135] When the ring member 3 is formed into a slope shape in side view, the slope shape can be also realized by inclining only the lower end edge of the ring member 3, and a similar effect can be obtained.

[0136] Further, causing the height dimension of the ring member 3 to differ partially is not limited to the modes of inclining the upper end edge and the lower end edge of the ring member 3, but as shown in Figure 5(c), for example, the upper end edge and the lower end edge of the ring member 3 can be partially cut out (these portions are referred to as cutouts 31), and the height dimension of the ring member 3 can be partially made small. Note that in Figure 5(c), the upper and lower cutouts 31 are provided to be located on a substantially vertical straight line, and in this case, in the secondary shock absorbing stroke, the upper side pressure receiving portion 4U deforms to incline toward a site with a smaller height dimension.

[0137] The upper and lower cutouts 31 formed in the ring member 3 can be formed by being shifted somewhat in a circumferential direction as shown in Figure 5(d), for example, and in this case, a twist action is considered to be applied to the upper and lower pressure receiving portions 4 simultaneously with the inclining motion of the pressure receiving portion 4. That is, the shock absorbing structure 1 in this case can guide the foot to a specific direction in such a manner as to twist the foot while tilting the foot at the time of absorbing impact.

[0138] Further, in the ring member 3, a wall thickness dimension in the radial direction does not have to be constant throughout an entire circumference, but as shown in Figure 5(e), for example, the column member 2 is provided in an eccentric state to the ring member 3, and the wall thickness dimension in the radial direction of the ring member 3 can be made to differ. In this case, if the height dimension of the ring member 3 is constant on the entire

circumference, as shown in Figure 5(e) in combination, the pressure receiving portion 4 inclines (easily inclines) toward a smaller wall thickness side (a thinner side) of the ring member 3 at the time of pressure reception, and has the same guiding action as described above.

[0139] If the ring member 3 is not fixed by bonding or any other means to the column member 2, the user can properly set a tilt direction (a load guiding direction) by rotating the ring member 3 at will, as shown in Figure 5(f), for example, and a pleasure of finding out a unique shock absorbing characteristic can be provided to the user. In this connection, such an idea can be widely applied to a case where the ring member 3 is not fixedly attached to the column member 2, and the tilt direction and the load guiding direction can be changed in accordance with a position where the ring member 3 is provided by being fitted.

[0140] Further, in the column member 2, a depressed concave-shaped ring bulging space AS can be formed in a contact site to the ring member 3, as shown in Figure 6(a), for example. The ring bulging space AS functions as a deformation space in a case where the ring member 3 causes bulging deformation at the time of pressure reception, as shown in a secondary shock absorbing stroke drawn in Figure 6(a), so that the ring member 3 easily undergoes bulging deformation, and the ring bulging space AS can enhance a shock absorbing characteristic (an impact absorbing characteristic) as the shock absorbing structure 1.

[0141] Although in Figure 6(a), an inner circumferential face (ring bulging space AS side) of the ring member 3 which bulges in the secondary shock absorbing stroke is illustrated to reach an inner part in the ring bulging space AS, a deformation behavior is not always limited to such a deformation behavior, and it is conceivable that the inner circumferential face of the ring member 3 does not reach the inner part of the ring bulging space AS depending on the hardnesses of the ring member 3 and the column member 2, and the like. However, at least a deformation space for the ring member 3 is ensured by the ring bulging space AS, and therefore, the ring member 3 is easily deformed at the time of pressure reception.

[0142] Further, the ring bulging space AS is not necessarily provided only in the column member 2, but also can be provided in the ring member 3 as shown in Figure 6(b), for example. In this case, the ring bulging space AS functions as the deformation space for the ring member 3 at the time of pressure reception, and enhances the shock absorbing characteristic, in particular, the impact absorbing characteristic as the shock absorbing structure 1. Note that in this case, the ring bulging space AS formed in the ring member 3 seems to reduce gradually, with advance of pressure reception, apparently.

[0143] Modes of providing the ring bulging spaces AS in the column member 2 and the ring member 3 are the modes of forming cavities in the mutual contact portions, and decreasing the contact areas of both of them, and therefore, the restriction force to the column member 2

by the ring member 3 is somewhat reduced. Further, deformation of the column member 2 at the time of pressure reception occurs easily correspondingly.

[0144] Further, a bulging restriction portion ER that restricts bulging deformation of the ring member 3 can be provided outside (at an outer circumferential side of) the ring member 3, as shown in figure 7, for example.

[0145] Here, Figure 7(a) shows a mode in which the bulging restriction portion ER is formed at one side of an outside of the shock absorbing structure 1 like a standing wall. In this case, as shown in the drawing, the ring member 3 naturally bulges significantly to a side without the wall, especially in a secondary shock absorbing stroke. That is, the ring member 3 undergoes bulging deformation significantly in a site where the bulging restriction portion ER is not present as much as bulging deformation is restricted by the bulging restriction portion ER.

[0146] Further, Figure 7(b) shows a mode in which the bulging restriction portion ER is formed into a ring shape (an annular shape) in an upper portion of the shock absorbing structure 1, and this is on the assumption that the shock absorbing structure 1 is installed on the sole of the shoe S. Further, for this reason, the upper side pressure receiving portion 4U is formed integrally with the sole S1, and the bulging restriction portion ER corresponds to slashed portions in the drawing, and is also formed integrally with the sole S1 or provided in a buried state. In this case, as also shown in Figure 7(b), an upper side of the ring member 3 is firmly in close contact with the bulging restriction portion ER, especially in the secondary shock absorbing stroke, and correspondingly to this, the ring member 3 bulges greatly at a lower side where no bulging restriction portion ER is present.

[0147] Further, Figure 7(c) is a mode in which the bulging restriction portion ER is provided by being directly fitted to an outer side of the ring member 3, and assumes a case where a hard metal ring is applied as the bulging restriction portion ER, for example. In this case, a deformation situation of the ring member 3, that is, the shock absorbing performance of the shock absorbing structure 1 differs, depending on a position where the bulging restriction portion ER is provided.

[0148] Like this, as for the bulging restriction portion ER, a material, a shape, an installation spot, a number of bulging restriction portions ER to be provided and the like can be properly set in accordance with how the ring member 3 is desirably deformed and restricted at the time of pressure reception (in accordance with intended control). Conversely speaking, the shock absorbing performance of the shock absorbing structure 1 can be controlled by controlling a way of deformation of the column member 2 and the ring member 3 at the time of pressure reception.

[0149] In the embodiment described above, the column member 2 (or the ring member 3) is basically formed from one kind of material, but the present invention is not necessarily limited to this, and as shown in Figure 8(a), for example, the single column member 2 can be formed

from materials having different properties in an upper portion and a lower portion thereof so that hardnesses (repulsive forces) or the like can be caused to differ. In this case, deformation of the column member 2 at the time of pressure reception, the bulging deformation especially in a case where the column member 2 is formed from a solid material differs between the upper portion and the lower portion even in the same column member 2. More specifically, the portion with a lower hardness more easily undergoes bulging deformation, and a bulging degree thereof is larger.

[0150] Further, an embodiment shown in Figure 8(b) is a mode where properties such as hardness are made to differ between a left and right semicircular column portions, in the single column member 2. In this case, deformation, in particular, compression deformation of the column member 2 at the time of pressure reception differs between the left and right of the column member 2 even in the same column member 2, so that the upper side pressure receiving portion 4U tilts to the semicircular column side with a lower hardness (softer), and correspondingly to this, a bulging degree of the semicircular column side with the lower hardness becomes larger.

[0151] Further, an embodiment shown in Figure 8(c) is a mode in which properties such as hardness are made to differ between an upper portion and a lower portion of the single ring member 3. In this case, the restriction forces to the column member 2 by the ring member 3 also differ in an upper part and a lower part, and deformation of the ring member 3 itself at the time of pressure reception, bulging deformation especially in the case where the ring member 3 is formed from a solid material, differs in the upper part and the lower part.

[0152] An embodiment shown in Figure 8(d) is a mode in which in the single ring member 3, only an inner side (an inner circumferential side) of a lower portion thereof has different kinds of properties, the restriction forces to the column member 2 by the ring member 3 also differ in an upper part and a lower part in this case, and deformation (bulging deformation) of the ring member 3 itself at the time of pressure reception also differs in the upper part and the lower part.

[0153] Even when the single ring member 3 is formed from the same material, properties can be made to differ partially, and if a number of small holes 32 are opened in only a lower portion of the ring member 3, as shown in Figure 8(e), for example, the properties can be made to differ partially even in the same ring member 3.

[0154] Further, when properties such as hardness are made to differ in the same column member 2 or ring member 3, the properties can be made to differ in a multi-stage state of three stages or more. More specifically, as shown in Figure 8(f), for example, it is possible to form upper and lower portions of the single column member 2 from a material having the same properties (low hardness, for example), and form a middle portion from a material having different properties (high hardness, for example). In this connection, in Figure 8(f), the properties

of the ring member 3 are not changed.

[0155] Further, as shown in Figure 8(g), for example, it is also possible to form upper and lower portions of the single ring member 3 from a material having the same properties (high hardness, for example), and form a middle portion from a material having different properties (low hardness, for example). In this connection, properties of the column member 2 are not changed in Figure 8(g).

[0156] As a matter of course, properties such as hardness of both the column member 2 and the ring member 3 may be caused to differ, as shown in Figures 8(h) to (j), for example. As for smudging attached to sectional views of Figures 8(h) to (j), the same kinds of smudging show materials with the same properties (hardness and the like).

[0157] Further, although in each of the embodiments described above, both the column member 2 and the ring member 3 are basically formed into straight shapes in the height direction, that is, formed to have the same sectional shapes and the same sectional sizes in the vertical direction, the present invention is not necessarily limited to this. More specifically, as shown in Figure 9(a), for example, a mode in which the ring member 3 which is narrowed toward an upper side is provided by being fitted onto the column member 2 in the columnar shape can be adopted. In this case, a wall thickness dimension in the radial direction of the ring member 3 becomes larger toward a lower side, so that the ring member 3 becomes more difficult to deform in a lower portion at the time of pressure reception (in particular, bulging deformation), and the shock absorbing characteristic becomes lower toward the lower portion of the ring member 3.

[0158] Further, an embodiment shown in Figure 9(b) is a mode in which the column member 2 is formed into a truncated cone shape narrower toward a bottom, and the ring member 3 with a wall thickness dimension in a radial direction made substantially constant is provided by being fitted to a circumference of the column member 2. Since in this case, the wall thickness dimension of the ring member 3 is substantially constant, a difference does not occur in easiness (difficulty) of deformation, in other words, a shock absorbing characteristic to the ring member 3 itself, but the dimension in the radial direction of the column member 2 becomes smaller toward the lower portion, and therefore, deformation more easily occurs (in particular, bulging deformation more easily occurs) toward the lower portion at the time of pressure reception.

[0159] Further, when the sectional shapes and the sectional sizes of the column member 2 and the ring member 3 are varied, the sectional shapes and the sectional sizes are not always varied smoothly (uniformly), but the sectional size (diameter dimension) of the ring member 3 may be varied in a stepwise manner in the height direction as shown in Figures 9(c) and (d), for example, whereby more various kinds of multi-stage shock absorbing performance can be realized.

[0160] An embodiment shown in Figure 9(d) is the shock absorbing structure 1 in which the sectional size (the diameter dimension) of the ring member 3 is varied in the stepwise manner in the height direction, and the ring member 3 is formed into a spiral shape. In this case, a twist action is applied as the ring member 3 deforms to extend and contract in the vertical direction, and therefore, the shock absorbing structure 1 in this case is useful, for example, in a case where a user having a habit of excessive inward roll or excessive outward roll desires to get out of the habit, at a time of running, and the like.

[0161] Further, although in the embodiments described above, the upper and lower pressure receiving portions 4 are formed into the state respectively separate and independent, the present invention is not necessarily limited to this, and as shown in Figure 10, for example, it is possible to connect the upper and lower pressure receiving portions 4, and cause the upper and lower pressure receiving portions 4 to function as a so-called flat spring. In this case, in addition to the elasticity of the column member 2, the elasticity of the ring member 3 itself, and the restriction force to the column member 2 by the ring member 3, elasticity of the upper and lower pressure receiving portions 4 which function as the flat spring is added, and therefore, a more peculiar multi-stage shock absorbing characteristic is shown.

[0162] In this connection, when the upper and lower pressure receiving portions 4 are connected like the flat spring as in the present embodiment, the pressure receiving portions 4 are preferably formed of a different member from the sole S1, for example, a totally different rigid resin material, and a polyether block amide copolymer (for example, Pebax (a registered trademark)) or the like is applicable to this case, as an example.

[0163] Further, although in the embodiments described above, the single shock absorbing structure 1 includes the single column member 2, the present invention is not necessarily limited to this. More specifically, as shown in Figure 11, for example, it is possible to provide a plurality of column members 2 in the single shock absorbing structure 1, and this is a mode in which the column members 2 are formed into a cage shape.

[0164] Here, for example, Figure 11(a) shows a mode in which the single ring member 3 is fitted onto outer sides of a plurality of column members 2. However, as a mode of providing the ring member 3 by fitting, it is possible to fit the ring members 3 to the respective column members 2 one by one (the ring members 3 of the same number as the column members 2 are required), as shown in Figure 11(b), for example, and in addition, as shown in Figure 11(c), for example, it is possible to divide a plurality of column members 2 into several groups, and provide the ring members 3 by fitting the ring members 3 to the respective groups (the number of ring members 3 is smaller than the number of column members 2).

[0165] In this way, when three column members 2 or more are provided in the single shock absorbing structure 1, various multi-stage shock absorbing characteristics

and load guide characteristics can be caused to appear by changing a pattern of providing the ring member 3 by fitting. Further, if hardnesses, the thicknesses (shapes) and the like of the respective column members 2 and the respective ring members 3 are caused to differ, more various shock absorbing characteristics can be caused to appear. The plurality of column members 2 shown in Figure 11 may be formed from a material of the same properties, or may be formed from materials of different kinds of properties.

[0166] In this connection, in the case where the ring members 3 are provided by being fitted to the individual column members 2 one by one, or the like, as shown in Figure 11(b) described above, the adjacent shock absorbing structures 1 (the ring members 3) can interfere with one another at the time of pressure reception, as shown in a side sectional view in Figure 11(b), and therefore, more various shock absorbing characteristics can be obtained by the interference. As a matter of course, in the case like Figure 11(c) described above, the ring members 3 similarly interfere with each other at the time of pressure reception.

[0167] Further, when a plurality of column members 2 are provided in the single shock absorbing structure 1 as in Figure 11 described above, it is possible to form the individual column members 2 from a rigid resin material, and subject the column members 2 to bulging deformation positively to an outer circumferential side especially from the primary shock absorbing stroke at the time of pressure reception.

[0168] Here, as an example of the rigid resin material, a polyether block amide copolymer (for example, Pebax (registered trademark)) is cited.

[0169] Further, although in each of the embodiments described above, the column member 2 is essentially formed of a single member (is not formed by combining a plurality of parts), the present invention is not necessarily limited to this, and it is possible to form the column member 2 of a plurality of members (a composite structure), and to movably deform the plurality of members at the time of pressure reception.

[0170] More specifically, as shown in Figure 13, for example, the column member 2 is vertically divided into two, and these two parts are configured into a nest state where the two parts are fitted to each other. Here, an upper portion of the two divided column member 2 is referred to as an upper column member 2U, whereas a lower portion is referred to as a lower column member 2D, and in particular, the present embodiment adopts a fit in which the upper column member 2U is located outside and the lower column member 2D is located inside. Further, the upper column member 2U is configured to be always movable integrally with the upper side pressure receiving portion 4U, for example, by being formed integrally with the upper side pressure receiving portion 4U from the beginning (can be a separate member and joined), and the lower column member 2D is similarly configured to be movable integrally with the lower side

pressure receiving portion 4D. Further, the ring member 3 does not contact the lower side pressure receiving portion 4D in an initial state, that is, the clearance C is formed between the ring member 3 and the lower side pressure receiving portion 4D.

[0171] Further, in this case, air is sealed into a fitting space between the upper column member 2U and the lower column member 2D, and at a time of both the members approaching each other, the air in the internal space is compressed to cause an air damper (air spring) action. Further, in the initial state, the lower column member 2D is not disengaged (fallen off) from the upper column member 2U.

[0172] In the case of Figure 13 described above, in the primary shock absorbing stroke, the upper column member 2U and the lower column member 2D relatively approach (compressed as the shock absorbing structure 1) by a length of the clearance C by received pressure load, and only a damper action of the upper column member 2U and the lower column member 2D functions as a shock absorbing action. Further, since the primary shock absorbing stroke is a stage until the ring member 3 touches the lower side pressure receiving portion 4D, the ring member 3 is not influenced by the received pressure load.

[0173] In a secondary shock absorbing stroke, compression deformation of the ring member 3 is added to the damper action of the upper column member 2U and the lower column member 2D, and by the amount of addition of the compression deformation, the shock absorbing structure 1 is more difficult to crush than in the primary stroke (the shock absorbing characteristic is reduced). In the present embodiment, the ring member 3 is illustrated by being assumed to be formed from a solid material (undergoes bulging deformation, with compression).

[0174] In this connection, in the present embodiment, air is sealed into the fitting space of the upper column member 2U and the lower column member 2D, but a liquid or the like can be sealed instead of air.

[0175] The upper column member 2U and the lower column member 2D may be formed into a mere nest shape without a special fluid (substance) being filled into the fitting space of the upper column member 2U and the lower column member 2D, as shown in Figure 14, for example.

[0176] Here, in Figure 14, the sole S1 is formed to be separated in the vertical direction, so that the ring member 3 can be accommodated between upper and lower sides. Further, the upper side pressure receiving portion 4U and the upper column member 2U are integrally formed in the sole S1 at the upper side, and the lower side pressure receiving portion 4D and the lower column member 2D are integrally provided in the sole S1 at the lower side.

[0177] For example, in a case where a user replaces the ring member 3 for himself or herself or the like, the user accesses the sole S1 from a side portion of the shoe S, separates the sole S1 into the upper side and the lower

side, that is, separates the upper column member 2U and the lower column member 2D by the operation, and replaces the ring member 3.

[0178] Furthermore, as another mode of configuring the column member 2 by combination of a plurality of members, a mode shown in Figure 15 is cited, for example.

[0179] In this mode, as shown in Figure 15 in combination, a column element 21 facing downward (forming a part of the column member 2, and specially referred to as an upper column element 21U) is formed on the upper side pressure receiving portion 4U first, a flange element 22 (specially referred to as an upper flange element 22U) is formed continuously to extend to an outer circumferential side from a lower end portion of the column element 21, and these upper side pressure receiving portion 4U, upper column element 21U and upper flange element 22U are generally called an upper part 10U.

[0180] Meanwhile, in the lower side pressure receiving portion 4D, a column element 21 facing upward (also forming a part of the column member 2, and specially referred to as a lower column element 21D) is formed, a flange element 22 (specially referred to as a lower flange element 22D) is continuously formed to extend to the outer circumferential side from an upper end portion of the column element 21, and these lower side pressure receiving portion 4D, lower column element 21D and lower flange element 22D are generally called a lower part 10D.

[0181] The column elements 21 and the flange elements 22 of the upper and lower parts 10U and 10D are formed alternately with each other in the respective upper and lower parts 10U and 10D. That is, as for the column elements 21, the lower column elements 21D are accommodated between the upper column elements 21U (meshed with one another) in a state where the upper part 10U and the lower part 10D are fully compressed (in a closest state), and the upper and lower column elements 21U and 21D present an appearance of a three-dimensional cylinder shape. Meanwhile, as for the upper and lower flange elements 22U and 22D, the lower flange elements 22D are located between the upper flange elements 22U, for example, in an initial state where no load is applied, and are configured to present a single disk shape in which the upper flange elements and the lower flange elements extend in an outer circumferential direction.

[0182] Consequently, when the separate upper and lower parts 10U and 10D are individually seen respectively, they are visually recognized as if the column elements 21U and 21D and the flange elements 22U and 22D are formed in continuous hook shapes on the upper and lower pressure receiving portions 4U and 4D, and have such an external appearance as to make it difficult to find out that these elements form the three-dimensional column member 2 and flange element 22, as also shown in Figure 15.

[0183] Further, due to such a configuration, a groove

33 for receiving the flange element 22 is formed into a bored shape throughout an entire circumference in a central portion of an inner side of the ring member 3.

[0184] In the present embodiment, the ring member 3 does not contact the lower side pressure receiving portion 4D in the initial state, and has the clearance C.

[0185] Here, in the case of the present embodiment, in the primary shock absorbing stroke, as also shown in Figure 15, the upper column element 21U (the upper part 10U) and the lower column element 21D (the lower part 10D) relatively approach (the shock absorbing structure 1 is compressed) by the length of the clearance C by the received pressure load.

[0186] At this time, the upper flange element 22U of the upper part 10U presses the ring member 3 downward, while the lower flange element 22D of the lower part 10D presses the ring member 3 upward. Consequently, on the groove 33 formed in the ring member 3, forces that alternately work in the up and down directions (forces that tear up vertically: shearing forces) act, and the forces function as a shock absorbing action in the present primary shock absorbing stroke. If the ring member 3 is formed from a solid material, bulging deformation to some degree is generated by the forces of the upper and lower flange elements 22U and 22D pushing each other in the opposite directions, and Figure 15 is illustrated on the basis of the assumption.

[0187] In a secondary shock absorbing stroke, the upper and lower pressure receiving portions 4 press the ring member 3, in addition to compression by the aforementioned upper and lower flange elements 22U and 22D, the compression deformation by this is added to the ring member 3. Consequently, in the secondary shock absorbing stroke, the shock absorbing structure 1 inevitably becomes more difficult to crush than in the primary shock absorbing stroke (the shock absorbing characteristic is reduced).

[0188] Although in the embodiments described above, many of the shock absorbing structures 1 have the axes set in the pressure receiving direction, the present invention is not necessarily limited to this. That is, a main feature of the present invention is the behavior of causing the column member 2 to undergo compression deformation, and thereafter causing the ring member 3 to undergo compression deformation with a time difference left, and thereby multi-stage shock absorbing characteristic is obtained. Accordingly, as long as modes adopt the deformation behavior like this, such modes are included in the present invention even if the axes of the shock absorbing structures 1 incline with respect to the pressure receiving direction. In reality, the shoe S at the time of landing on the ground or the like often lands on the ground in an inclined state or a bent state with a toe side slightly facing up, but hardly descends straight downward while keeping a horizontal state.

[0189] The shock absorbing structure 1 of the present invention has the basic structure as above, and when the shock absorbing structure 1 like this is actually incorpo-

rated in the shoe S, or the like, a plurality of shock absorbing structures 1 are often incorporated therein, and installation examples like this will be described hereinafter.

[0190] First, an installation example shown in Figure 16(a) is a mode in which a plurality of shock absorbing structures 1 are not incorporated into an entire sole, but are incorporated into a thenar (a base of a big toe), a hypothenar (a base of a little toe), a heel portion (three spots near a heel, in this case). This is because a weight of a wearer is said to be evenly applied to three points (a triangle) of a thenar, a hypothenar, and a heel portion, and by only providing the shock absorbing structures 1 intensively in those sites, a balance at a time of walking can be kept stably (balance keeping theory of triangle).

[0191] The reason why a larger number of shock absorbing structures 1 are provided on the heel portion than on the thenar and the hypothenar in Figure 16(a) is that many people land on the ground with heels first at the time of landing on the ground, and large impact is applied to the heels.

[0192] Further, an installation example shown in Figure 16(b) is an example in which although the shock absorbing structures 1 are incorporated entirely on the sole, the shock absorbing structures 1 with different shock absorbing characteristics are arranged in accordance with installation sites, and in this case, is a mode in which the relatively hard shock absorbing structures 1 (the shock absorbing performance is relatively low, and a repulsion characteristic appears relatively early) are disposed at an inner side (an IN side) of the foot, whereas the relatively soft shock absorbing structures 1 (the shock absorbing performance is relatively high, and a repulsion characteristic appears relatively later) are disposed at an outer side (an OUT side) of the foot. In this case, load (the center of gravity) which is applied to the sole until kick-out (separation from the ground) after landing on the ground can be moved in a desired direction (load guiding action), and a broken line drawn on the sole in the drawing corresponds to a proper pronation line that prevents excessive inward roll of a foot at the time of landing.

[0193] Further, when the present invention is applied to shoes for running or the like suitable for mid foot strike (Mid Foot Strike: midfoot landing) which has attracted attention in recent years, it is preferable to dispose a plurality of shock absorbing structures 1 with different properties in such a layout as to achieve a repulsion characteristic balance as shown in Figure 18(a), for example, to increase a repulsion characteristic (hardness) of an inner side (an IN side) of a foot, and a proper pronation line can be also realized in a mid-foot strike.

[0194] Further, when the present invention is applied to shoes for tennis, basketball and the like, it is preferable to dispose a plurality of shock absorbing structures 1 with different properties in such a layout as to achieve a repulsion characteristic balance as shown in Figure 18(b) to enhance a repulsion characteristic (hardness) of an outer side (an OUT side) of a foot, and a motion of quickly

striking back to a transverse direction can be realized.

Claims

1. A shock absorbing structure, comprising:

a column member;
an elastic ring member that is provided by being fitted onto the column member; and
upper and lower pressure receiving portions that are connected by the column member, wherein the column member is capable of being deformed and restored at least in a pressure receiving direction,
the ring member has an effective working height set to be lower than the column member, and is formed to be in a non-bonded state with the upper and lower pressure receiving portions, and at a time of pressure reception, the column member undergoes compression deformation in the pressure receiving direction first, and thereafter, the ring member undergoes compression deformation in the pressure receiving direction next, whereby multi-stage shock absorbing performance is exhibited.

2. The shock absorbing structure according to claim 1, wherein a ratio of the effective working height of the ring member is 0.2 to 0.95 with respect to the column member.

3. The shock absorbing structure according to claim 1 or 2, wherein at least one of the column member and the ring member is formed in such a manner that an effective working height is not constant throughout an entire circumference.

4. The shock absorbing structure according to claim 1, 2 or 3, wherein the column member is formed of a foam, and the ring member is formed from a solid material.

5. The shock absorbing structure according to claim 1, 2, 3 or 4, wherein a hardness of the column member is an Ask-er C hardness of 30 to 100 or a JIS A hardness of 40 to 120, and a hardness of the ring member is a JIS A hardness of 30 or less.

6. The shock absorbing structure according to claim 1, 2, 3, 4 or 5, wherein a ring bulging space in a depressed concave shape is formed in at least either one of contact faces of the ring member and the column member.

7. The shock absorbing structure according to claim

1, 2, 3, 4, 5, or 6,

wherein a bulging restriction portion that restricts bulging deformation of the ring member is provided in at least a part of an outside of the ring member.

8. The shock absorbing structure according to claim 1, 2, 3, 4, 5, 6 or 7,

wherein at least one of the ring member and the column member is formed by being configured by parts having a plurality of different materials or different repulsive forces.

9. The shock absorbing structure according to claim 1, 2, 3, 4, 5, 6, 7 or 8,

wherein the column member is formed by combining a plurality of members, and the members are configured to deform movably in the pressure receiving direction.

10. The shock absorbing structure according to claim 1, 2, 3, 4, 5, 6, 7, 8 or 9,

wherein the ring member is attached to the column member detachably and attachably.

11. A shoe formed by incorporating a shock absorbing structure that absorbs impact that is applied to a leg of a wearer at a time of landing on a ground, into a sole,

wherein the shock absorbing structure according to claim 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10 is applied to the shock absorbing structure.

12. The shoe according to claim 11, wherein the shock absorbing structure is provided on a bottom face of the sole.

FIG. 1

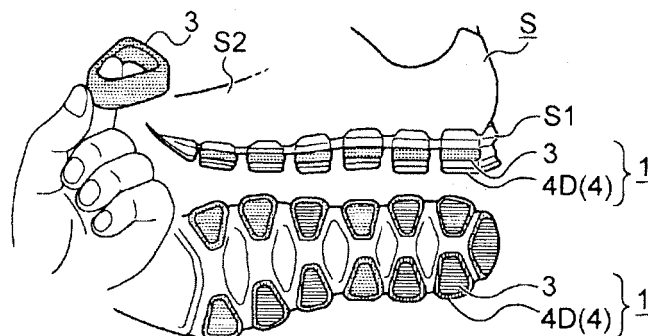


FIG. 1(a)

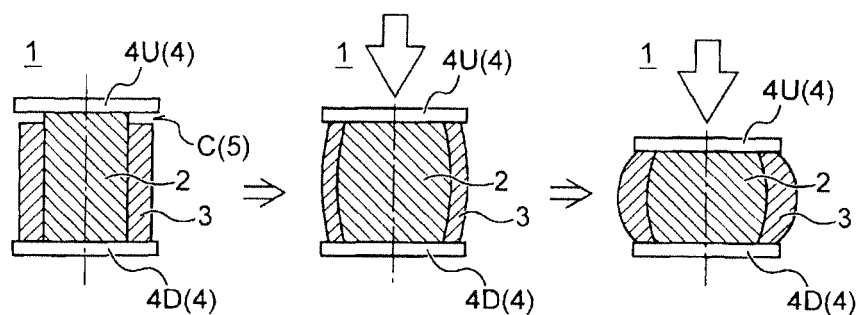


FIG. 1(b)

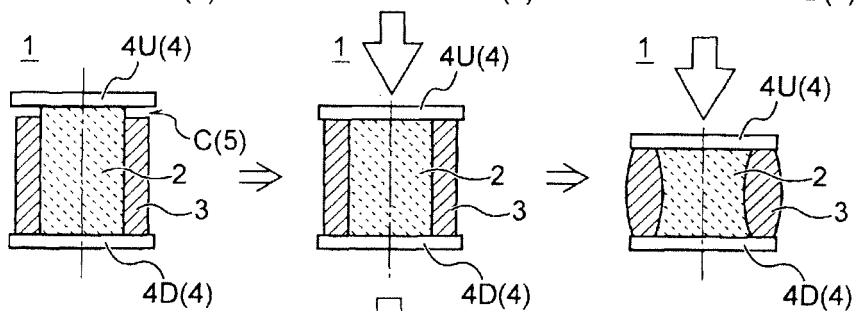


FIG. 1(c)

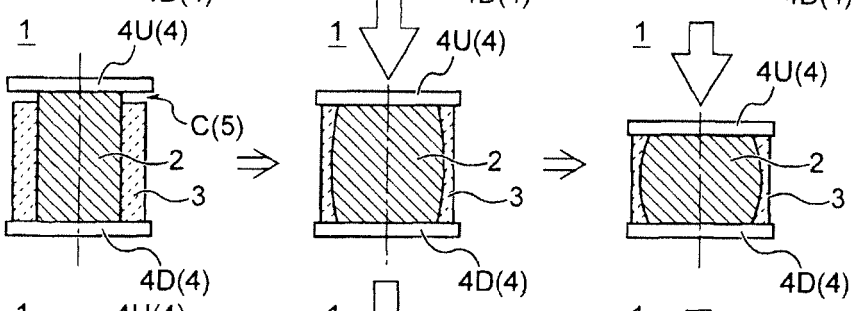
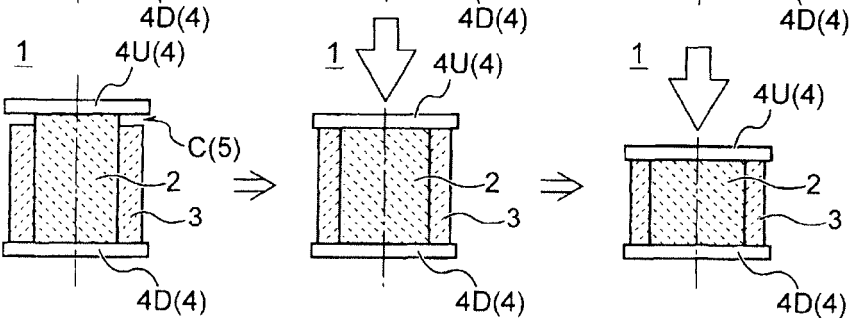


FIG. 1(d)



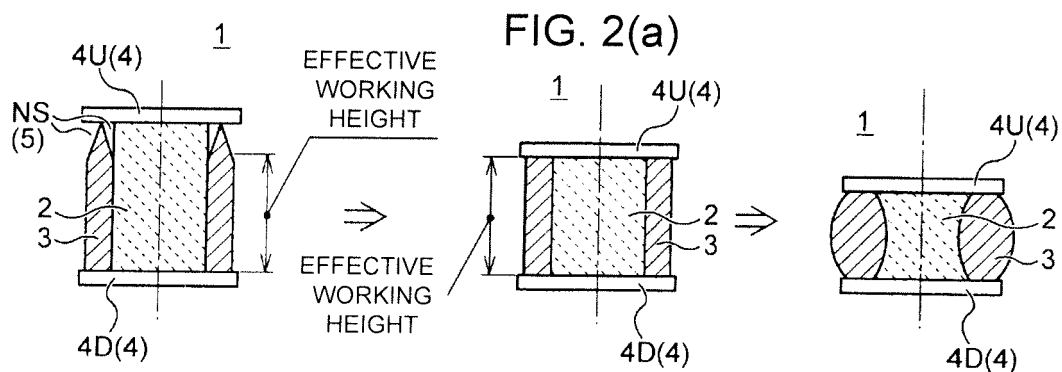


FIG. 2(b)

FIG. 2(c)

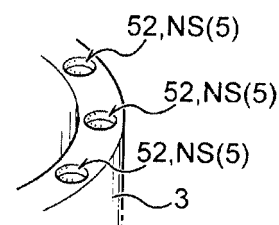
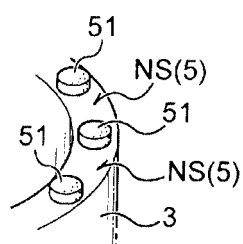


FIG. 2(d)

FIG. 2(e)

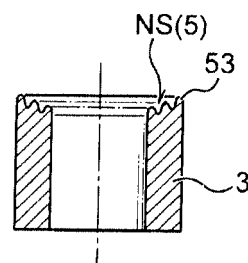
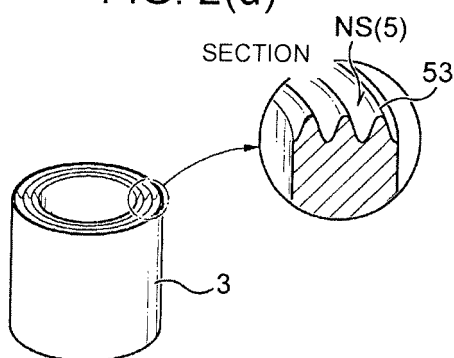


FIG. 2(f)

FIG. 2(g)

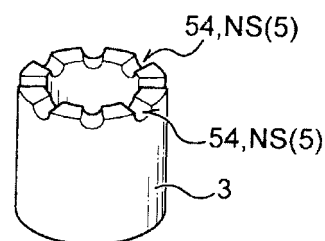
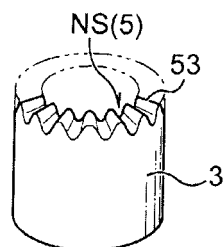


FIG. 3(a)

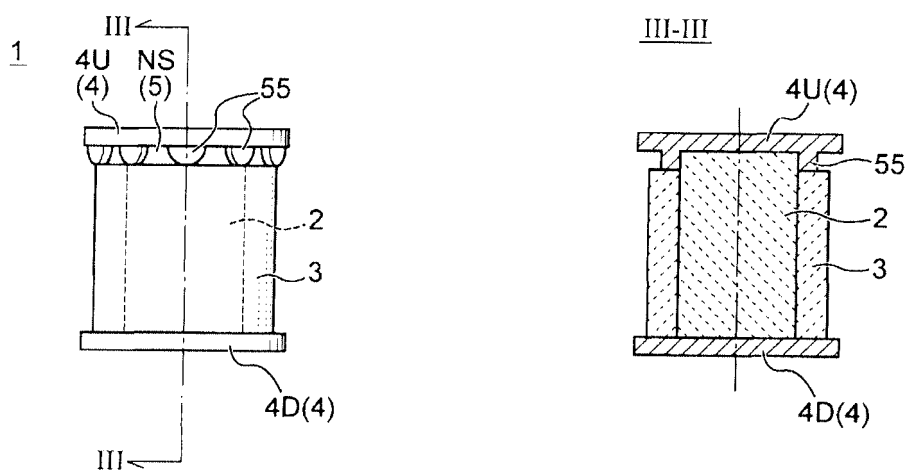


FIG. 3(b)

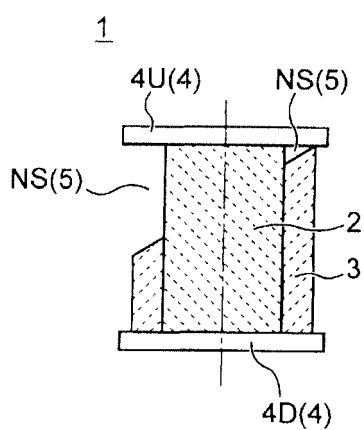
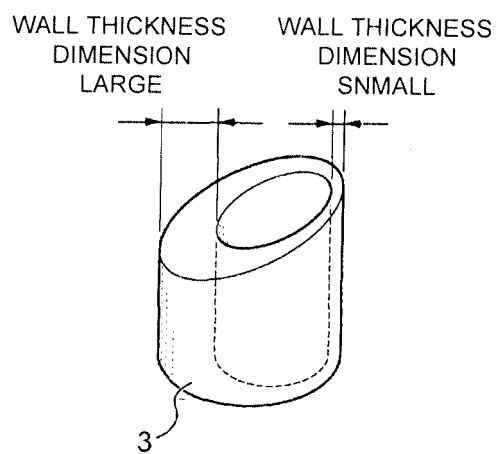


FIG. 3(c)



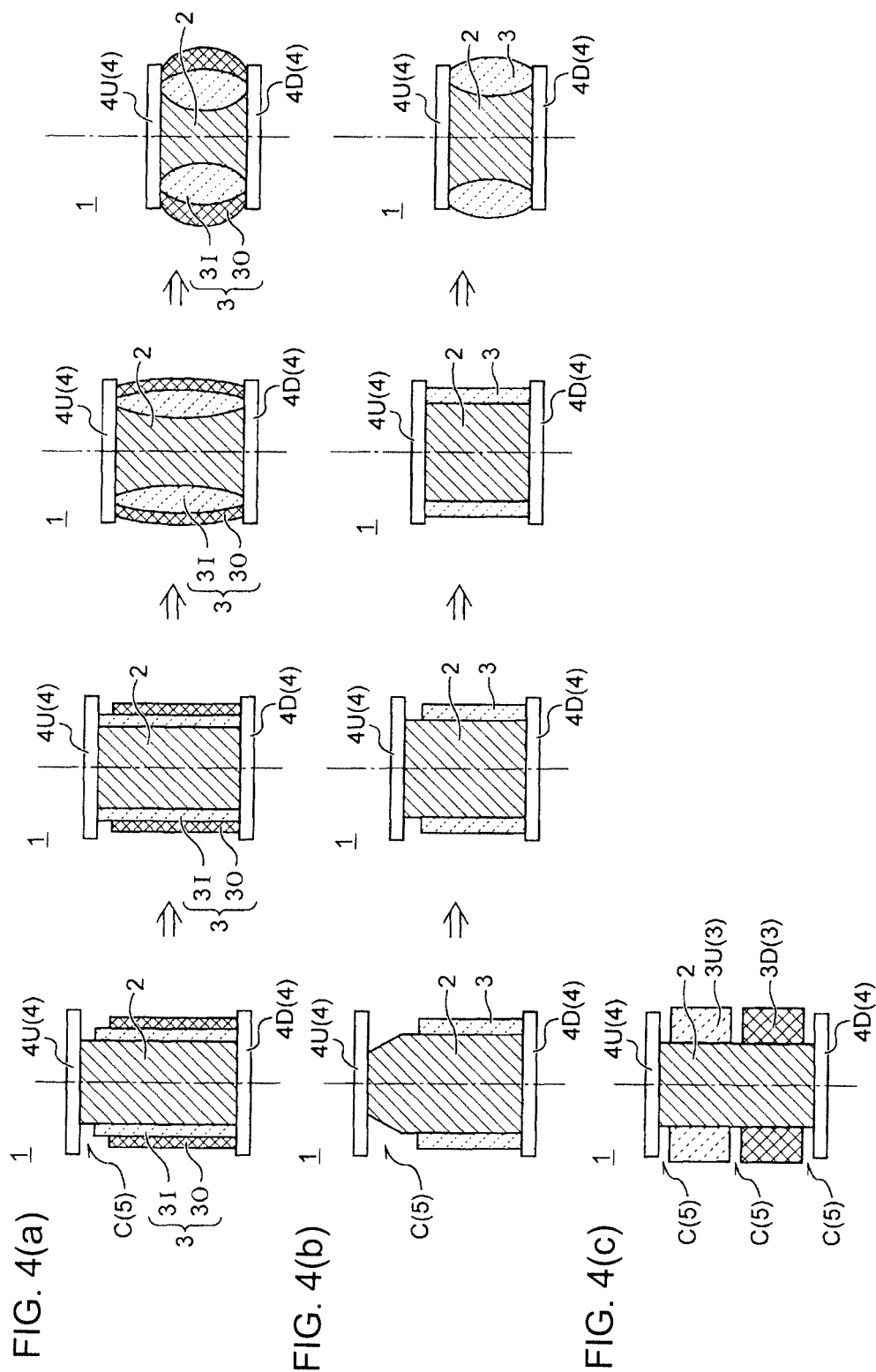


FIG. 5(a)

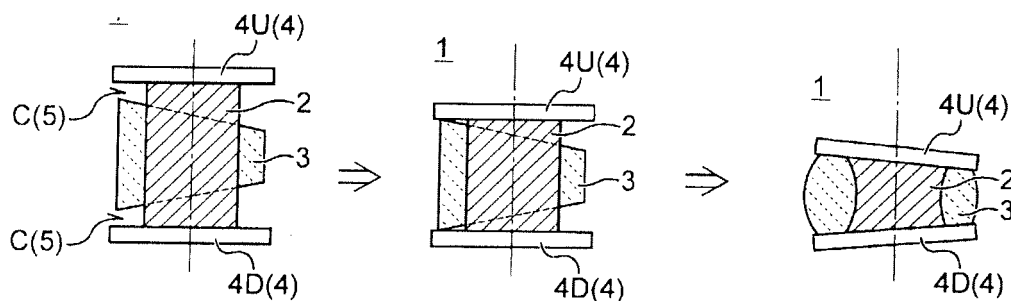


FIG. 5(b)

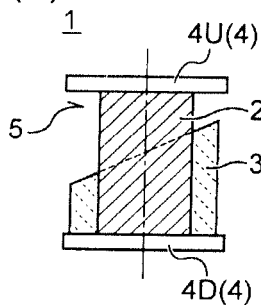


FIG. 5(c)

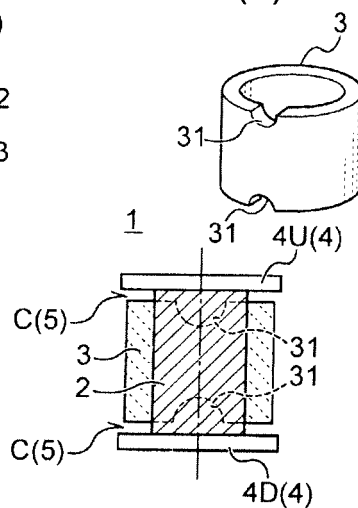


FIG. 5(d)

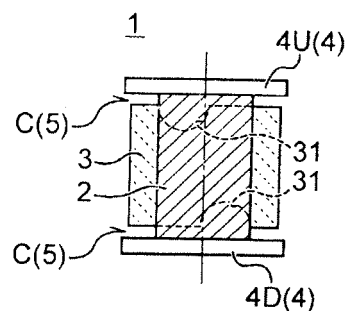


FIG. 5(e)

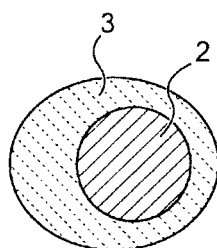
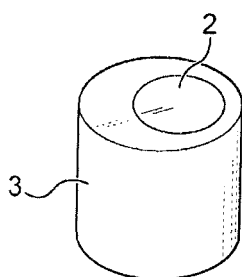


FIG. 5(f)

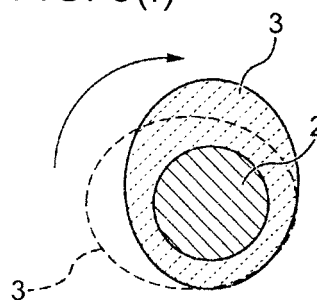


FIG. 6(a)

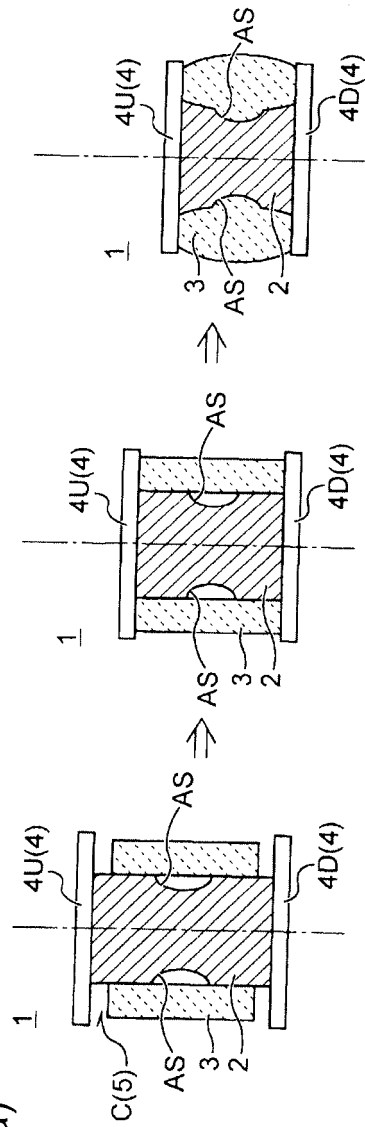
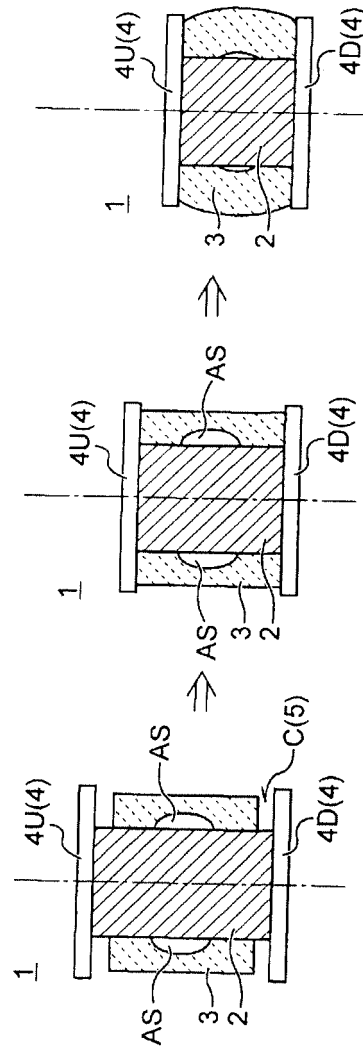
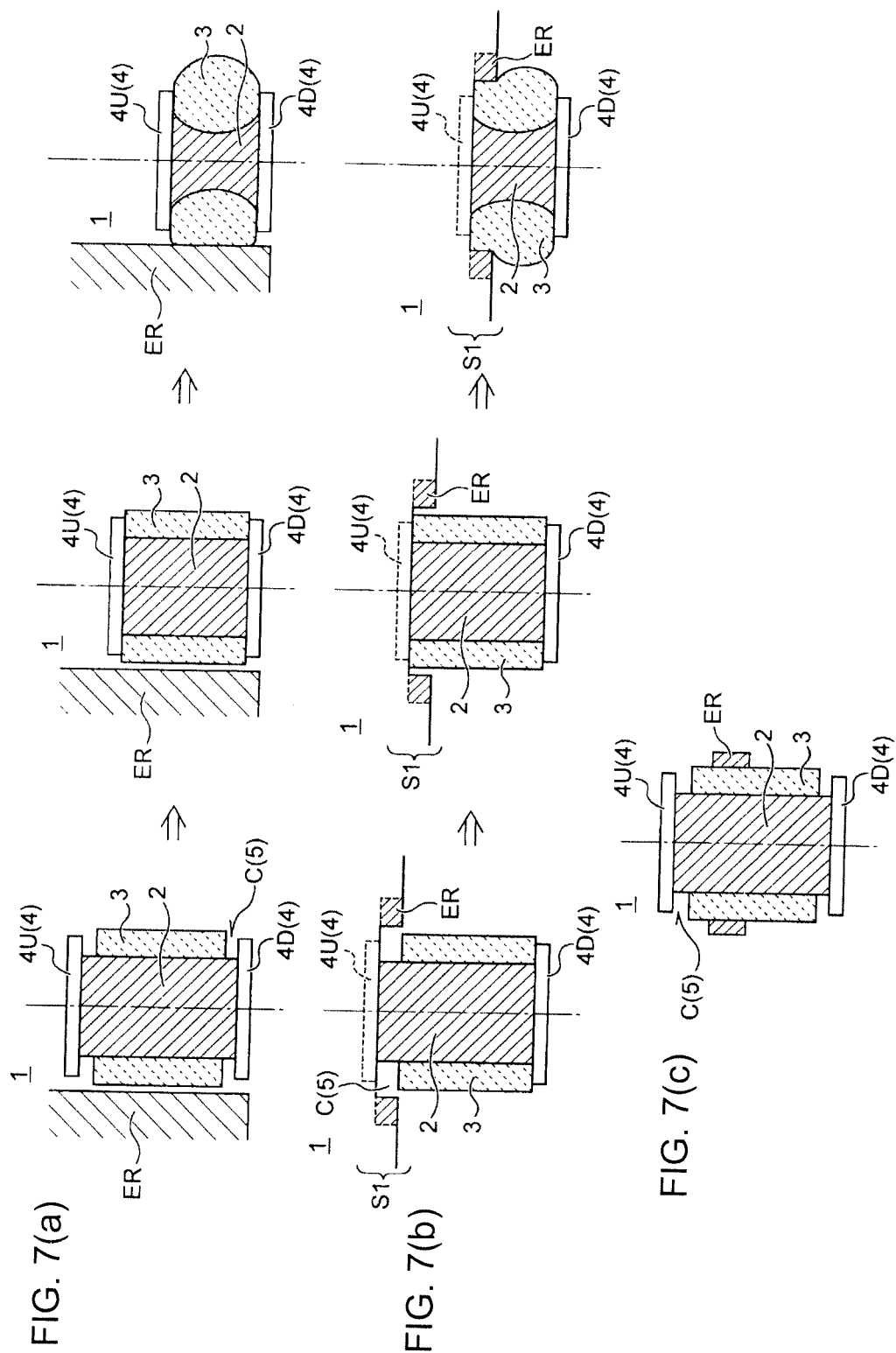


FIG. 6(b)





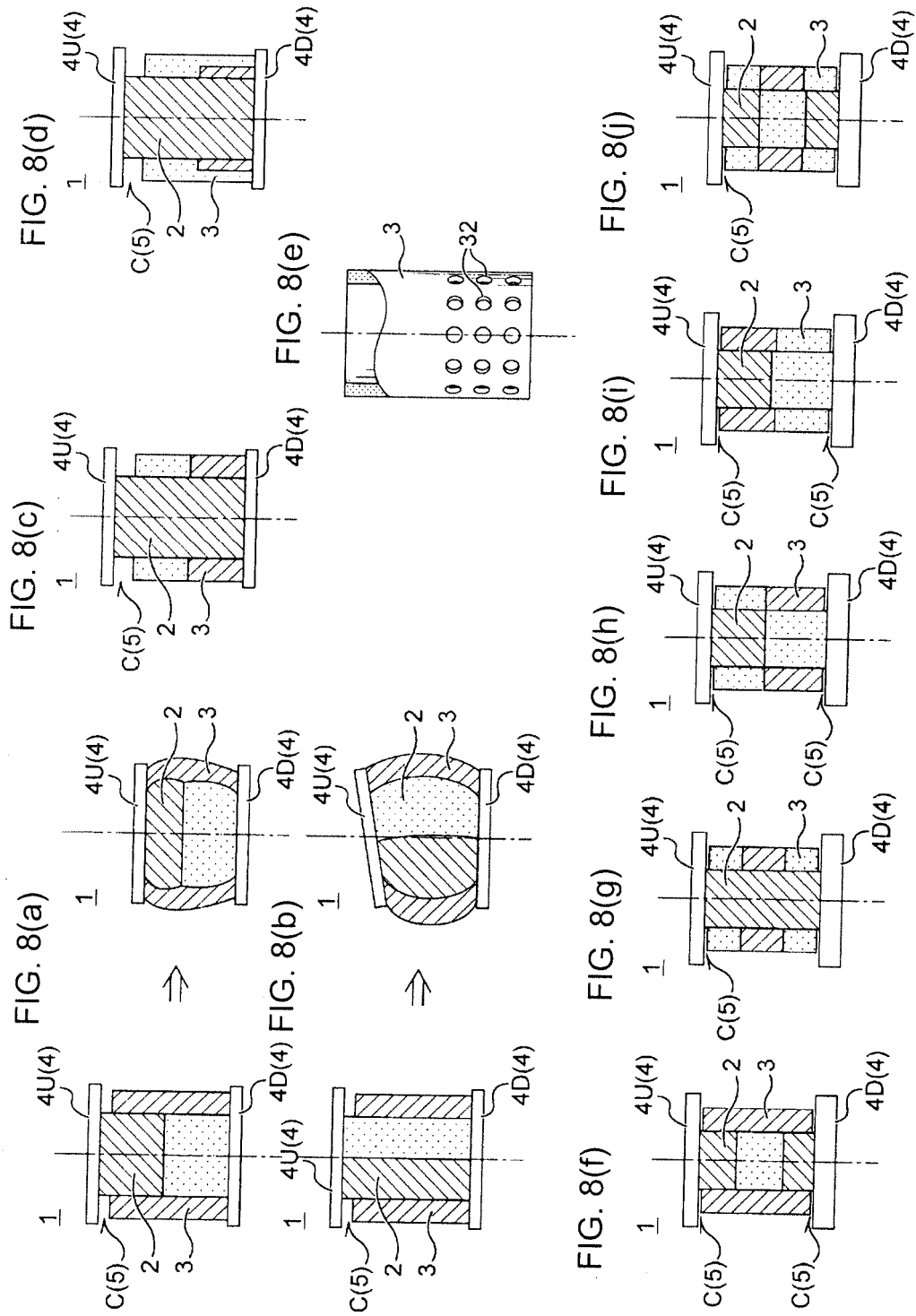


FIG. 9(a)

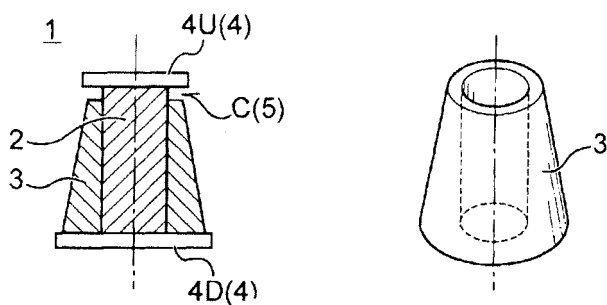


FIG. 9(b)

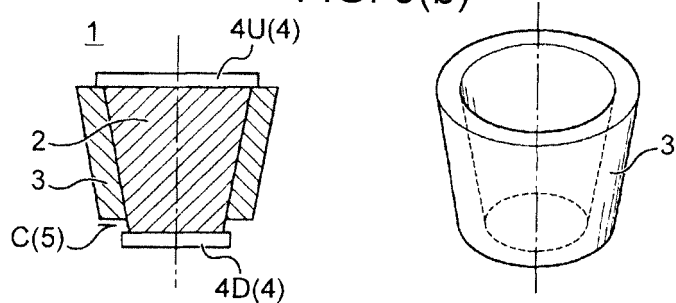


FIG. 9(c)

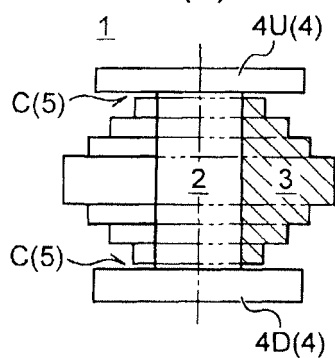


FIG. 9(d)

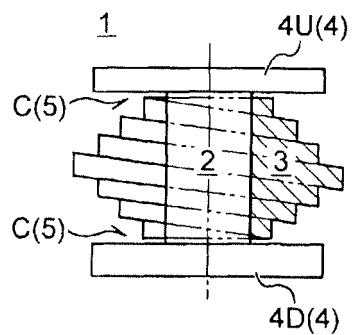


FIG. 10

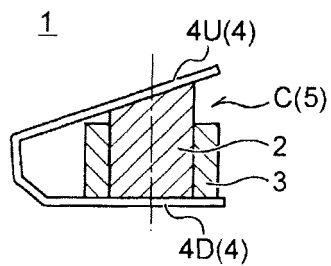


FIG. 11(a)

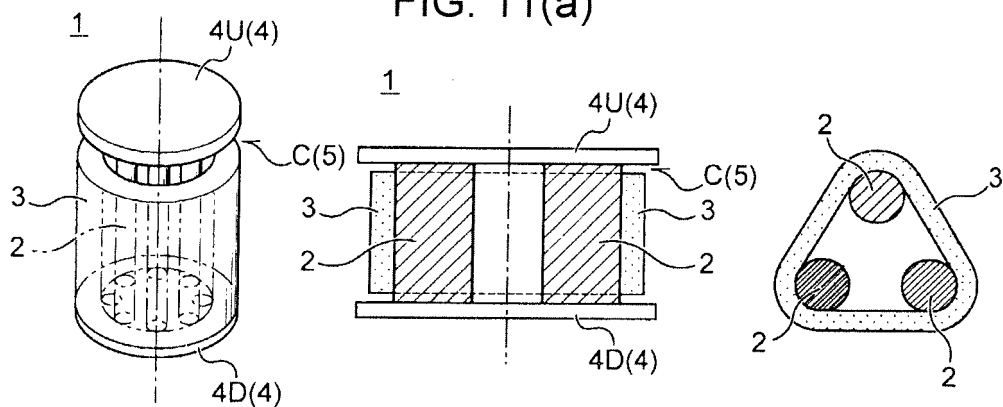


FIG. 11(b)

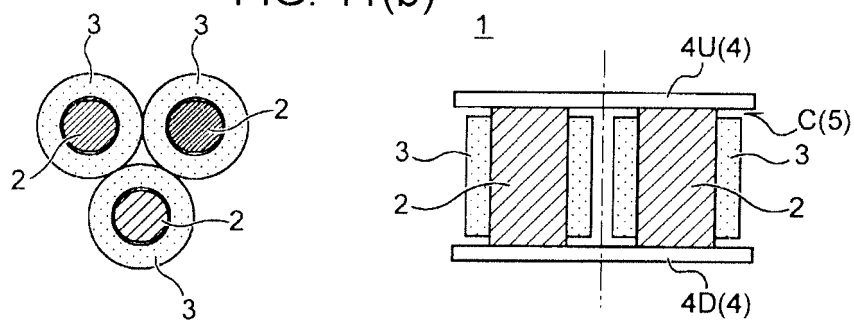


FIG. 11(c)

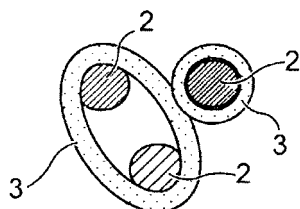


FIG. 12

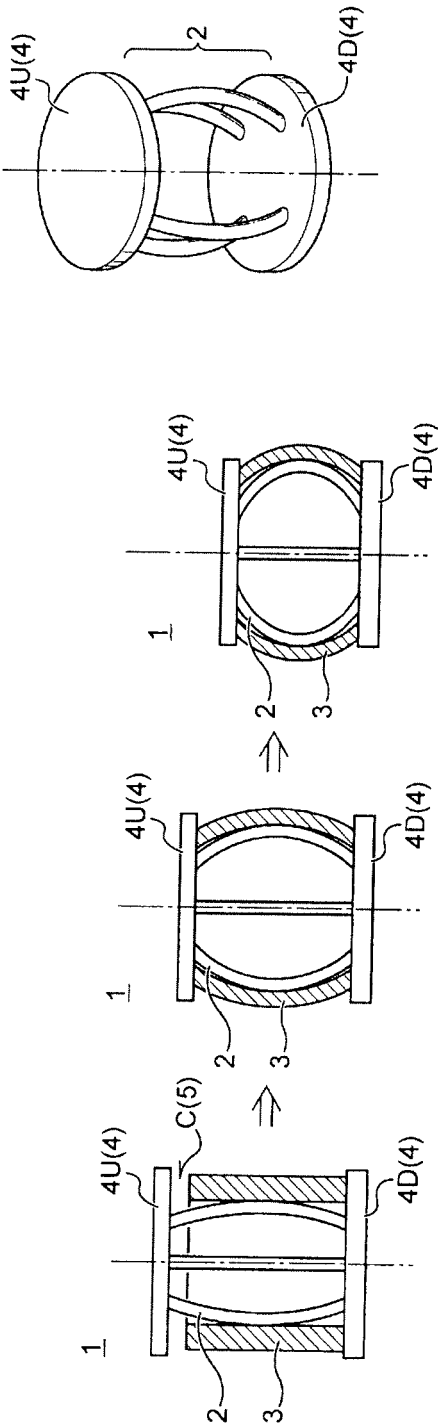


FIG. 13

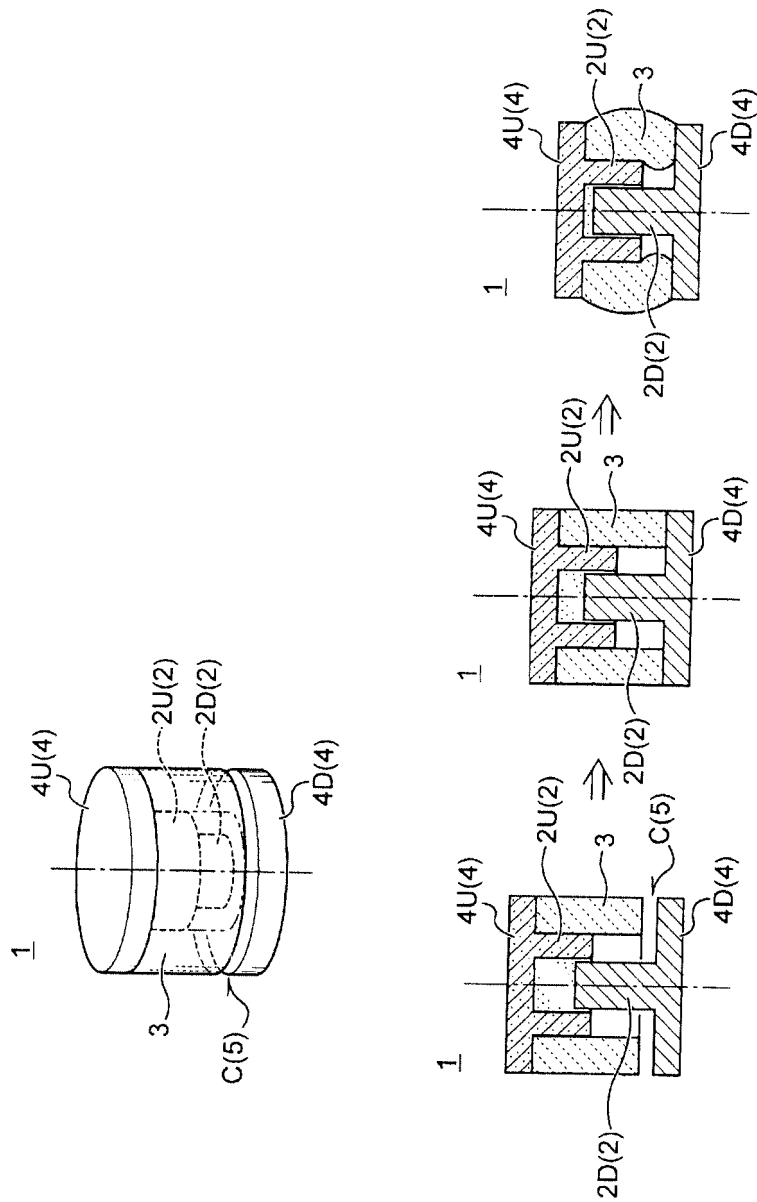


FIG. 14(a)

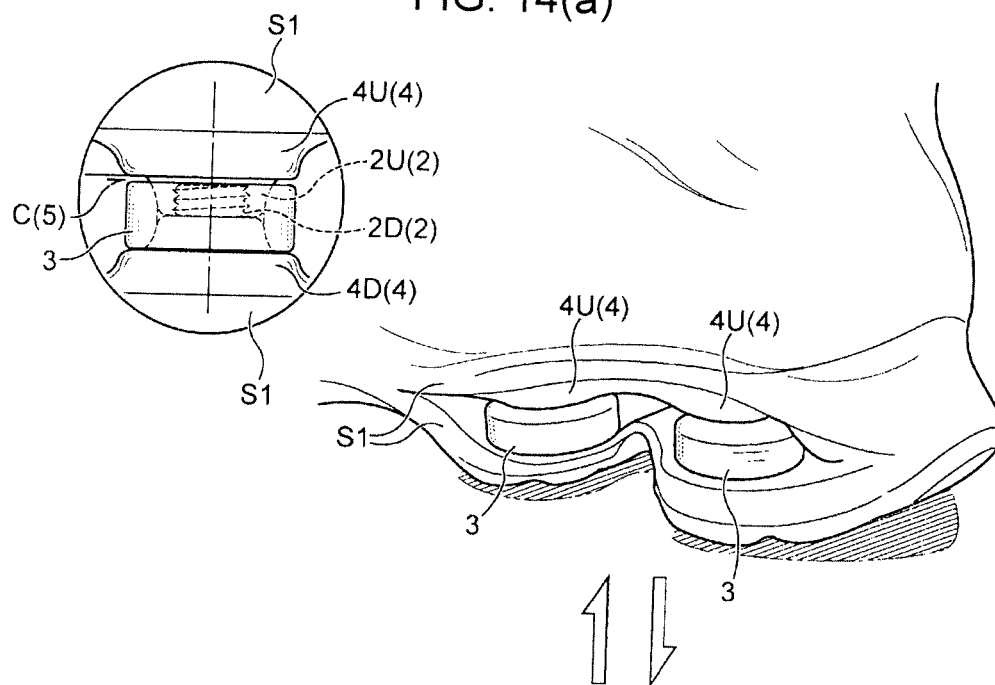


FIG. 14(b)

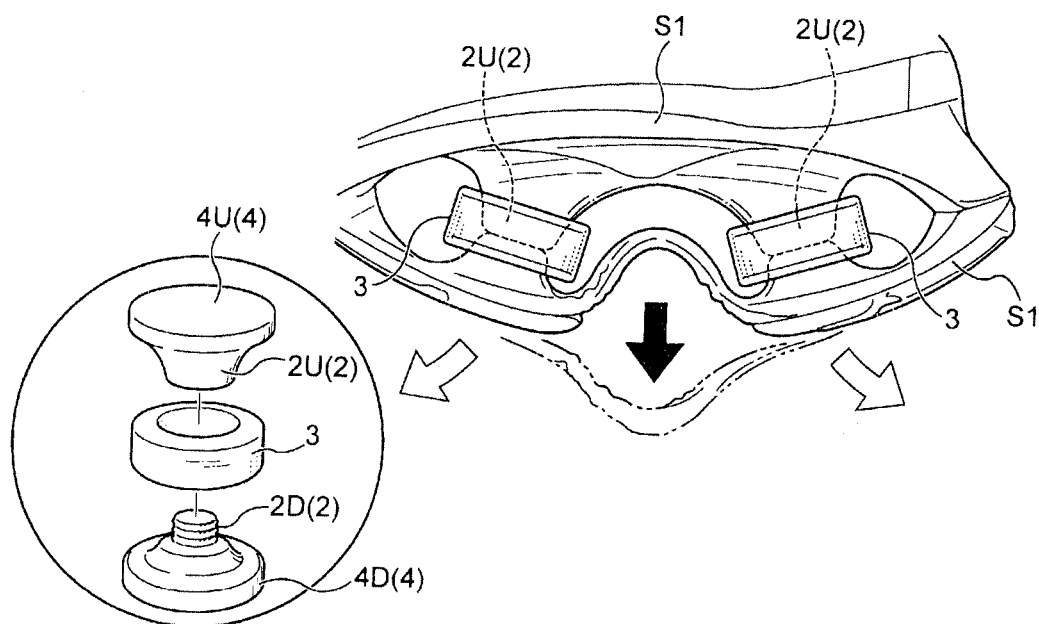


FIG. 15

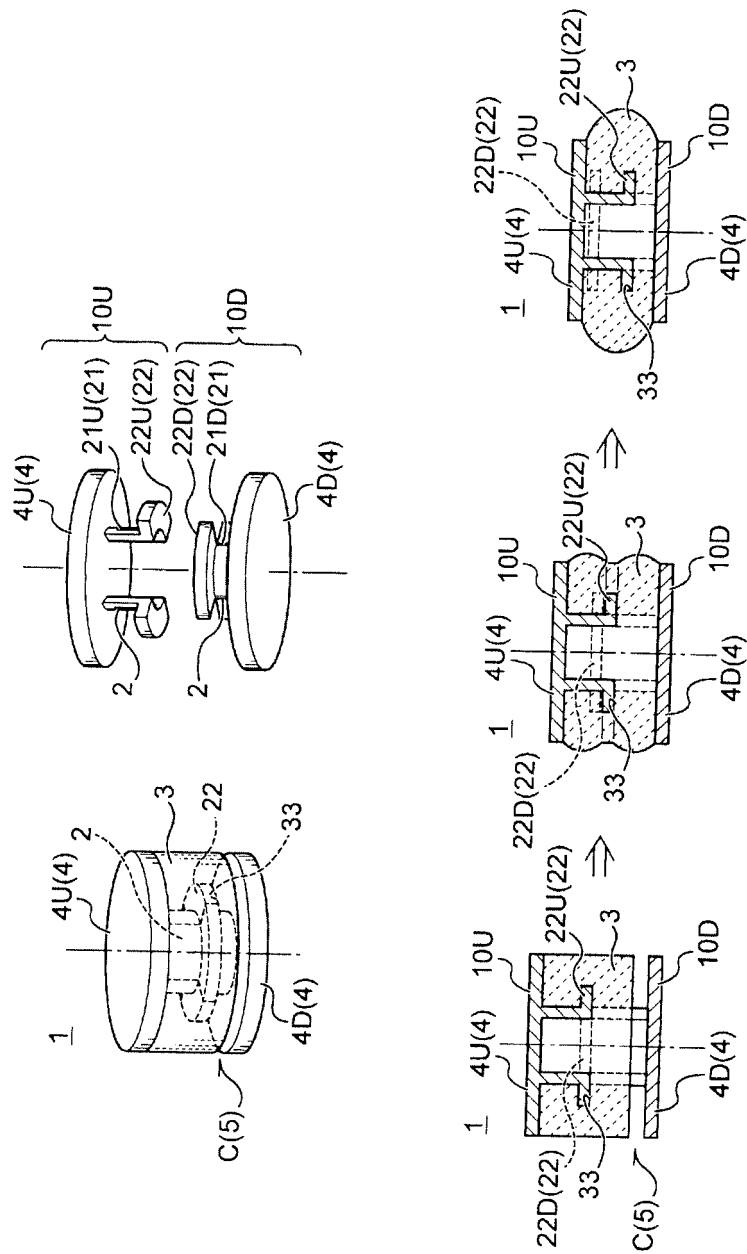


FIG. 16(a)

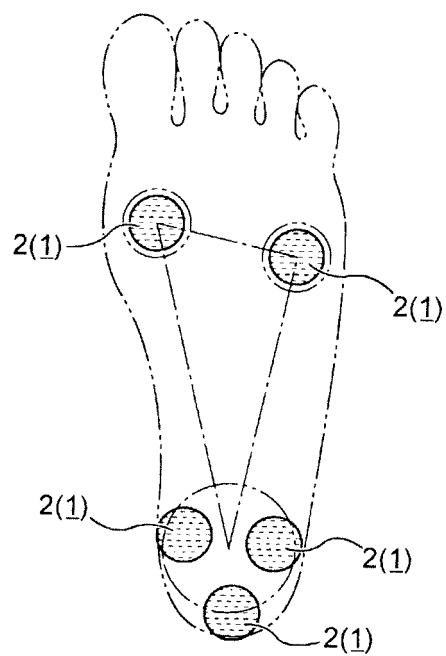


FIG. 16(b)

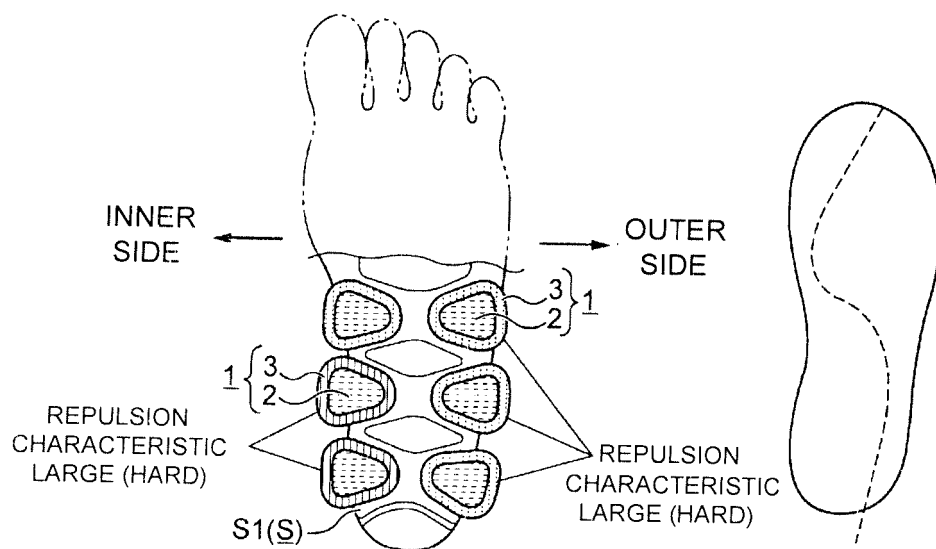


FIG. 17

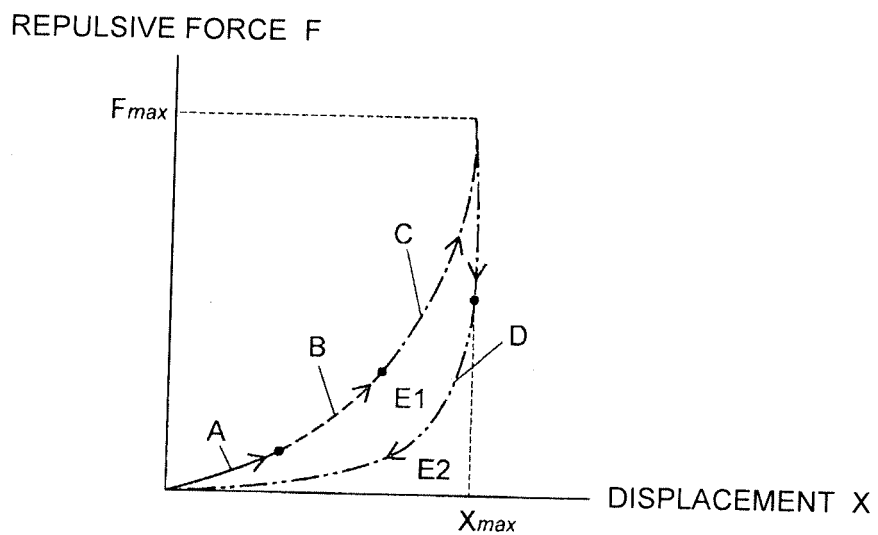


FIG. 18(a)

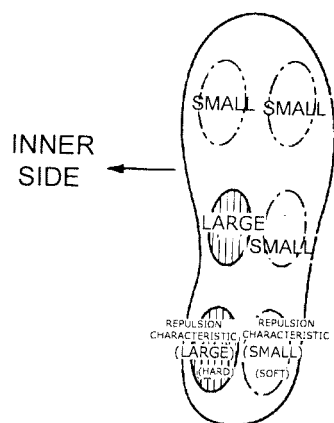
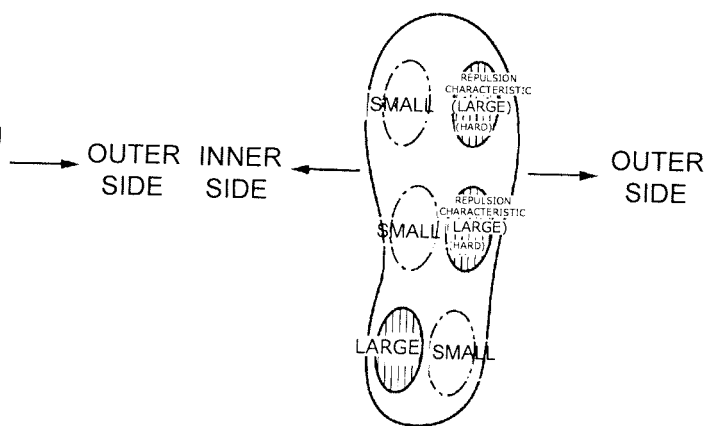


FIG. 18(b)



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/078442

A. CLASSIFICATION OF SUBJECT MATTER
A43B13/18(2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A43B13/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013
Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 32744/1993 (Laid-open No. 86514/1994) (Achilles Corp.), 20 December 1994 (20.12.1994), (Family: none)	1-12
A	JP 10-327906 A (Asahi Corporation Co., Ltd.), 15 December 1998 (15.12.1998), (Family: none)	1-12

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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Date of the actual completion of the international search
26 December, 2013 (26.12.13)

Date of mailing of the international search report
14 January, 2014 (14.01.14)

Name and mailing address of the ISA/
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Authorized officer

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2009142705 A [0010]
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