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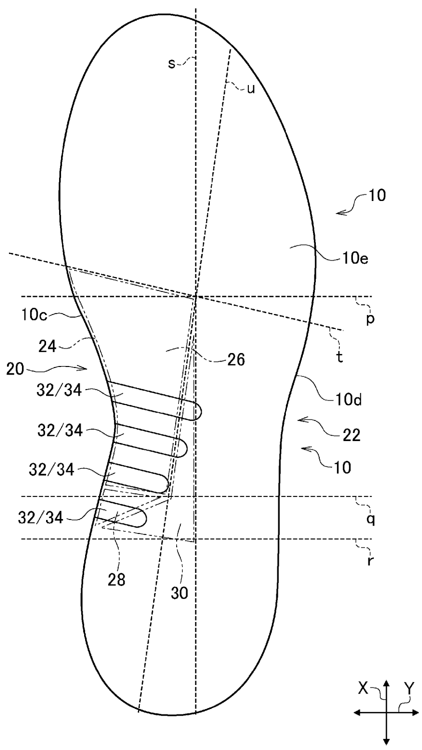
(54) SOLE AND SHOE

(57) When a midfoot portion 14 of a sole 10 is divided by a predetermined sole center line s into an medial midfoot region 20 and a lateral midfoot region 22 one on each side in the foot width direction, a rigidity lowering portion 32, which is provided in the medial midfoot region 20, is provided and, in such a manner that the bending rigidity of the medial midfoot region 20 around a foot width direction axis becomes smaller than that of the lateral midfoot region 22, the rigidity lowering portion 32 in the medial midfoot region 20 reduces the bending rigidity of the medial midfoot region 20 due to another factor other than the shape of the medial edge 10c and the shape of the lateral edge 10d of the sole 10 in a planar view.

FIG. 16



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Description

[TECHNICAL FIELD]

[0001] The present invention relates to shoe bottoms of shoes.

[BACKGROUND ART]

[0002] In the related art, attempts have been made for providing various functions to shoes by devising soles of shoe bottoms (e.g., see Patent Document 1).

[0003] [Patent Document 1] International Publication No. 2017/046959

[DISCLOSURE OF THE INVENTION]

[PROBLEM TO BE SOLVED BY THE INVENTION]

[0004] When doing a front bridge motion or the like during core training, a wearer of shoes (hereinafter simply referred to as a wearer) may take a standing on tiptoe posture. The expression "standing on tiptoe posture" in the present specification means a posture in which at least a rearfoot portion of the sole is lifted from the ground under the condition that a forefoot portion of the sole described later is in contact with the ground. There is no particular limitation on the angle that the sole makes with the ground at parts other than the part in contact with the ground.

[0005] If the muscular strength of the wearer's legs is weak, it tends to be difficult to stably maintain the standing on tiptoe posture. From the viewpoint of supporting the exercise of the wearer, it is desirable to propose shoe bottoms that allow for good stability while taking a standing on tiptoe posture. As a result of study based on such a viewpoint, the inventors of the present invention have come to realize that there is room for improvement in the shoe bottoms described in Patent Document 1, as described later in detail.

[0006] One embodiment of the present invention has been made in view of such problems, and one of the purposes of the invention is to provide shoe bottoms that are capable of improving the stability of a standing on tiptoe posture.

[MEANS TO SOLVE THE PROBLEM]

[0007] One embodiment of the present invention relates to a shoe bottom that is a shoe bottom comprising a sole, wherein when a midfoot portion of the sole is divided by a predetermined sole center line into an medial midfoot region and a lateral midfoot region one on each side in the foot width direction, the shoe bottom has a rigidity lowering portion that is provided in the medial midfoot region, and wherein, in such a manner that the bending rigidity of the medial midfoot region around a foot width direction axis becomes smaller than that of the lateral midfoot region, the rigidity lowering portion in the medial midfoot region reduces the bending rigidity of the medial midfoot region due to another factor other than the shape of the medial edge and the shape of the lateral edge of the sole in a planar view.

[ADVANTAGE OF THE INVENTION]

[0008] According to the present invention, shoe bottoms that are capable of improving the stability of a standing on tiptoe posture can be provided.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0009]

Fig. 1 is a plan view of a sole that serves as one invention example;
Fig. 2 is a plan view showing the skeleton of a foot of a human body;
Figs. 3 are diagrams in which the skeleton of the right foot of a wearer is viewed from the front side in the foot longitudinal direction; Fig. 3A shows a positional relationship when the toes and heel of the wearer are in contact with the ground; Fig. 3B shows a state where a crossing angle is larger compared to the positional relationship of Fig. 3A;
Figs. 4 are diagrams showing the calcaneocuboid joint surface and talonavicular joint surface of the right foot of the wearer; Fig. 4A shows a positional relationship when the toes and heel of the wearer are in contact with the ground; Fig. 4B shows a state where a crossing angle is larger compared to the positional relationship of Fig. 4A;
Figs. 5 are diagrams for explaining the axis of motion of a Chopart joint; Fig. 5A is a plan view of the skeleton of the right foot; Fig. 5B is a view of the skeleton thereof viewed from the medial side in the foot width direction;
Fig. 6 is a bottom view showing another invention example of a sole provided with rigidity lowering portions;
Fig. 7 is a bottom view of a sole that serves as still another invention example;
Fig. 8 is a perspective view schematically showing a model simulating a sole used for analysis;
Fig. 9 is a diagram showing the result of the analysis;
Fig. 10 is a diagram for explaining an external torsional resistance expected region;
Fig. 11 is a diagram showing a sole according to a reference example used for the analysis;
Fig. 12 is a graph showing torsional frequencies obtained by the analysis;
Fig. 13A is a diagram showing the measurement result for torsion angles obtained by an experiment;
Fig. 13B is a diagram showing the measurement result for the amount of the ankle unstableness;
Fig. 14 is a bottom view of a sole according to a first

exemplary variation;

Fig. 15 is a side view of a shoe using a shoe bottom according to a first embodiment as viewed from the medial side in the foot width direction;

Fig. 16 is a bottom view of a sole according to the first embodiment;

Fig. 17 is a bottom view of a sole according to a second embodiment;

Fig. 18A is a side view of the sole according to the second embodiment as viewed from the medial side in the foot width direction; Fig. 18B is a side view of the sole viewed from the lateral side in the foot width direction;

Fig. 19A is a bottom view of a sole according to a second exemplary variation; Fig. 19B is a bottom view of a sole according to a third exemplary variation; Fig. 19C is a bottom view of a sole according to a fourth exemplary variation;

Fig. 20 is a side view of a shoe bottom according to a third embodiment as viewed from the same viewpoint as that of Fig. 15; and

Fig. 21 is a side view of a shoe bottom according to a fourth embodiment as viewed from the same viewpoint as that of Fig. 15.

[MODE FOR CARRYING OUT THE INVENTION]

[0010] Terms used in this specification will be explained. Fig. 1 is a plan view showing a sole 10, which serves as one invention example. A "foot longitudinal direction Lx" in the present specification means a direction along a straight line connecting a tip 10a on the toe side and an end 10b on the heel side of the sole 10. The toe side in the foot longitudinal direction Lx is also referred to as the front side, and the heel side is also referred to as the back side. A "foot width direction Y" refers to a horizontal direction orthogonal to the foot longitudinal direction Lx. A first toe side of the foot of a wearer supported by the sole 10 is referred to as the medial side, and a fifth toe side is referred to as the lateral side. A "full length La" in the foot longitudinal direction Lx is the longest length in the foot longitudinal direction Lx, and a "full width Lb" in a foot width direction Ly is the longest length in the foot width direction Ly.

[0011] Fig. 2 is a plan view showing the skeleton of a foot of a human body. The foot of a human body is mainly composed of cuneiform bones Ba, a cuboid bone Bb, a navicular bone Bc, a talus Bd, a calcaneus Be, metatarsal bones Bf, and phalanges Bg. The joint of the foot includes an MP joint Ja, a Lisfranc joint Jb, and a Chopart joint Jc. The Chopart joint Jc includes a calcaneocuboid joint Jc1 formed by the cuboid bone Bb and the calcaneus Be and a talonavicular joint Jc2 formed by the navicular bone Bc and the talus Bd. A "midfoot portion" of a wearer (hereinafter, simply referred to as a human midfoot portion) in the present specification means the portion from the MP joint Ja to the Chopart joint Jc.

[0012] Fig. 1 is referred back. A straight line along the foot width direction Y, which is assumed to pass the heel side end of the MP joint Ja of the wearer, is defined as a line p. A straight line along the foot width direction Y, which is assumed to pass the toe side end of the Chopard joint Jc of the wearer, is defined as a line q. The line p and the line q are, for example, straight lines along the foot width direction Y that divide the full length La of the sole 10 in the foot longitudinal direction Lx into 1.5:1.0:1.1 from the toe side to the heel side. A "forefoot portion 12" of the sole 10 in the present specification means a region on the toe side of the line p, a "midfoot portion 14" (hereinafter simply referred to as a sole midfoot portion 14) of the sole 10 means a region from the line p to the line q, and a "rearfoot portion 16" of the sole 10 means a region on the heel side of the line q. The sole midfoot portion 14 can be also considered to be a region that is assumed to overlap with the range from the heel side end of the MP joint Ja to the toe side end of the Chopard joint Jc of the wearer, that is, a range that is assumed to overlap with the human midfoot portion.

[0013] The background for how the shoe bottom according to the present embodiment has been conceived of will be explained. As described above, if the muscular strength of the wearer's legs is weak, it tends to be difficult to stably maintain the standing on tiptoe posture. Further, if the muscular strength of the wearer's legs is weak, a decrease in propulsive force in a pushing-off motion during the terminal stance of a gait cycle is known as a factor for falling down. This wearer is, for example, a woman, an elderly person, or the like.

[0014] From the viewpoint of solving these problems, the inventors of the present invention found out, based on the anatomical viewpoint of the foot of the human body, that it was effective to induce a bony locking mechanism in the human midfoot portion of the wearer.

[0015] Figs. 3 and 4 are diagrams in which the skeleton of a right foot of the wearer is viewed from the front side in the foot longitudinal direction Lx. Figs. 3 are external views of the skeleton, and Figs. 4 are diagrams showing a calcaneocuboid joint surface Sja and a talonavicular joint surface Sjb of the right foot. Figs. 3A and 4A show a positional relationship when the toes and heel of the wearer are in contact with the ground, and Figs. 3B and 4B show a state where a crossing angle θc described later is larger compared to the positional relationship of Figs. 3A and 4A, respectively. The crossing angle between a joint axis Aj1 of the calcaneocuboid joint Jc1 of the Chopart joint Jc viewed from the front in the foot longitudinal direction Lx and a joint axis Aj2 of the talonavicular joint Jc2 is defined to be θc.

[0016] Figs. 5 are a diagram for explaining the axis of motion of the Chopart joint Jc. Fig. 5A is a plan view of the skeleton of the right foot, and Fig. 5B is a view of the skeleton thereof viewed from the medial side in the foot width direction. The Chopart joint Jc has a longitudinal axis and a clinoaxis as two axes of motion, of which the longitudinal axis serves as the joint axis Aj1 of the calcaneocuboid joint Jc1 and the clinoaxis serves as the joint axis Aj2 of the talonavicular joint Jc2. Although there are individual differences in terms of a skeleton, in general, the calcaneocuboid joint Jc1 is an axis obtained by tilting the toe side inward by 9 degrees in the foot width direction with respect to the horizontal plane and tilting the toe side upward by 15 degrees with respect to the sagittal plane, based on the state where the toe and the heel are in contact with the ground. Normally, the talonavicular joint Jc2 is an axis obtained by tilting the toe side inward by 57 degrees in the foot width direction with respect to the horizontal plane and tilting the toe side upward by 52 degrees with respect to the sagittal plane, based on the state where the toe and the heel are in contact with the ground.

[0017] As shown in Fig. 3B, the bony locking mechanism is realized when the crossing angle θc is increased to a certain extent compared to that obtained when the wearer's toe and heel are in contact with the ground. Due to an increase in this crossing angle θc, the mobility of the Chopart joint Jc is reduced compared with a case where the crossing angle θc is small, and the Chopart joint Jc can be turned into a rigid body. This allows unstable between a plurality of bones constituting the Chopart joint Jc to be prevented when taking a standing on tiptoe posture, and the stability of the standing on tiptoe posture can be improved. Further, as a result of turning the Chopart joint Jc into a rigid body, the propulsive force transmission between the plurality of bones constituting the Chopart joint Jc becomes smooth, and the propulsive force in the pushing-off motion can be improved.

[0018] The crossing angle θc of the plurality of joint axes forming the Chopart joint Jc described above is known to increase as the amount of external torsion at the human midfoot portion increases. Therefore, in inducing the bony locking mechanism, it is necessary to increase the amount of external torsion at the human midfoot portion. The external torsion means that the heel is twisted in the supination direction with respect to the toes based on the positional relationship obtained when the toes and heel of the human body are in contact with the ground. The present inventors have found that it is preferable to satisfy the following condition in order to achieve such an increase in the amount of external torsion at the human midfoot portion.

[0019] When the human midfoot portion is attempted to be twisted outward (external torsion), the sole 10 is also attempted to be twisted outward in a range including the sole midfoot portion 14 following the deformation of the human midfoot portion. Therefore, in order to increase the amount of external torsion at the human midfoot portion, it is desirable to reduce the external torsional resistance of the sole 10 within the range including the sole midfoot portion 14.

[0020] In order to respond to such a demand, the inventors of the present invention found out that it is effective to provide a rigidity lowering portion 32 for lowering the bending rigidity around a foot width direction axis (hereinafter, simply referred to as "bending rigidity") in an medial midfoot region 20 of the sole midfoot portion 14, as shown in Fig. 1. The medial midfoot region 20 means a region located on the medial side when the sole midfoot portion 14 is divided into two regions one on each side in the foot width direction by a predetermined sole center line s. Of these two regions, the region located on the lateral side is referred to as a lateral midfoot region 22.

[0021] This sole center line s is defined as a line passing through the center part of the sole 10 in the foot width direction Y. In this example, a straight line along the foot longitudinal direction X that divides the full width Lb of the sole 10 into 1.2:1.0 from the medial side to the lateral side in the foot width direction is defined as the sole center line s. The sole center line s in this example is also a part on which a foot width direction center part of the foot of the wearer is assumed to be located. The foot width direction center part is assumed to be a part located on a straight line passing through a third metatarsal bone Bf3 and a medial process of calcaneal tuberosity Be1 of the calcaneus Be of a human body. Fig. 1 shows a range in which the medial process of calcaneal tuberosity Be1 is assumed to be located.

[0022] Rigidity lowering portions 32 of the medial midfoot region 20 reduce the bending rigidity of the medial midfoot region 20 such that the bending rigidity of the medial midfoot region 20 becomes smaller than that of the lateral midfoot region 22. The expression "the bending rigidity of the medial midfoot region 20 becomes smaller than that of the lateral midfoot region 22" includes the following two cases. The first case is a case where, in the lateral midfoot region 22 and the medial midfoot region 20, only the bending rigidity of the medial midfoot region 20 is reduced. The second case is a case where, when reducing the bending rigidity of both the lateral midfoot region 22 and the medial midfoot region 20, the amount of decrease in the bending rigidity in the medial midfoot region 20 is set to be larger than that in the lateral midfoot region 22.

[0023] The rigidity lowering portions 32 in the medial midfoot region 20 reduce the bending rigidity of the medial midfoot region 20 due to another factor other than the shape of an medial edge 10c and the shape of a lateral edge 10d of the sole 10 in a planar view. This "another factor" is, for example, any one or a combination of two of recessed portions that are open on the ground contact surface of the sole 10 and the elongation characteristic of the material constituting the sole 10 such as those explained in the following.

[0024] The expression "recessed portions that are open on the ground contact surface of the sole 10" means those that are recessed upward from the ground contact surface of the sole 10, which comes into contact with the road surface. The recessed portions may be groove portions continuous in the in-plane direction of a ground contact surface 10e of the sole 10 or may not be continuous in the in-plane direction thereof. Fig. 6 is a bottom view showing another invention example of the sole 10 provided with rigidity lowering portions 32. When the recessed portions constituting the rigidity lowering portion 32 are not continuous in the in-plane direction, the recessed portions may be provided intermittently so as to be aligned on a virtual line such as a straight line, a curved line or the like. As the recessed portions, Fig. 1 shows medial transverse groove portions 34 extending from the medial edge 10c of the sole 10 in the foot width direction Y. When such recessed portions are provided in the medial midfoot region 20, the bending rigidity of the medial midfoot region 20 can be lowered compared to that in a case where such recessed portions do not exist. The bending rigidity of the medial midfoot region 20 being reduced due to the recessed portions means such a situation. When the recessed portions are the medial transverse groove portions 34, the bending rigidity can be effectively reduced.

[0025] Further, the expression "the elongation characteristic of the material constituting the sole 10" means, specifically, the Young's modulus [N/mm^2] in the foot longitudinal direction X of the material constituting the sole 10. The rigidity lowering portions 32 are formed using a second material having a smaller Young's modulus in the foot longitudinal direction X than that of a first material constituting portions adjacent to the rigidity lowering portions 32 of the sole 10. This allows the bending rigidity of the medial midfoot region 20 to be lowered compared to a case where the rigidity lowering portions 32 are formed using the first material. The bending rigidity of the medial midfoot region 20 being reduced due to the elongation characteristic of the material constituting the sole 10 means such a situation.

[0026] On the medial edge 10c of the sole midfoot portion 14, a curved-in part 10f recessed outward in the foot width direction X is formed. The bending rigidity of the medial midfoot region 20 of the sole 10 is often smaller than the bending rigidity of lateral midfoot region 22 due to the influence of the curved-in part 10f. In order to exclude the influence of this curved-in part 10f, the shape of the medial edge 10c and the lateral edge 10d of the sole 10 in a planar view is excluded from the above-mentioned factors, which cause a decrease in bending rigidity.

[0027] By providing such a rigidity lowering portion 32 in the medial midfoot region 20, it is easier to lower the bending rigidity of the medial midfoot region 20 than that of the lateral midfoot region 22 as compared with the case where the rigidity lowering portion 32 is not provided. As the bending rigidity of the medial midfoot region 20 is lowered compared to that of the lateral midfoot region 22, the elongation amount of the medial midfoot region 20 at the ground contact surface can be increased compared to that of the lateral midfoot region 22 when the sole 10 is bendingly deformed around the foot width direction axis. This means that when the wearer is taking a standing on tiptoe posture, the medial midfoot region 20 can be more easily deformed in an extended manner in the foot longitudinal direction X than the lateral midfoot region 22, that is, the medial midfoot region 20 tends to be easily twisted outward. In other words, it means that external torsional resistance at the sole midfoot portion 14 can be lowered compared with the case where an medial midfoot region 20 is not provided with a rigidity lowering portion 32. Therefore, by providing a rigidity lowering portion 32 in the medial midfoot region 20, when the wearer attempts to twist his/her human midfoot portion while taking a standing on tiptoe posture, the amount of external torsion can be increased compared to the case where a rigidity lowering portion 32 is not provided. As a result, it is possible to induce the bony locking mechanism and thus improve the stability of the standing on tiptoe posture and improve the propulsive force in the pushing-off motion.

[0028] The medial midfoot region 20 is formed such that the bending rigidity thereof is smaller than that of the lateral midfoot region 22. This is realized by providing a rigidity lowering portion 32 in the medial midfoot region 20 or due to the shape of the medial edge 10c or the lateral edge 10d of the sole 10 in a planar view. These bending rigidities may be evaluated based on the strain amount of the ground contact surface in the foot longitudinal direction obtained when a bending moment of a predetermined size around the foot width direction axis is applied toward the upper surface of the sole at a toe side end portion and a heel side end portion of the midfoot region being mentioned. It means that the bending rigidity becomes small as this strain amount increases. The bending rigidity of the medial midfoot region 20 being smaller than that of the lateral midfoot region 22 means that the strain amount in the medial midfoot region 20 is larger than the strain amount in the lateral midfoot region 22. The strain amount may be acquired by actually cutting out the midfoot region being mentioned from the sole 10 and measuring the strain amount using the piece that has been cut out.

[0029] Further, as described above, the line q indicates a portion where the Chopard joint of the foot of the wearer is assumed to be located. As a rigidity lowering portion 32 is located closer to this line q, the sole midfoot portion 14 becomes more likely to be twisted outward at a location closer to the Chopart joint Jc, and the bony locking mechanism is more likely to be induced accordingly. Therefore, the rigidity lowering portion 32 is preferably provided in a region on the heel side of a straight line y along the foot width direction Y, which bisects the full length of the sole midfoot portion 14 in the foot longitudinal direction, in the medial midfoot region 20 of the sole midfoot portion 14.

[0030] During the standing on tiptoe posture, a load for twisting the sole 10 outward is applied to the sole 10 via the upper of the shoe in a state where the forefoot portion 12 of the sole 10 is restrained. At this time, the toe side end portion of the sole midfoot portion 14 is fixed, and an external torsion load is applied to the heel side end portion thereof. At this time, the most deformed portion of the sole midfoot portion 14 is a region on the toe side of the sole midfoot portion 14 close to the forefoot portion

12 restrained in the sole 10. In this region on the toe side of the sole midfoot portion 14, it is possible to effectively twist the sole midfoot portion 14 outward by having different bending rigidity on the medial side and the lateral side in the foot width direction of the sole midfoot portion 14. Therefore, the rigidity lowering portion 32 is also preferably provided in the region on the toe side of the straight line y bisecting the sole midfoot portion 14 in the foot width direction.

[0031] Next, another condition will be described that is preferably satisfied in order to increase the amount of external torsion at the human midfoot portion. A case is taken into consideration where an external torsional load for twisting the sole 10 outward is applied to the sole 10 via the upper of the shoe when the wearer is taking a standing on tiptoe posture. A case is taken into consideration where a transverse groove portion extending from the medial edge 10c to the lateral edge 10d is formed in the rearfoot portion 16 of the sole 10. In this case, even when the external torsional load described above is applied to the sole 10, the bending deformation at the transverse groove portion of the rearfoot portion 16 thereof becomes dominant, and the amount of external torsion at the sole midfoot portion 14 becomes small. As a result, when the wearer attempts to twist his/her human midfoot portion outward while taking a standing on tiptoe posture, it is difficult to increase the amount of external torsion at the human midfoot portion due to resistance from parts other than the sole midfoot portion 14.

[0032] Fig. 7 is a bottom view showing a sole 10, which serves as another invention example. In order to solve the above problems, as another condition, it is defined that a continuous surface 16c continuous in the foot longitudinal direction from a toe side end portion 16a to a heel side end portion 16b of a rearfoot portion 16 of the sole 10 is formed on the ground contact surface of the sole 10. In this figure, the range in which the continuous surface 16c is formed is indicated by hatching with two-dot chain lines. This means that a transverse groove portion extending from an medial edge 10c to a lateral edge 10d is not formed in the rearfoot portion 16 of the sole 10. In the illustrated example, this continuous surface 16c is formed in the entire range in the foot width direction Y; however, the continuous surface 16c may be formed in at least a part of the range in the foot width direction Y.

[0033] Thereby, when the wearer attempts to twist the midfoot portion outward while taking a standing on tiptoe posture, the bending deformation of the sole 10 at the rearfoot portion 16 can be suppressed by the continuous surface 16c, and a situation can be prevented where the amount of external torsion at the sole midfoot portion 14 becomes small in accordance with the bending deformation. Accordingly, by satisfying the above-mentioned conditions, it becomes easier to obtain the effect of reducing the external torsional resistance at the sole midfoot portion 14, and it thus becomes easier to increase the amount of external torsion at the human midfoot portion.

[0034] When a reinforcing member such as a shank is attached to the sole midfoot portion 14, the bending rigidity of the shoe bottom becomes excessively increased, and the external torsional resistance of the sole midfoot portion 14 thus becomes excessively increased. Therefore, in the shoe bottom according to the present embodiment, a reinforcing member such as a shank is preferably not attached to the sole midfoot portion 14. This prevents an excessive increase in the bending rigidity of the sole midfoot portion 14 and allows the external torsional resistance of the sole midfoot portion 14 to be easily reduced.

[0035] The reinforcing member used in this case is those other than a midsole 56 and an outer sole 58 of the sole 10 described later. This reinforcing member is used, for example, for enhancing bending rigidity around the foot width direction axis of the shoe bottom just like a shank or the like and is formed using a material whose hardness is larger than the maximum hardness of the sole 10. This material is, for example, various metals or synthetic resins having a JIS A hardness of 80 degrees or more. The JIS A hardness is a value obtained by measurement using an A type hardness meter in compliance with JIS K 6301. The hardness of the midsole 56 is, for example, 35 to 75 degrees in terms of JIS C hardness, and the hardness of the outer sole 58 is, for example, 50 to 75 degrees in terms of JIS A hardness. The JIS C hardness is a value obtained by measurement using a C type hardness meter in compliance with JIS K 6301.

[0036] Even when the reinforcing member is not attached to the sole midfoot portion 14, a reinforcing member may be attached to the sole forefoot portion 12 and the sole rearfoot portion 16. Even under this configuration, the external torsional resistance of the sole midfoot portion 14 can be easily reduced.

[0037] Next, an analysis performed for coming up with the shoe bottom according to the embodiment will be explained. Fig. 8 is a perspective view schematically showing a model simulating a sole 10 used for the analysis. In this analysis, a sole having the same size as that of the sole 10 shown in Fig. 7 was used. The sole 10 had a full length La of 280 mm, a full width Lb of 200 mm, and a uniform thickness of 20 mm. The physical conditions of the sole 10 were set to have a Young's modulus of 6 [N/mm^2], a Poisson's ratio of 0.25 [-], and a density of 3 x 10^2 [kg/m^3]. It is assumed that this analysis reproduce the deformed state of the sole 10 during a front bridge motion. For this reason, a region Sa in which the ball of foot of the toes of the wearer were assumed to hit was completely restrained, and an upward load Fz was applied to the rearfoot portion 16 of the sole 10. In order to apply an external torsional load to the sole 10, a load Fy directed outward in the foot width direction Y was applied to the rearfoot portion 16 of the sole 10.

[0038] Fig. 9 is a diagram showing the result of this analysis. In this figure, the distribution of the maximum principal stress at the bottom surface of the sole 10 obtained under the above-described conditions is shown.

The higher the density of dots, the greater the stress. It can be confirmed that when the external torsional load is applied to the sole 10, the stress becomes larger in a region 24, which includes the medial midfoot region 20 and the peripheral region of the sole 10, than those in other regions. This means that this region 24 is strongly resisting the external torsion of the sole midfoot portion 14. Therefore, it is considered that the external torsion at the sole midfoot portion 14 can be effectively reduced by providing a rigidity lowering portion 32 in the foregoing region 24 (hereinafter referred to as an external torsional resistance expected region 24), which is assumed to be resisting the external torsion of the sole midfoot portion 14. Therefore, as a region in which a rigidity lowering portion is preferably provided, the external torsional resistance expected region 24 obtained by this analysis is used.

[0039] Fig. 10 is a diagram for explaining the external torsional resistance expected region 24. The external torsional resistance expected region 24 is geometrically specified in relation to the shape of the sole 10. Hereinafter, an explanation will be given with reference to the positional relationship of the sole 10 in the planar view.

[0040] The definition of a line s, a line p, and a line q is the same as the definition described above. A straight line along the foot width direction Y that divides a region on the heel side of the line q of the sole 10 into 0.2:0.9 is defined as a line r. Being viewed from a point o1, which is the intersection point of the line p and the line s, a straight line obtained by rotating the line p by 13 degrees around the point o1 in an outward direction Pa, which rotates the toe side outward in the foot width direction, is defined as a line t. Being viewed from the point o1, which is the intersection point of the line s and the line p, a straight line obtained by rotating the toe side of the line s by 8 degrees around the point o1 in the aforementioned outward direction Pa is defined as a line u. Being viewed from a point o2, which is the intersection point of the line u and the line q, a straight line obtained by rotating the line q by 5 degrees around the point o2 in the outward direction Pa is defined as a line v. Being viewed from a point P, which is the intersection point of the line r and the line u, a straight line obtained by rotating the line r by 4 degrees around the point P in the outward direction Pa is defined as a line w. A straight line connecting a point o5, which is the intersection point of the medial edge 10c of the sole 10 and the line w, and the point o2 is defined as a line x.

[0041] At this time, the external torsional resistance expected region 24 is defined to be formed of a first region 26 surrounded by the line t, the line u, the line v, and the medial edge 10c of the sole 10. This external torsional resistance expected region 24 is provided on the ground contact surface of the sole 10 in the planar view of the sole 10. A rigidity lowering portion 32 is preferably provided in the foregoing external torsional resistance expected region 24. It is considered that by providing the rigidity lowering portion 32 in this external torsional resistance expected region 24, the external torsional resistance of the sole midfoot portion 14 can be effectively reduced.

[0042] The rigidity lowering portion 32 is preferably provided in a part (the part indicated by a range S1) that belongs to the external torsional resistance expected region 24 outside the medial midfoot region 20, other than the part that belongs to the external torsional resistance expected region 24 in the medial midfoot region 20. The rigidity lowering portion 32 provided in the part belonging to the external torsional resistance expected region 24 outside the range of the medial midfoot region 20 also lowers the bending rigidity of the part due to a recessed portion that is open on the ground contact surface of the sole 10, the elongation characteristic of the material constituting the sole 10, and the like.

[0043] Referring to the analysis result of Fig. 9, the first region 26 defined as the external torsional resistance expected region 24 of the sole 10 mainly spreads largely in a direction Lb heading toward the heel side of the foot longitudinal direction Lx. Further, the first region 26 also spreads somewhat in a direction Lc heading toward the outside in the foot width direction Y. This analysis is intended for a front bridge motion. It is expected that a larger external torsional load will be applied to the sole 10 in other motions such as running or the like. If a large load is applied to the sole 10, the external torsional resistance expected region 24 is considered to first spread in the direction Lb heading toward the heel side in the foot longitudinal direction Lx. Further, the external torsional resistance expected region 24 is considered to spread in the direction Lc heading toward the outside in the foot width direction Y in an extent smaller than how the external torsional resistance expected region 24 spreads toward the heel side of the foot longitudinal direction Lx.

[0044] Therefore, as shown in Fig. 10, the external torsional resistance expected region 24 may be defined to be formed of the first region 26 and a second region 28 surrounded by the line v, the line x, and the medial edge 10c of the sole 10 in planar view. It is considered that by providing the rigidity lowering portion 32 in the foregoing external torsional resistance expected region 24, the external torsional resistance of the sole midfoot portion 14 can be effectively reduced when a large external torsional load is applied to the sole 10.

[0045] This rigidity lowering portion 32 is also preferably provided in parts (the range S1 and the part indicated by a range S2) that belong to the external torsional resistance expected region 24 outside the medial midfoot region 20, other than the part that belongs to the external torsional resistance expected region 24 in the medial midfoot region 20.

[0046] Further, the external torsional resistance expected region 24 may be defined to be formed of the first region 26, the second region 28, and a third region 30 surrounded by the line s, the line u, the line x, and the line w in planar view. It is considered that by providing the rigidity lowering portion 32 in the foregoing external torsional resistance expected region 24, the external torsional resistance of the sole midfoot portion 14 can be effectively reduced when a larger external torsional load is applied to the sole 10.

[0047] This rigidity lowering portion 32 is also preferably provided in parts (the range S1, the range S2, and the part indicated by a range S3) that belong to the external torsional resistance expected region 24 outside the medial midfoot region 20, other than the part that belongs to the external torsional resistance expected region 24 in the medial midfoot region 20.

[0048] Next, the effects of the invention based on the presence or absence of the above-described conditions will be explained using analysis. Fig. 11 shows a sole 100 of a reference example used for the analysis. The sole 10 according to an exemplary embodiment is shown in Fig. 7. The dimensional conditions and physical conditions of the soles 10 and 100 were set to be the same as those in the analysis of Fig. 8.

[0049] In each of the sole 100 according to the reference example and the sole 10 according to the exemplary embodiment, a transverse groove portion 40 is provided at a part corresponding to the MP joint in the forefoot portion 12 of the sole such that the sole is bent at the forefoot portion 12 of the sole around the foot width direction axis during a standing on tiptoe posture. In the sole 10 according to the exemplary embodiment, two medial transverse groove portions 34 are provided as rigidity lowering portions 32 that lower the bending rigidity of the medial midfoot region 20. Further, in the sole 10 according to the exemplary embodiment, one more medial transverse groove portion 34 is provided as a rigidity lowering portion 32 that lowers the bending rigidity of the external torsional resistance expected region 24 in the part S1 located outside the range of the medial midfoot region 20. The three medial transverse groove portions 34 extend in the foot width direction Y from the medial edge 10c of the sole 10 and are provided at intervals in the foot longitudinal direction Lx. No similar rigidity lowering portion 32 is provided in the sole midfoot portion 14 according to the reference example.

[0050] The respective deformation characteristics of the soles 10 and 100 with respect to external torsion were evaluated by eigenvalue analysis. More specifically, the respective torsional frequencies, which were the respective natural frequencies occurring when the characteristic vibration mode of the soles 10 and 100 was torsional vibration, were obtained by the eigenvalue analysis, and the deformation characteristics of the soles 10 and 100 were evaluated using the respective torsional frequencies. It means that the smaller the torsional frequencies become, the smaller the respective external torsional resistances of the soles 10 and 100 become.

[0051] Fig. 12 is a graph showing the torsional frequencies obtained by this analysis. As shown in this figure, the torsional frequency of the sole 10 according to the exemplary embodiment was smaller than that of the sole 100 according to the reference example. This indicates that the sole 10 according to the exemplary embodiment had smaller external torsional resistance than the sole 100 according to the reference example.

[0052] Next, the effects of the invention based on the presence or absence of the above-described conditions will be explained using an experiment example. In this experiment, a sole whose size and physical properties as the same as those of the two types of soles shown in Figs. 7 and 11 was used. In this experiment, shoes using these soles were worn. Using these shoes, the wearer kept a posture for 40 seconds where the wearer focused on keeping his/her body torso lifted from the ground contact surface while having his/her elbows touching the ground and having the respective forefoot portions 12 of the soles touching the ground such that the body parts from the head to the heel became straight.

[0053] The result of this experiment was evaluated using the torsion angle of the sole midfoot portion 14 and the amount of the ankle unstableness of the wearer. Using a motion capture system, this torsion angle was measured by acquiring three-dimensional positional information of markers attached to a plurality of parts of the sole 10. This torsion angle is defined as the angle formed by the ground contact surface of the sole midfoot portion with respect to the ground contact surface of the sole rearfoot portion. In the same way as in the torsion angle, the amount of the ankle unstableness of the wearer was also measured by acquiring three-dimensional positional information of markers attached to the ankle.

[0054] Fig. 13A shows the measurement result for torsion angles obtained by the experiment, and Fig. 13B shows the measurement result for the amount of the ankle unstableness. As compared with the sole 100 according to the reference example, it can be confirmed that the sole 10 according to the exemplary embodiment had a larger torsion angle of the sole midfoot portion 14. Based on this, it can be confirmed that the sole 10 according to the exemplary embodiment had smaller external torsional resistance than the sole 100 according to the reference example. Further, it can be confirmed that the sole 10 according to the exemplary embodiment had a smaller amount of the ankle unstableness than the sole 100 according to the reference example. Based on this, it can be confirmed that good stability can be obtained during a take standing on tiptoe posture by the shoe using the sole 10 according to the example. This is considered to be due to the bony locking mechanism being able to be induced in accordance with an increase in the torsion angle of the sole midfoot portion 14, as described above.

[0055] Fig. 14 is a bottom view showing a sole 10 according to a first exemplary variation. Lateral transverse groove portions 44, which are open on the ground contact surface 10e of the sole 10 and extend from the lateral edge 10d of the sole 10 in the foot width direction Y, are formed in the sole midfoot portion 14 and the rearfoot portion 16 of the sole 10 according to the first exemplary variation. In this case, the bending rigidity decreases in a range including a lateral midfoot region 22 of the sole 10. In accordance with this, it is difficult to provide a sufficient difference in bending rigidity between the medial midfoot region 20 and a lateral midfoot region 22 of the sole 10. In order to sufficiently obtain the effect of reducing the external torsional resistance at the sole midfoot portion 14, this difference in the bending rigidity is preferably as large as possible.

[0056] Therefore, the lateral transverse groove portions 44 extending from the lateral edge 10d of the sole 10 in the foot width direction Y are preferably not formed in a partial range Sb of the sole 10 in the foot longitudinal direction X. The partial range Sb includes a range Sb1 in the foot longitudinal direction X where all rigidity lowering portions 32 are provided and all of a range Sb2 on the heel side of the range Sb1. This allows a sufficient difference in bending rigidity to be provided between the medial midfoot region 20 and the lateral midfoot region 22 of the sole 10, and the effect of reducing the external torsional resistance at the sole midfoot portion 14 can thus be more easily obtained. From the same point of view, it can be considered that the lateral transverse groove portions 44 are preferably not formed in a range Sc, which is located on the heel side of the line y described above.

(First Embodiment)

[0057] Fig. 15 is a side view of a shoe 52 using a shoe bottom 50 according to a first embodiment as viewed from the medial side in the foot width direction. The shoe 52 is used, for example, for exercise in a room such as a gym; however, the usage thereof is not particularly limited. The shoe 52 includes a shoe bottom 50, which supports the wearer's foot, and an upper 54, which covers the wearer's foot.

[0058] The shoe bottom 50 includes a sole 10. The sole 10 according to the present embodiment includes a midsole 56. The sole 10 has a ground contact surface 10e, which comes into contact with the road surface. The ground contact surface 10e according to the present embodiment is formed by the lower surface of the midsole 56. The midsole 56 mainly has a role of alleviating the impact of landing. The midsole 56 is formed using, for example, a foam or non-foam resin, or the like.

[0059] Fig. 16 is a bottom view of the sole 10. A plurality of medial transverse groove portions 34 are formed on the sole 10. The plurality of medial transverse groove portions 34 are formed so as to be open on the ground contact surface 10e of the sole 10 and to extend in the in-plane direction of the ground contact surface 10e. The plurality of medial transverse groove portions 34 extend in the foot width direction Y from the medial edge 10c of the sole 10 toward the lateral edge 10d. The plurality of medial transverse groove portions 34 are provided at intervals in the leg longitudinal direction Lx. The respective end portions of the plurality of medial transverse groove portions 34 on the lateral side in the foot width direction Y are provided at intermediate positions in the foot width direction Y of the sole 10.

[0060] The extending direction of the medial transverse groove portions 34 is set to be a direction oblique to the foot width direction axis. More specifically, the extending direction is set to be a direction that is the same as the direction along a line t in the planar view. As shown in Fig. 2, this direction along the line t is a direction that is the same as the direction along a straight line Ld connecting the rear end portion of the first metatarsal bone Bf1 to the rear end portion of the fifth metatarsal bone Bf5 constituting the Lisfranc joint Jb. The expression "the same" includes not only the case where the directions are the same as interpreted literally but also the case where the directions are almost the same. When this condition is satisfied, the heel side end portion of the sole 10 easily turns in the supination direction, and as a result, the sole midfoot portion 14 can be easily twisted outward.

[0061] The depth of the medial transverse groove portions 34 from the ground contact surface 10e is preferably as deep as possible from the viewpoint of effectively reducing the bending rigidity of the medial midfoot region 20 of the sole 10. From this viewpoint, the depth of the medial transverse groove portions 34 is preferably 1% or more, more preferably 5% or more, and particularly preferably 10% or more, with respect to the average thickness of the entire sole 10.

[0062] The groove width of the medial transverse groove portions 34 is preferably 1 mm or more. The groove width means the opening width of the medial transverse groove portions 34 at the ground contact surface 10e of the sole 10. The groove width is set to 1 mm or more in order to effectively reduce the bending rigidity of the medial midfoot region 20 of the sole 10. Although the upper limit value of the groove width is not particularly limited, the groove width is preferably, for example, 20 mm or less.

[0063] An example is shown in which the shape of the medial transverse groove portions 34 is a straight line shape extending in the in-plane direction; however, the shape is not limited thereto. For example, a curved shape extending in the in-plane direction or a shape such as a combination of a straight line and a curved line may be employed.

[0064] Each of the plurality of medial transverse groove portions 34 constitutes a rigidity lowering portion 32, which lowers the bending rigidity of the medial midfoot region 20. A plurality of rigidity lowering portions 32 are thus provided. One medial transverse groove portion 34, which is a part of the plurality of medial transverse groove portions 34, is formed so as to extend from the medial midfoot region 20 to the lateral midfoot region 22. As described above, the rigidity lowering portions 32 are assumed to be provided in the medial midfoot region 20; however, the rigidity lowering portions 32 may be provided such that a portion of the rigidity lowering portions 32 extends over the lateral midfoot region 22. Further, the plurality of rigidity lowering portions 32 are formed so as to be located on the first region 26, the second region 28, and the third region 30 of the external torsional resistance expected region 24, respectively. Even when the rigidity lowering portions 32 are provided in the external torsional resistance expected region 24 as described above, the rigidity lowering portions 32 may be provided so as to extend outside the external torsional resistance expected region 24.

(Second Embodiment)

[0065] Fig. 17 is a bottom view showing a sole 10 according to a second embodiment. Fig. 18A is a side view of the sole 10 viewed from the medial side in the foot width direction, and Fig. 18B is a side view of the sole 10 viewed from the lateral side in the foot width direction.

[0066] The sole 10 according to the second embodiment has a longitudinal groove portion 36 extending in the foot longitudinal direction X in addition to a plurality of medial transverse groove portions 34. The longitudinal groove portion 36 is open on the ground contact surface 10e of the sole 10. The longitudinal groove portion 36 is connected to the end portion on the lateral side in the foot width direction of each of the plurality of medial transverse groove portions 34. The longitudinal groove portion 36 according to the present embodiment is provided so as to fit in an medial midfoot region 20 and is not provided in a lateral midfoot region 22.

[0067] The longitudinal groove portion 36 according to the present embodiment has a heel side portion 36b provided on the heel side of an intermediate portion 36a in the foot longitudinal direction X thereof and a toe side portion 36c provided on the toe side of the intermediate portion 36b. The intermediate portion 36a of the longitudinal groove portion 36 according to the present embodiment is provided so as to form a convex shape toward the lateral side in the foot width direction. The heel side portion 36b is provided being inclined with respect to the foot longitudinal axis so as to become closer to the medial edge 10c of the sole 10 toward the heel side of the sole 10. The distal end portion of the heel side portion 36b connects with the medial edge 10c of the sole 10. The toe side portion 36c is provided being inclined with respect to the foot longitudinal axis so as to become closer to the medial edge 10c of the sole 10 toward the toe side of the sole 10. The distal end portion of the toe side portion 36c connects with the medial edge 10c of the sole 10. The longitudinal groove portion 36 is provided such that a part of the range thereof that extends from the intermediate portion 36a to the heel side overlaps with a line u.

[0068] A plurality of island-like regions 38 surrounded by the plurality of medial transverse groove portions 34, the longitudinal groove portion 36, and the medial edge 10c of the sole 10 are formed in the medial midfoot region 20 of the sole 10. The island-like regions 38 are separated from the other region including the lateral midfoot region 22 of the sole 10 by a groove portion including the longitudinal groove portion 36. The "groove portion including the longitudinal groove portion 36" in the present embodiment refers to only the longitudinal groove portion 36. If the longitudinal groove portion 36 does not connect with the medial edge 10c of the sole 10, the medial transverse groove portion 34 closest to the toes or the heel is also included. It can be considered that the island-like regions 38 are separated from the region including the lateral midfoot region 22 by the groove portion including the longitudinal groove portion described above.

[0069] Thereby, when the medial midfoot region 20 is attempted to be bent and deformed at a part where the plurality of medial transverse groove portions 34 are formed, the deformation of the plurality of medial transverse groove portions 34 is prevented from influencing the lateral midfoot region 22 side of the longitudinal groove portion 36. Therefore, it becomes easier to design such that the bending rigidity of the medial midfoot region 20 and the bending rigidity of the lateral midfoot region 22 are different from each other.

[0070] The groove width of the longitudinal groove portion 36 is set to be larger than the respective groove widths of the medial transverse groove portions 34. The medial transverse groove portion 34 that connects with the end portion of the longitudinal groove portion 36 and is the closest to the toes is also set to be larger than the respective groove widths of the other medial transverse groove portions 34.

[0071] A plurality of second transverse groove portions 42 are formed in a forefoot portion 12 and a midfoot portion 14 of the sole 10 according to the second embodiment. The plurality of second transverse groove portions 42 are provided at intervals in the leg longitudinal direction Lx. Some second transverse groove portions 42 of the plurality of second transverse groove portions 42 are provided so as to reach the medial edge 10c from the lateral edge 10d of the sole 10. The other second transverse groove portions 42 of the plurality of second transverse groove portions 42 are provided so as to extend toward the medial edge 10c from the lateral edge 10d of the sole 10. The respective end portions of the other second transverse groove portions 42 are provided at intermediate positions in the foot width direction of the sole 10. Any of the second transverse groove portions 42 is provided on the toe side of the above-described line y.

[0072] Fig. 19A is a bottom view of a sole 10 according to a second exemplary variation. Fig. 19B is a bottom view of a sole 10 according to a third exemplary variation. Fig. 19C is a bottom view of a sole 10 according to a fourth exemplary variation. Regarding the longitudinal groove portion 36 in the example of Fig. 17, an example has been explained where both end portions of the longitudinal groove portion 36 connect with the medial edge 10c of the sole 10. Both end portions of the longitudinal groove portion 36 according to the present example are provided at locations away from the medial edge 10c of the sole 10 in the foot width direction. In the longitudinal groove portion 36 according to the present example, the end portions of the medial transverse groove portions 34 and the end portions of the longitudinal groove portion 36 are connected so as to form corner portions with the medial transverse groove portions 34. In addition to this, the end portions of the longitudinal groove portion 36 may be provided so as to end without connecting with other groove portions.

[0073] Fig. 19A shows an example where a single longitudinal groove portion 36 is provided, and Fig. 19B shows an example where a plurality of longitudinal groove portions 36-A and 36-B (hereinafter, generically referred to as longitudinal groove portions 36). The plurality of longitudinal groove portions 36-A and 36-B include a first longitudinal groove portion 36-A on the lateral side in the foot width direction and a second longitudinal groove portion 36-B on the medial side in the foot width direction. The first longitudinal groove portion 36-A is provided so as to connect with end portions of the plurality of medial transverse groove portions 34. The second longitudinal groove portion 36-B is provided so as to connect with intermediate portions of the plurality of medial transverse groove portions 34 such that the second longitudinal groove portion 36-B intersect with the intermediate portions in a T-shape or X-shape.

[0074] Figs. 19A and 19B show examples where the respective longitudinal groove portions 36 are provided so as to extend in a linear manner along the respective lines s, and in Fig. 19C shows an example where the longitudinal groove portion 36 is provided so as to extend in a linear manner along the line u. The expression "linear" means a shape looking like a straight line and does not mean a strictly linear shape in a geometrical manner. An extending direction Pb in which the linear longitudinal groove portion 36 extends from the toe side to the heel side as described above is set to have, for example, an angle formed by the direction axis thereof with respect to the line s of from 0 to 15 degrees.

(Third Embodiment)

[0075] Fig. 20 is a side view of a shoe bottom 50 according to a third embodiment as viewed from the same viewpoint as that of Fig. 15. In the above-described embodiment, an example has been explained where a sole 10 has only a midsole 56; however, the sole 10 may have an outer sole 58 as well.

[0076] The outer sole 58 is disposed below the midsole 56 and is attached to the lower surface of the midsole 56 by adhesion or the like. The ground contact surface 10e of the sole 10 is formed by the lower surface of the outer sole 58. The outer sole 58 mainly has a role of securing grip performance against the road surface. The outer sole 58 is formed using, for example, a non-foam or foam rubber, or the like. The midsole 56 is formed to be thicker than the outer sole 58 from the viewpoint of playing the role of alleviating the impact of the landing. Further, since the outer sole 58 plays a role of securing the grip performance, the outer sole 58 may have hardness that is larger than that of the midsole 56. The medial transverse groove portions 34 according to the present embodiment are formed within a range that does not reach the midsole 56 from the ground contact surface 10e of the outer sole 58.

(Fourth Embodiment)

[0077] Fig. 21 is a side view of a shoe bottom 50 according to a fourth embodiment as viewed from the same viewpoint as that of Fig. 15. Different from the example of Fig. 20, medial transverse groove portions 34 according to the present example are formed within a range that reaches a midsole 56 from the ground contact surface 10e of an outer sole 58.

[0078] As described, a sole 10 may have either one or both of the midsole 56 and the outer sole 58. For example, although not shown in the figure, the sole 10 may have only the outer sole 58.

[0079] Described above is a detailed explanation of the embodiments of the present invention. All of the above-described embodiments merely show specific examples for carrying out the present invention. The details of the embodiments do not limit the technical scope of the present invention, and many design changes such as change, addition, deletion, etc., of constituent elements may be made without departing from the spirit of the invention as defined by the claims. In the above-described embodiments, such details that are changeable in a design manner are explained with notations of "according to the embodiment", "in the embodiment", etc.; however, it does not mean that design changes are not allowed for features without such notations. Further, hatching applied to cross sections of the drawings does not limit the material of an object with the hatching.

[0080] The expression "foot longitudinal direction Lx" may be defined as a direction along a straight line connecting the toe side end portion of the second toe to the rearmost end portion (calcaneus tuberosity) of the calcaneus of the wearer’s foot, which is assumed to be on the sole 10 by design.

[0081] As the sole center line s, a straight line extending along the foot longitudinal direction Y, which divides the full width Lb of the sole 10 into 1:1, may be used. From another viewpoint, a straight line along the foot longitudinal direction Y may be used by which the full width Lb of the sole 10 is divided from 1:1 to 3.7:3.2 from the medial side in the foot width direction to the lateral side in the foot width direction.

[0082] For example, the midsole 56 may be formed by stacking two or more parts having different material properties in the vertical direction or arranging the parts in the foot longitudinal direction.

[DESCRIPTION OF THE REFERENCE NUMERALS]

[0083] 10 sole, 10c medial edge, 10d lateral edge, 10e ground contact surface, 14 midfoot portion, 16 rearfoot portion, 16a toe side end portion, 16b heel side end portion, 16c continuous surface, 20 medial midfoot region, 22 lateral midfoot region, 24 external torsional resistance expected region, 26 first region, 28second region, 30 third region, 32 rigidity lowering portion, 34 medial transverse groove portion, 36 longitudinal groove portion, 44 lateral transverse groove portion, 50 shoe bottom, 52 shoe, 56 midsole, 58 outer sole

[INDUSTRIAL APPLICABILITY]

[0084] The present invention relates to shoe bottoms of shoes.

Claims

1. A shoe bottom comprising a sole, wherein when a midfoot portion of the sole is divided by a predetermined sole center line into an medial midfoot region and a lateral midfoot region one on each side in the foot width direction, the sole has a rigidity lowering portion that is provided in the medial midfoot region, and wherein, in such a manner that the bending rigidity of the medial midfoot region around a foot width direction axis becomes smaller than that of the lateral midfoot region, the rigidity lowering portion in the medial midfoot region reduces the bending rigidity of the medial midfoot region due to another factor other than the shape of an medial edge and the shape of a lateral edge of the sole in a planar view.

2. The shoe bottom according to claim 1, wherein a continuous surface that is continuous in the foot longitudinal direction from a toe side end portion to a heel side end portion of a rearfoot portion of the sole is formed on a ground contact surface of the sole.

3. The shoe bottom according to claim 1 or 2, wherein a lateral transverse groove portion that is open on the ground contact surface of the sole and that extends from the lateral edge in the foot width direction is not formed in a range in the foot longitudinal direction where the rigidity lowering portion is provided and in a range in the foot longitudinal direction located on the heel side of the range.

4. The shoe bottom according to any one of claims 1 through 3, wherein the rigidity lowering portion is open on the ground contact surface of the sole and serves as an medial transverse groove portion that extends in the foot width direction from the medial edge.

5. The shoe bottom according to any one of claims 1 through 4, wherein the sole has either one or both of a midsole and an outer sole, and wherein a reinforcing member is not attached to the midfoot portion of the sole.

6. The shoe bottom according to any one of claims 1 through 5, wherein on the sole, a plurality of medial transverse groove portions are formed that are open on a ground contact surface of the sole and extend in the foot width direction from the medial edge, and a longitudinal groove portion is formed that is open on the ground contact surface of the sole, extends in the foot longitudinal direction, and connects with respective end portions of the plurality of medial transverse groove portions in the foot width direction.

7. The shoe bottom according to any one of claims 1 through 6, wherein in a planar view of the sole, given that straight lines along the foot width direction that divide the full length La of the sole in the foot longitudinal direction into 1.5:1.0:1.1 from the toe side to the heel side are defined as lines p and q, respectively, a straight line along the foot longitudinal direction that divides the full width Lb of the sole into 1.2:1.0 from the medial side to the lateral side in the foot width direction is defined as a line s, which serves as the sole center line, being viewed from a point o1, which is the intersection point of the line p and the line s, a straight line obtained by rotating the line p by 13 degrees around the point o1 in an outward direction that rotates the toe side outward in the foot width direction, is defined as a line t, a straight line obtained by rotating the line s by 8 degrees around the point o1 in the outward direction viewed from the point o1 is defined as a line u, being viewed from a point o2, which is the intersection point of the line u and the line q, a straight line obtained by rotating the line q by 5 degrees around the point o2 in the outward direction is defined as a line v, a region surrounded by the line t, the line u, the line v, and the medial edge is defined as a first region, and a region formed of the first region is defined as an external torsional resistance expected region, a rigidity lowering portion is provided in the external torsional resistance expected region.

8. The shoe bottom according to any one of claims 1 through 6, wherein in a planar view of the sole, given that straight lines along the foot width direction that divide the full length La of the sole in the foot longitudinal direction into 1.5:1.0:0.2:0.9 from the toe side to the heel side are defined as lines p, q, and r, respectively, a straight line along the foot longitudinal direction that divides the full width Lb of the sole into 1.2:1.0 from the medial side to the lateral side in the foot width direction is defined as a line s, which serves

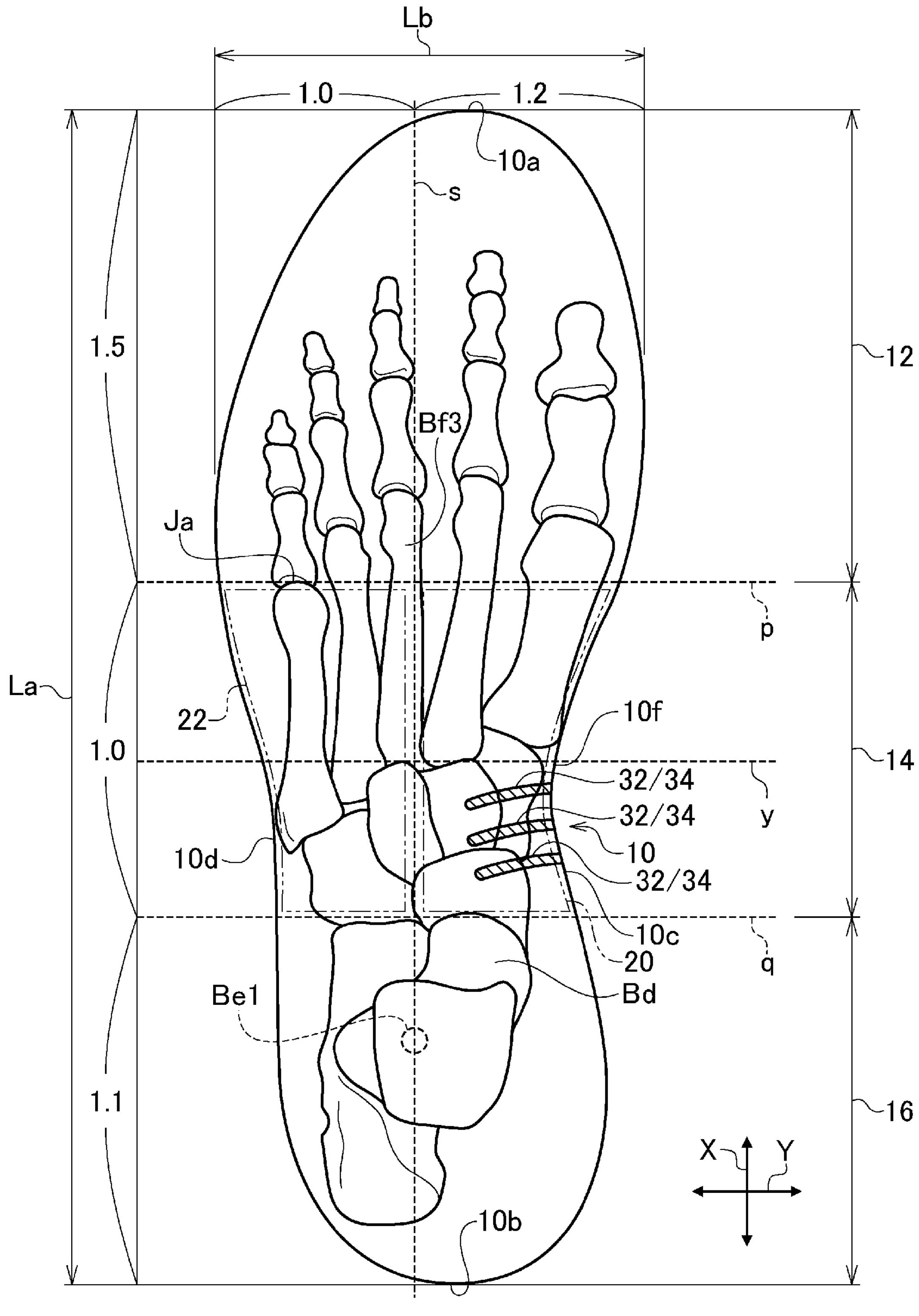
as the sole center line,
being viewed from a point o1, which is the intersection point of the line p and the line s, a straight line obtained by rotating the line p by 13 degrees around the point o1 in an outward direction that rotates the toe side outward in the foot width direction, is defined as a line t,
a straight line obtained by rotating the line s by 8 degrees around the point o1 in the outward direction viewed from the point o1 is defined as a line u, being viewed from a point o2, which is the intersection point of the line u and the line q, a straight line obtained by rotating the line q by 5 degrees around the point o2 in the outward direction is defined as a line v, being viewed from a point P, which is the intersection point of the line r and the line u, a straight line obtained by rotating the line r by 4 degrees around the point P in the outward direction is defined as a line w, a straight line connecting a point o5, which is the intersection point of the medial edge and the line w, and the point o2 is defined as a line x,
a region surrounded by the line t, the line u, the line v, and the medial edge is defined as a first region,
a region surrounded by the line v, the line x, and the medial edge is defined as a second region, and
a region formed of the first region and the second region is defined as an external torsional resistance expected region,
a rigidity lowering portion is provided in the external torsional resistance expected region.

9. The shoe bottom according to any one of claims 1 through 6,
wherein in a planar view of the sole, given that
straight lines along the foot width direction that divide the full length La of the sole in the foot longitudinal direction into 1.5:1.0:0.2:0.9 from the toe side to the heel side are defined as lines p, q, and r, respectively,
a straight line along the foot longitudinal direction that divides the full width Lb of the sole into 1.2:1.0 from the medial side to the lateral side in the foot width direction is defined as a line s, which serves as the sole center line,
being viewed from a point o1, which is the intersection point of the line p and the line s, a straight line obtained by rotating the line p by 13 degrees around the point o1 in an outward direction that rotates the toe side outward in the foot width direction, is defined as a line t,
a straight line obtained by rotating the line s by 8 degrees around the point o1 in the outward direction viewed from the point o1 is defined as a line u, being viewed from a point o2, which is the intersection point of the line u and the line q, a straight line obtained by rotating the line q by 5 degrees around the point o2 in the outward direction is defined as a line v, being viewed from a point P, which is the intersection point of the line r and the line u, a straight line obtained by rotating the line r by 4 degrees around the point P in the outward direction is defined as a line w, a straight line connecting a point o5, which is the intersection point of the medial edge and the line w, and the point o2 is defined as a line x,
a region surrounded by the line t, the line u, the line v, and the medial edge is defined as a first region,
a region surrounded by the line v, the line x, and the medial edge is defined as a second region,
a region surrounded by the line s, the line u, the line x, and the line w is defined as a third region, and
a region formed of the first region, the second region, and the third region is defined as an external torsional resistance expected region,
a rigidity lowering portion is provided in the external torsional resistance region.

10. The shoe bottom according to any one of claims 1 through 9, wherein the factor is any one or a combination of two of a recessed portion that is open on the ground contact surface of the sole and the elongation characteristic of a material constituting the sole.

11. A shoe comprising the shoe bottom according to any one of claim 1 through 10.

FIG. 1


Lb
1.0
1.2
10a
s
1.5
12
Bf3
Ja
p
La
22
10f
1.0
14
32/34
y
32/34
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32/34
10c
20
q
Bd
Be1
1.1
16
X
Y
10b

FIG. 2

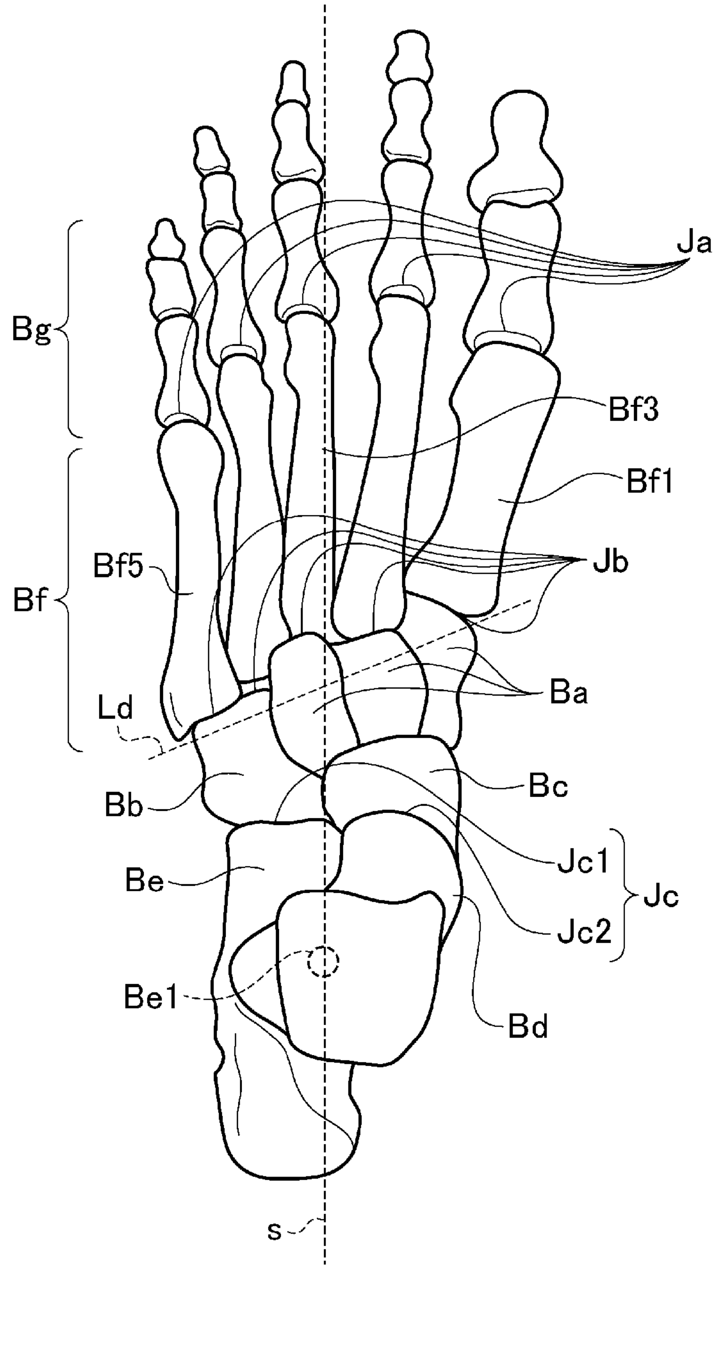

FIG. 3A

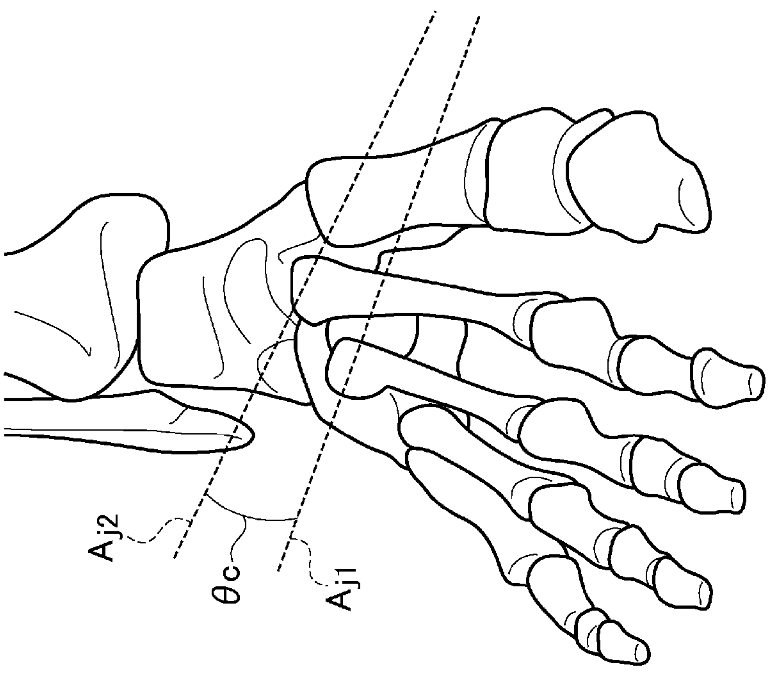

FIG. 3B

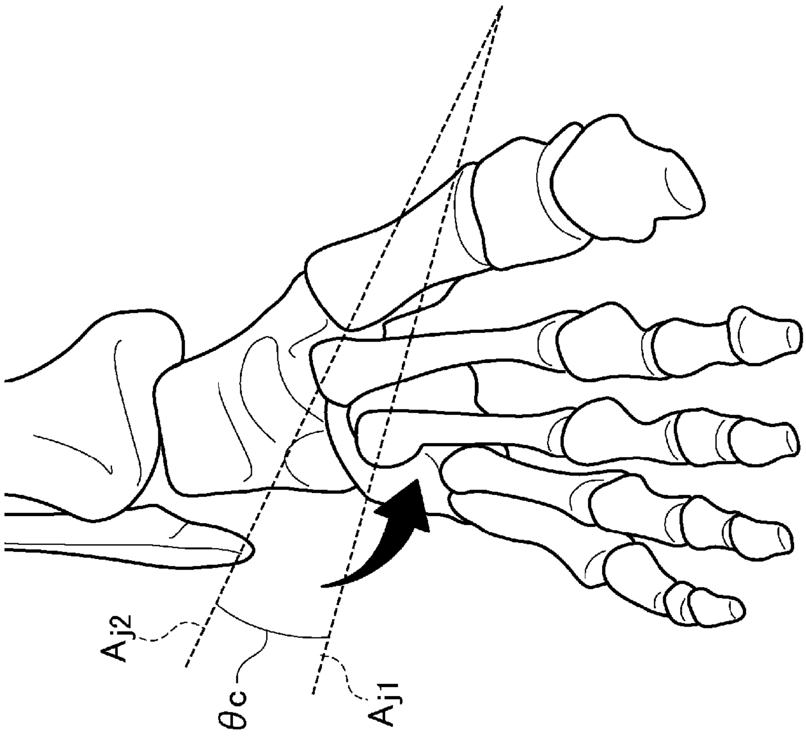

FIG. 4B

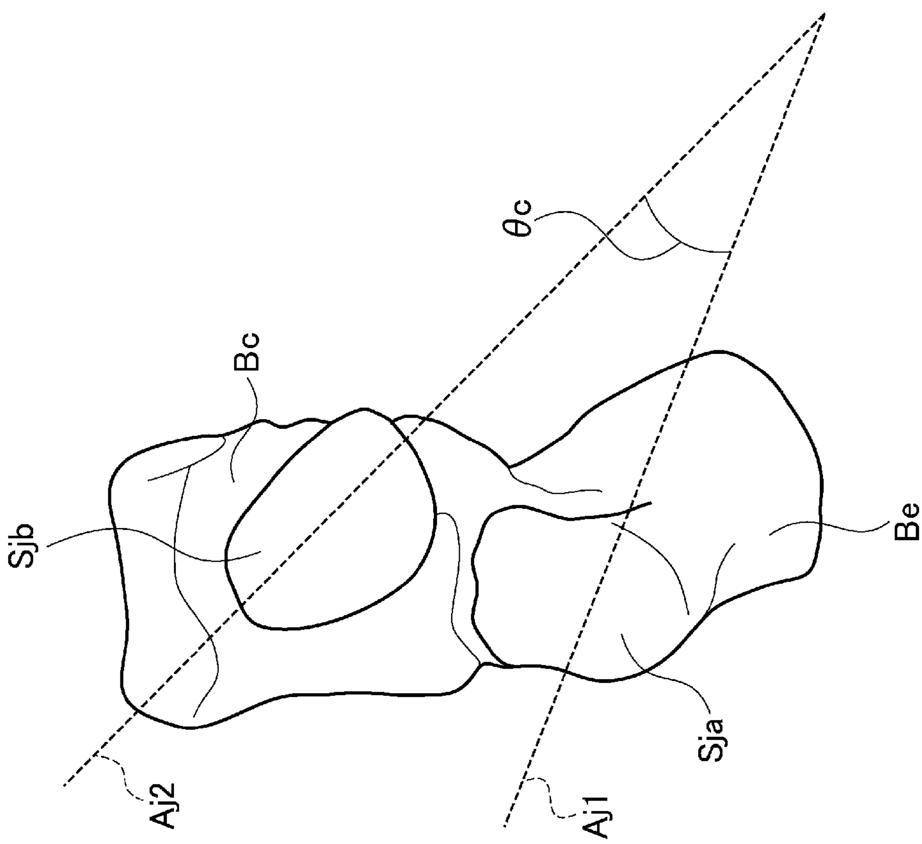

FIG. 4A

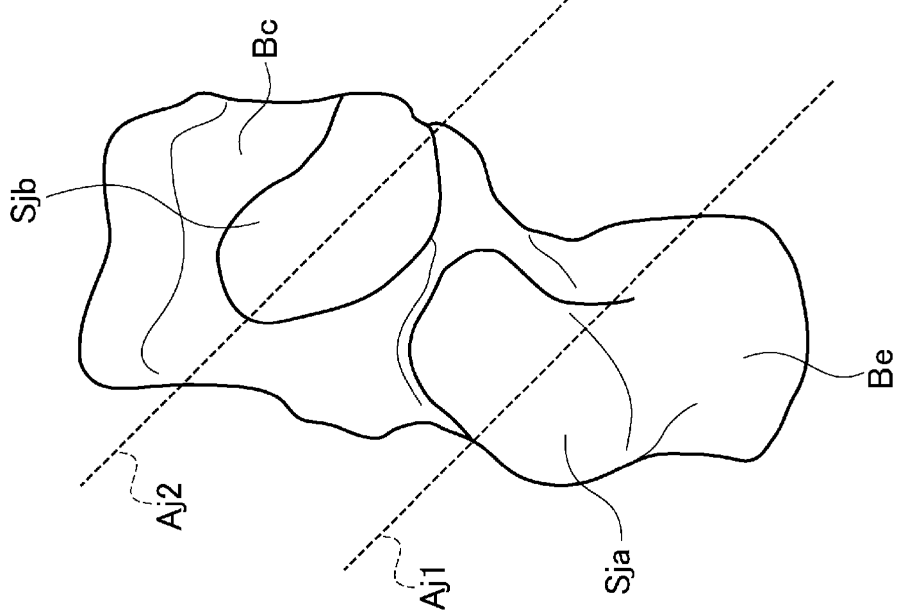

FIG. 5A

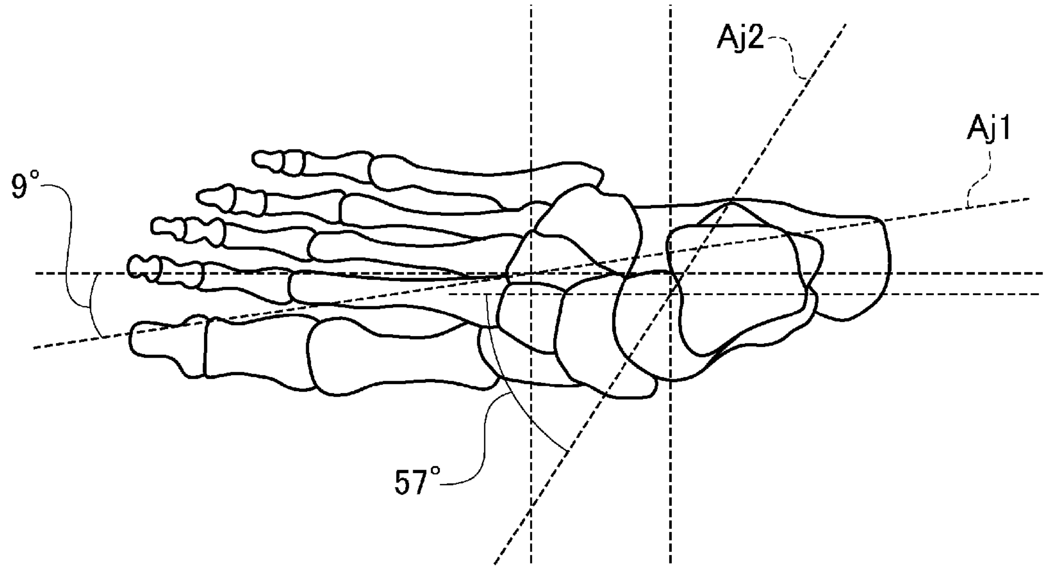

FIG. 5B

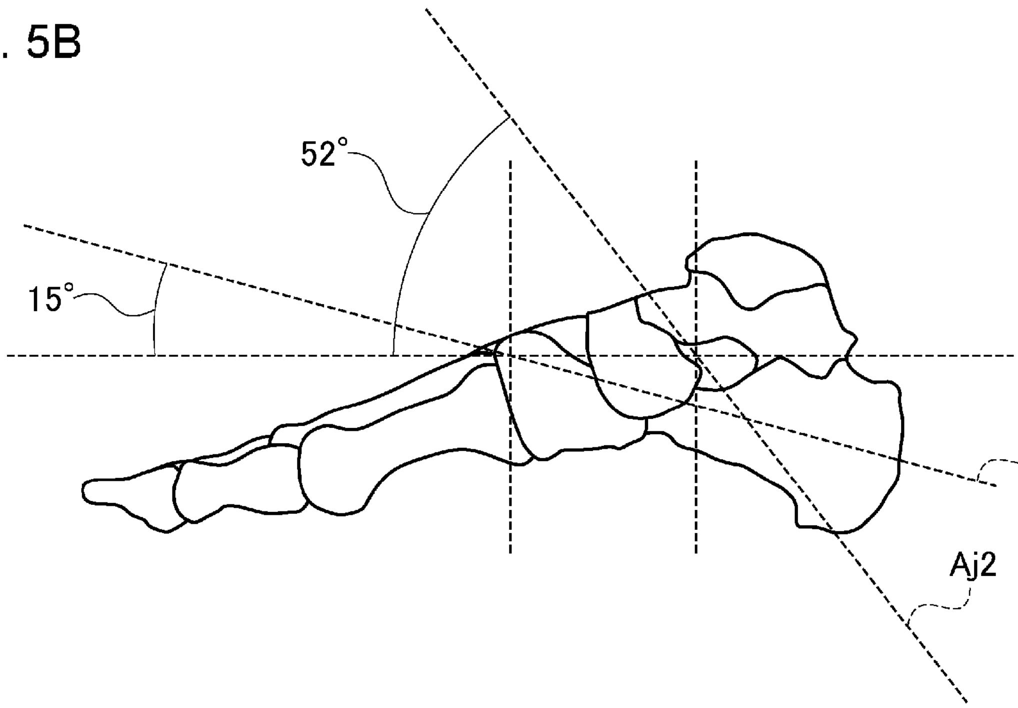

FIG. 6

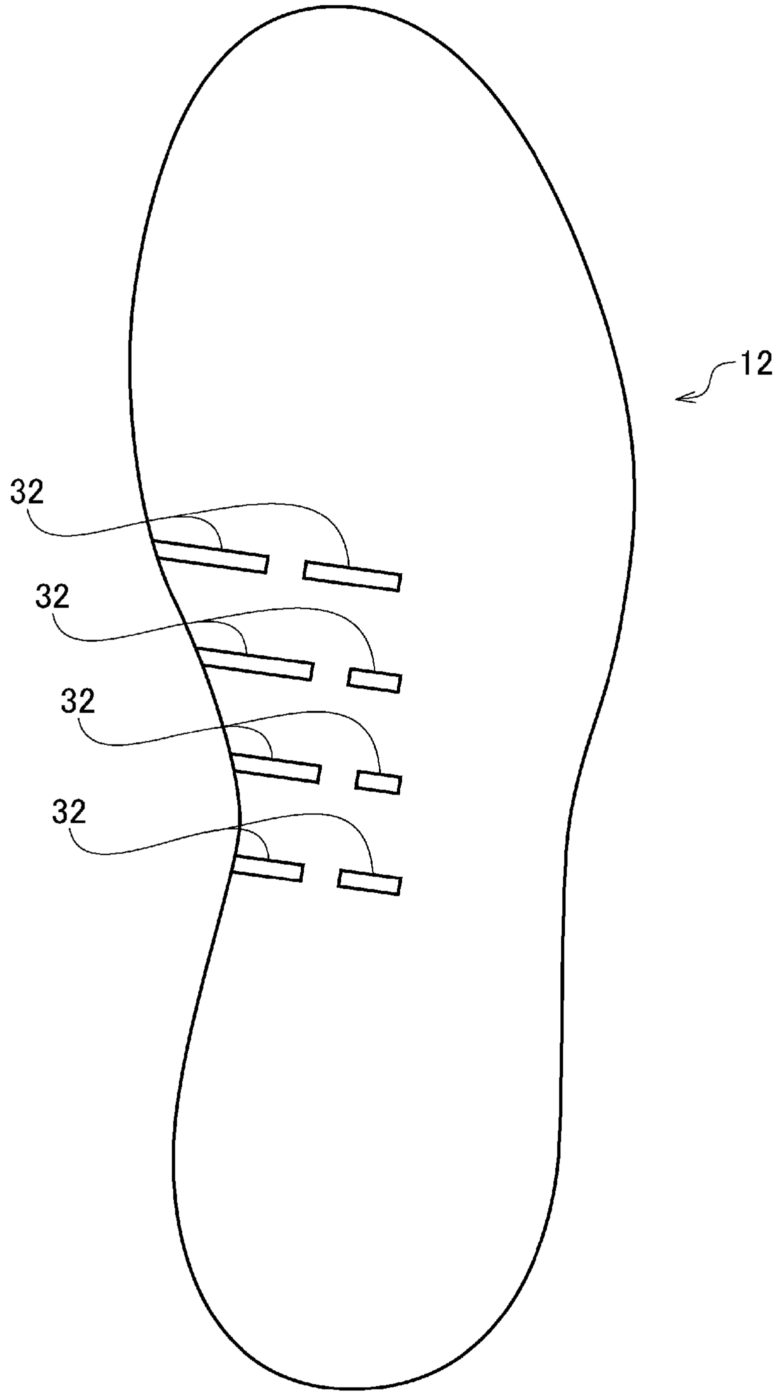

FIG. 7

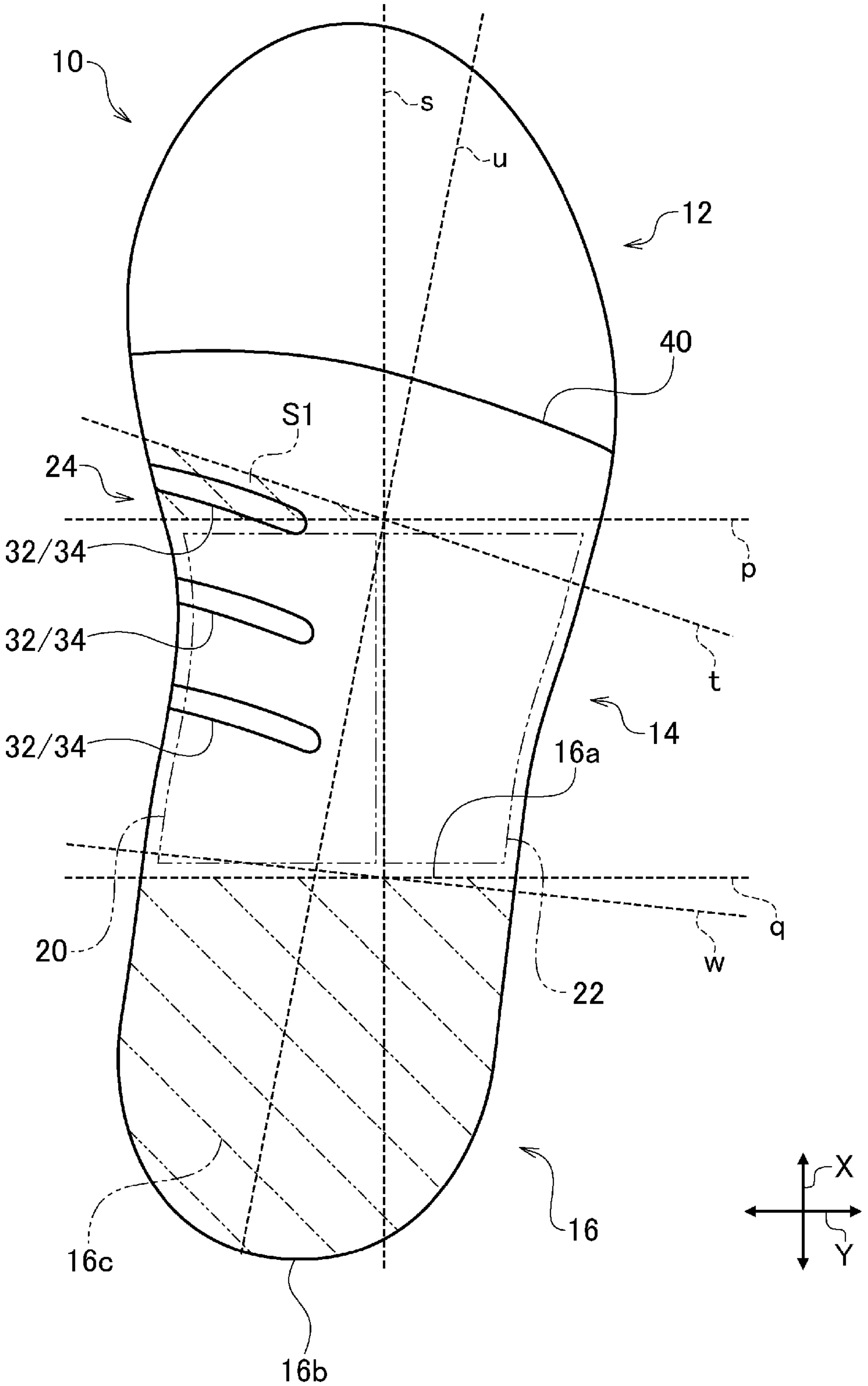

FIG. 8

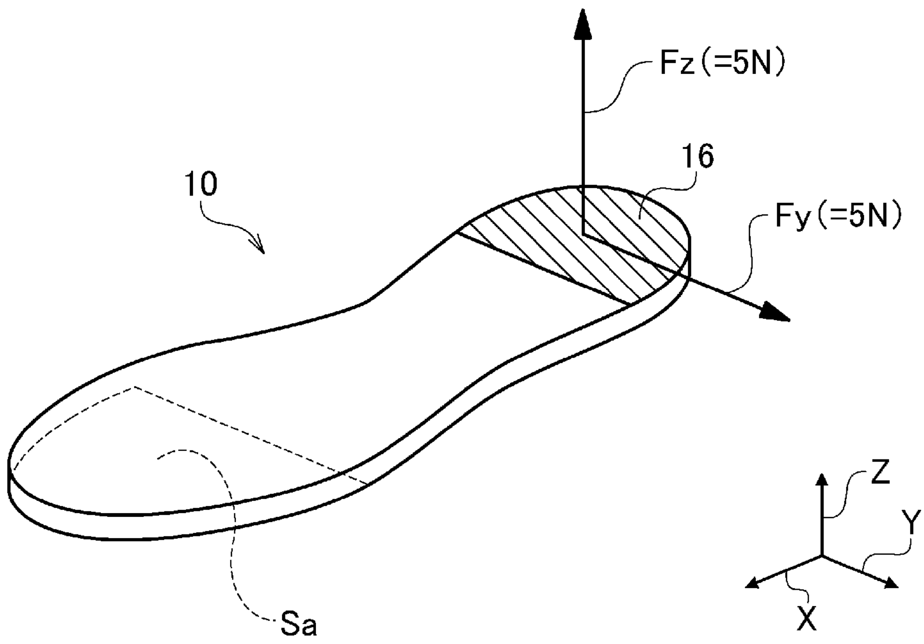

FIG. 9

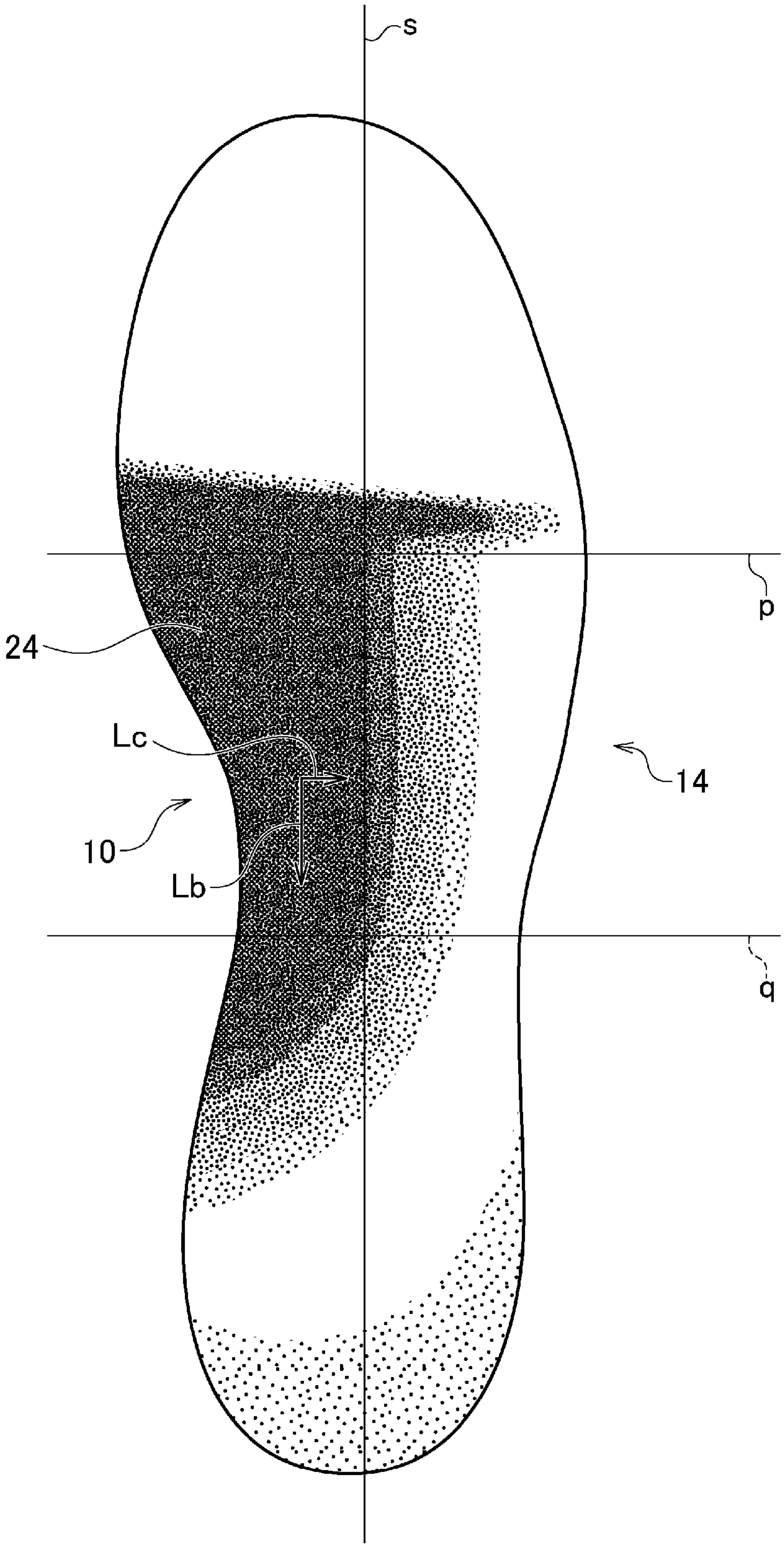

FIG. 10

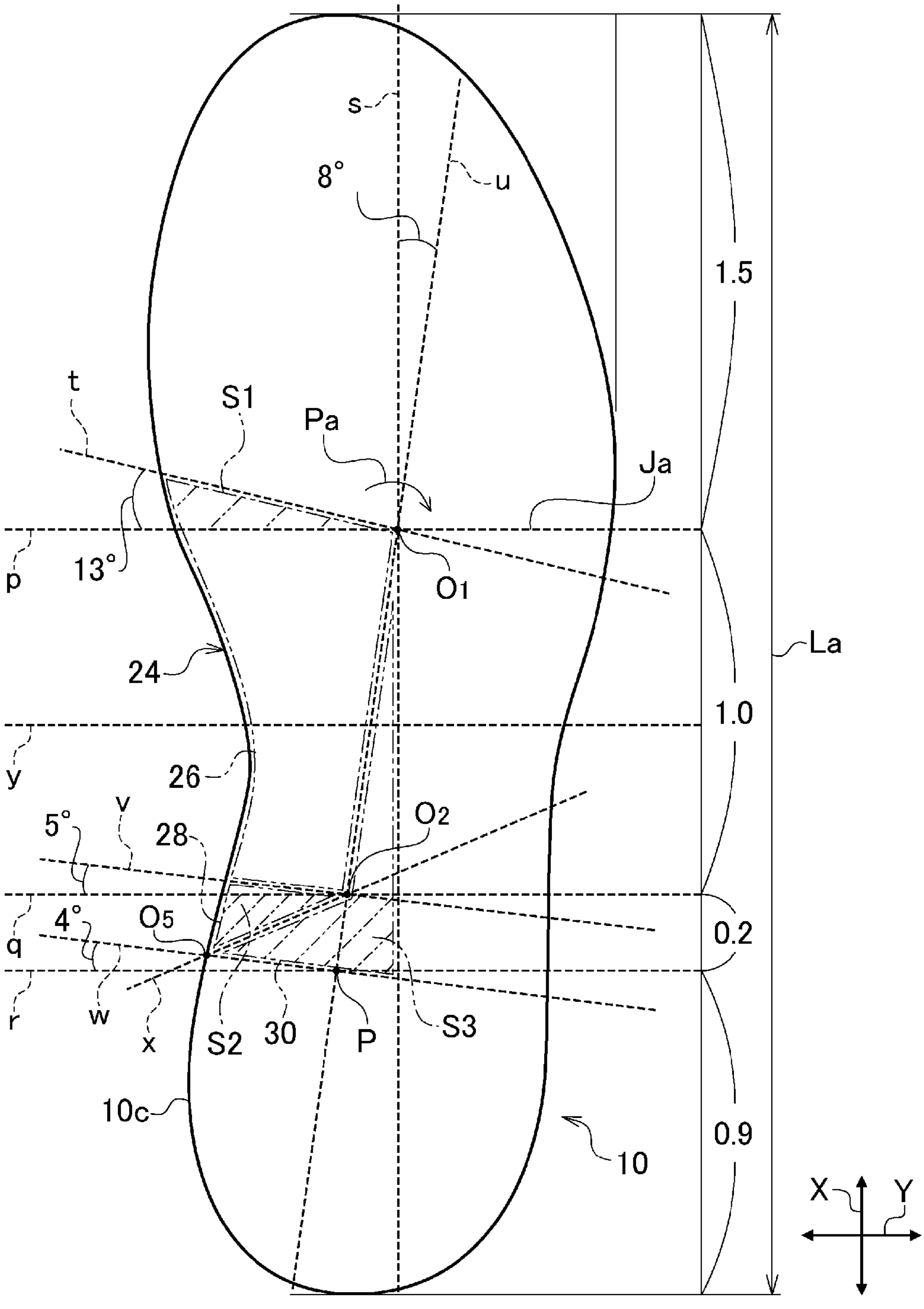
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FIG. 11

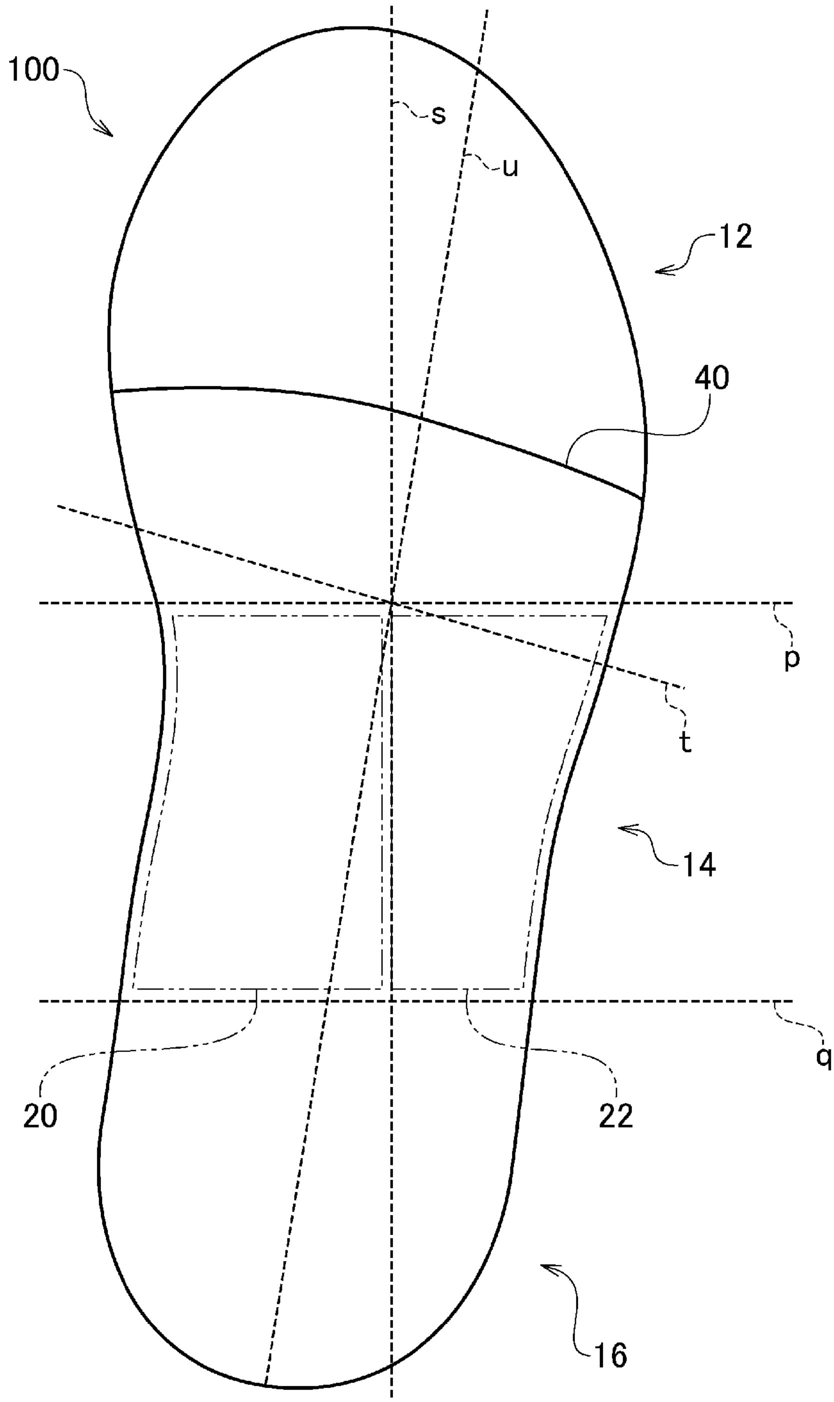


FIG. 12

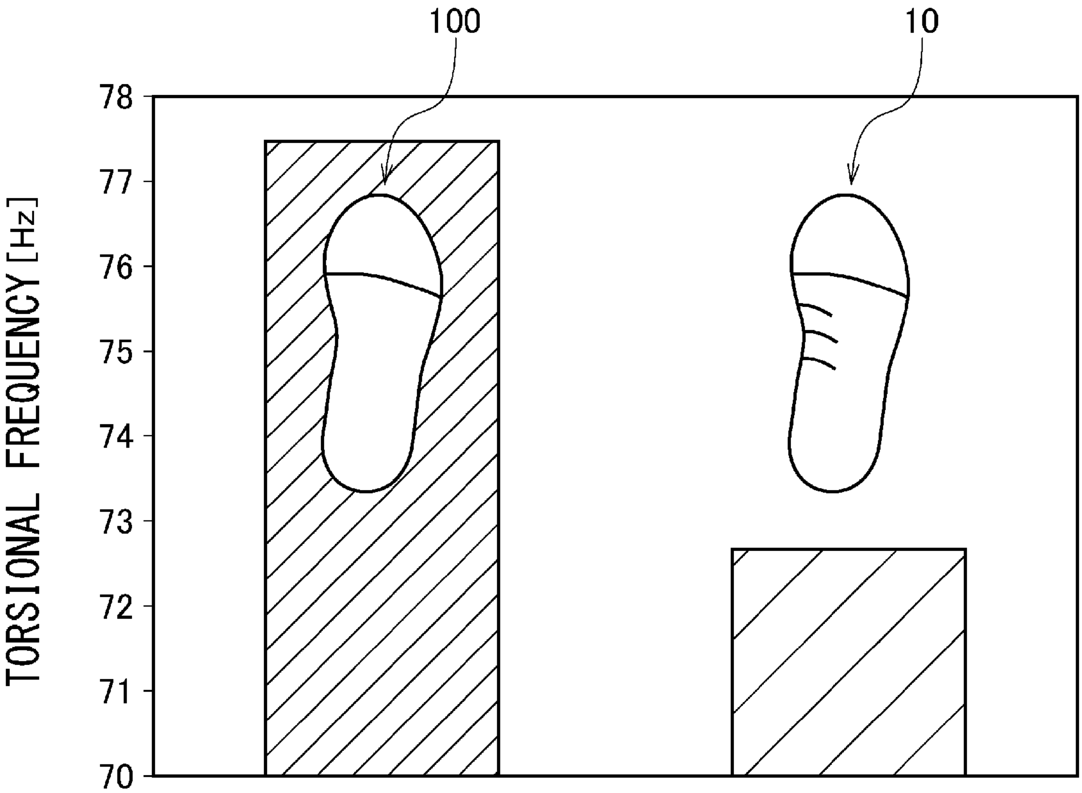


FIG. 13A

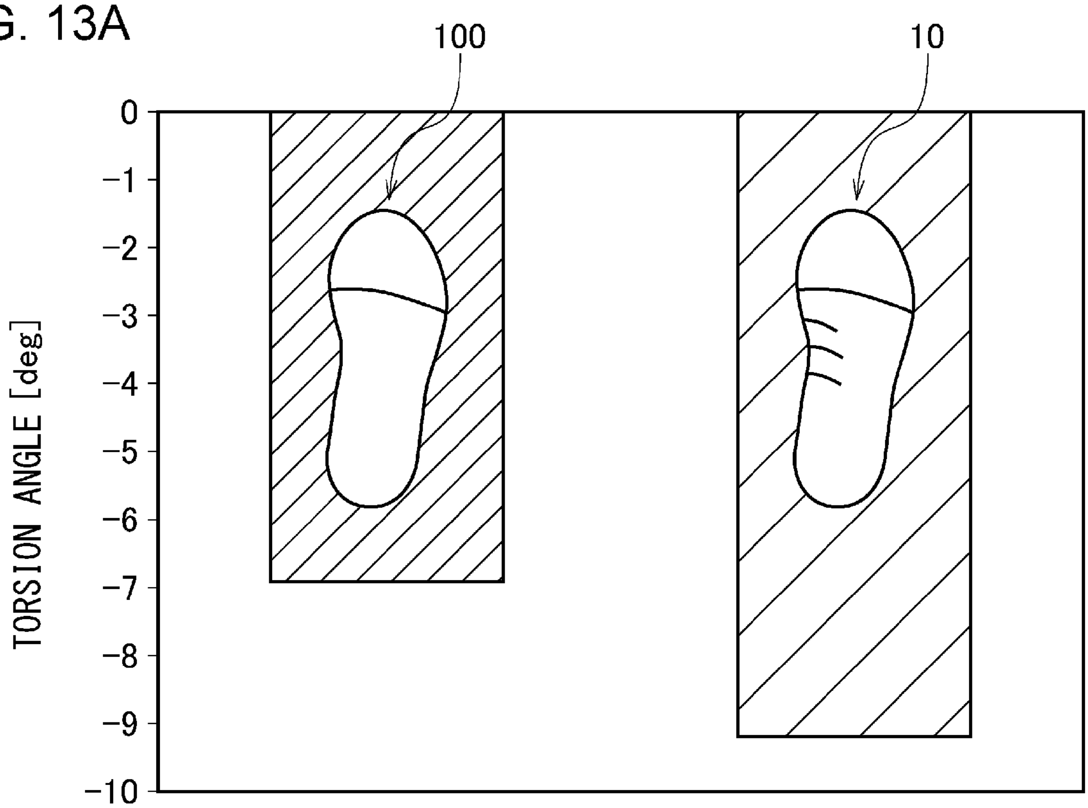


FIG. 13B

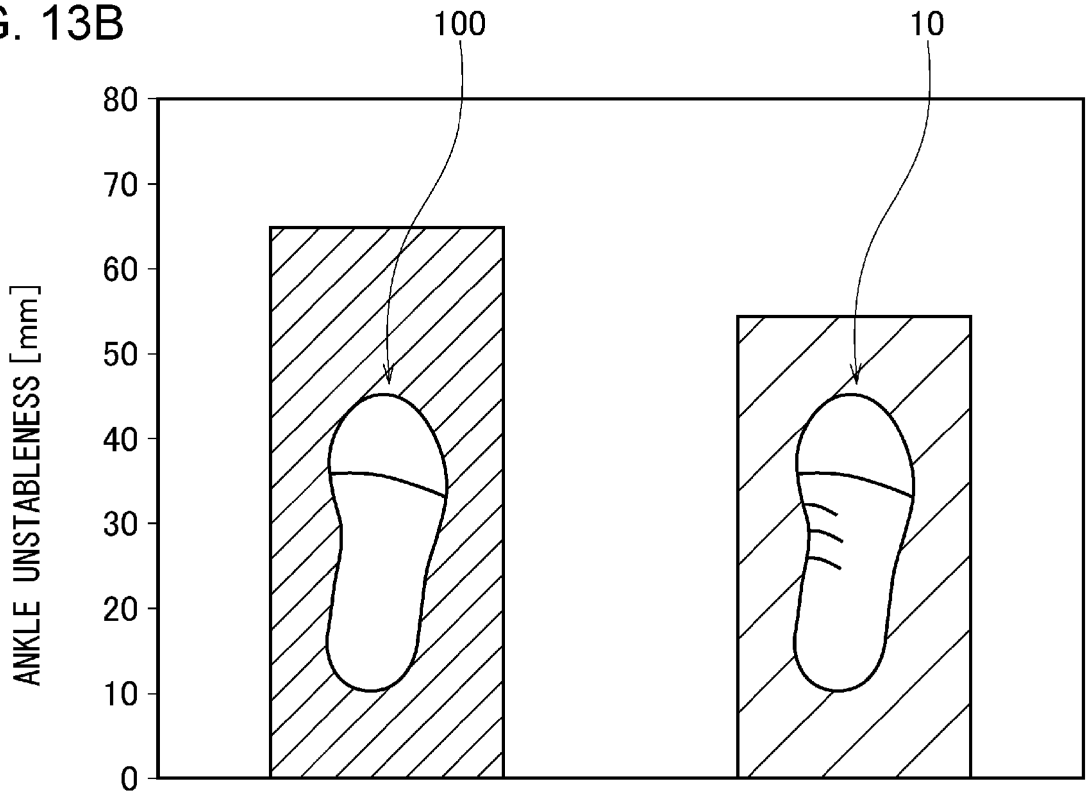
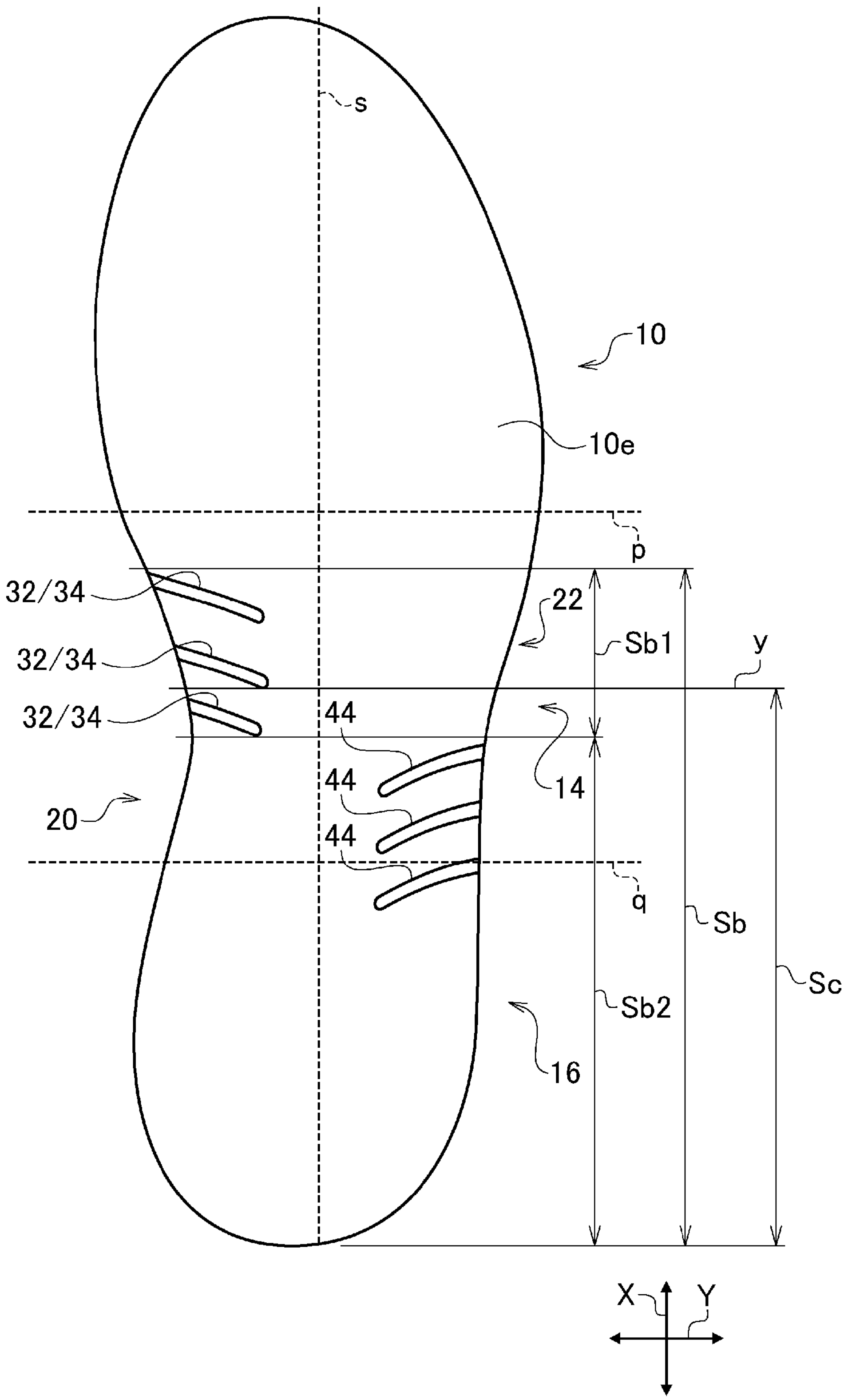


FIG. 14



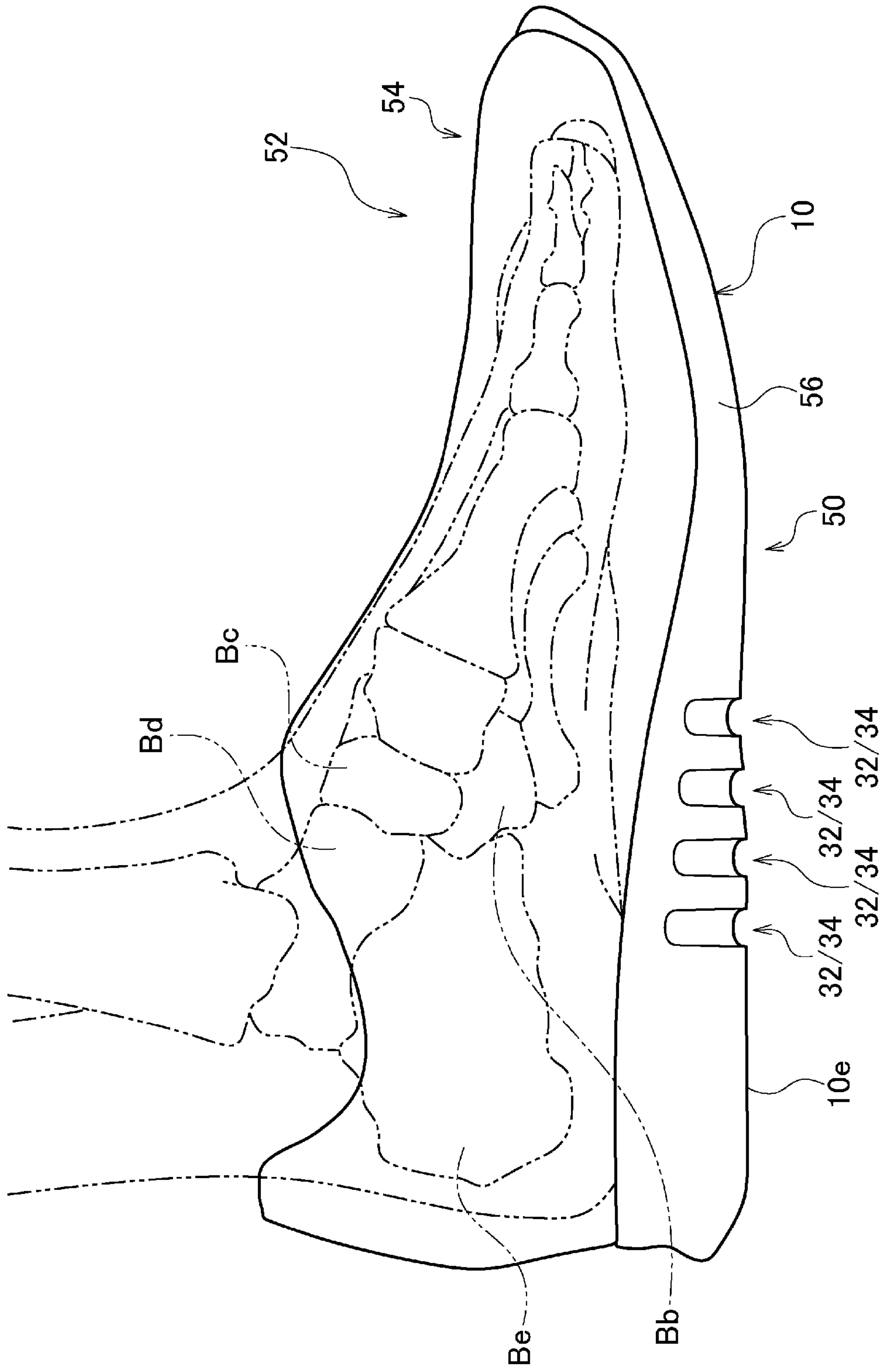


FIG. 15

FIG. 16

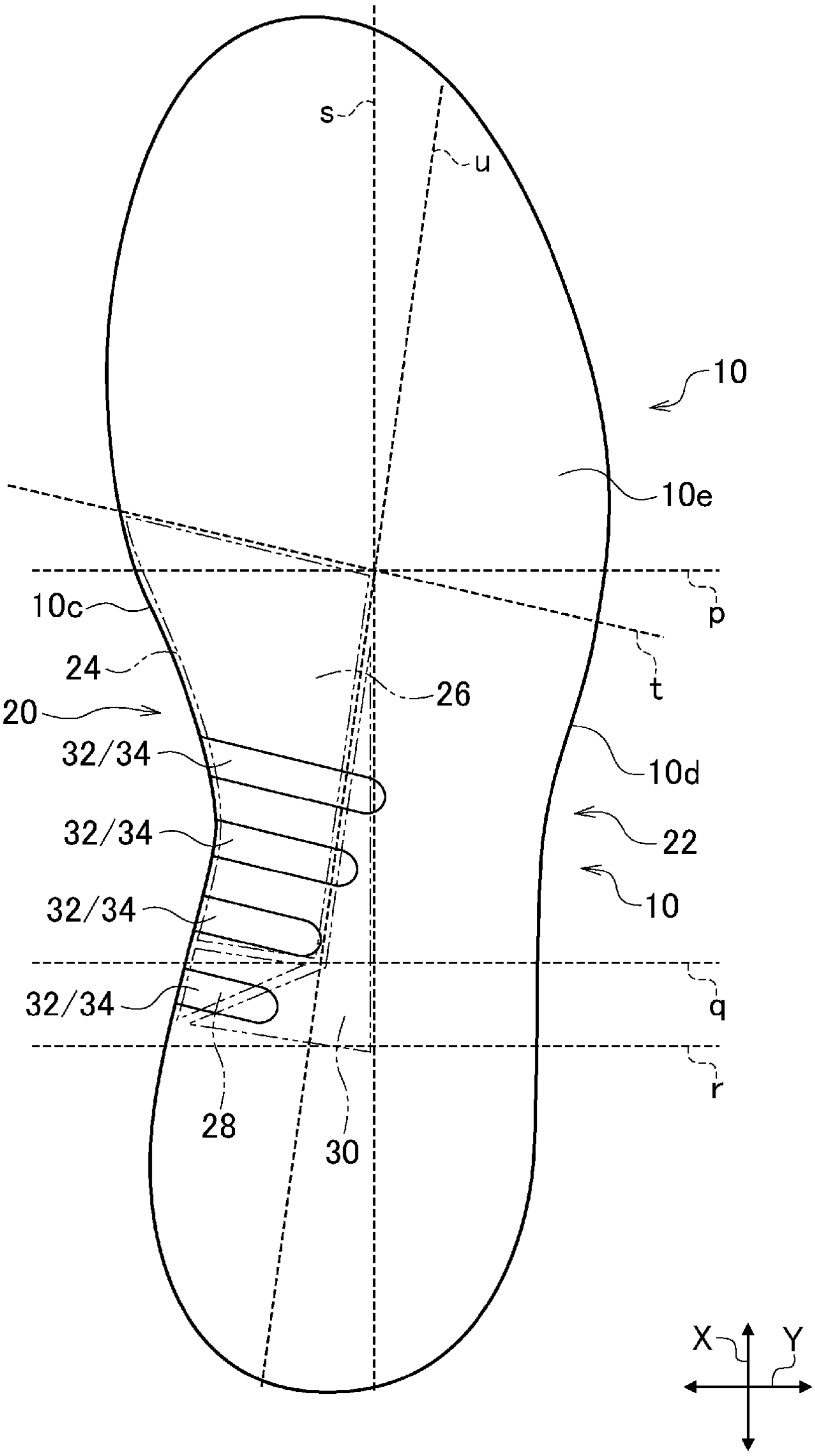
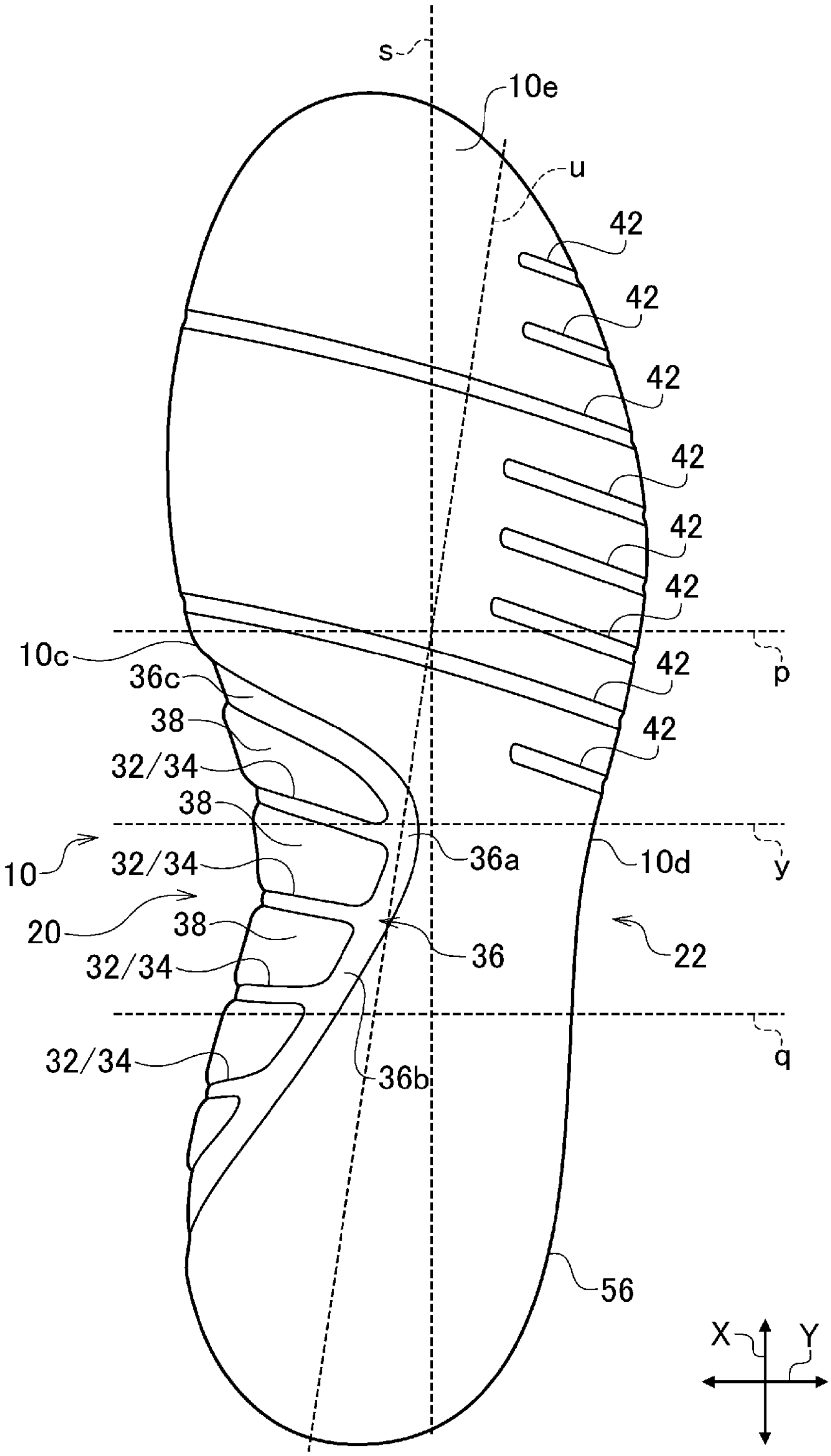


FIG. 17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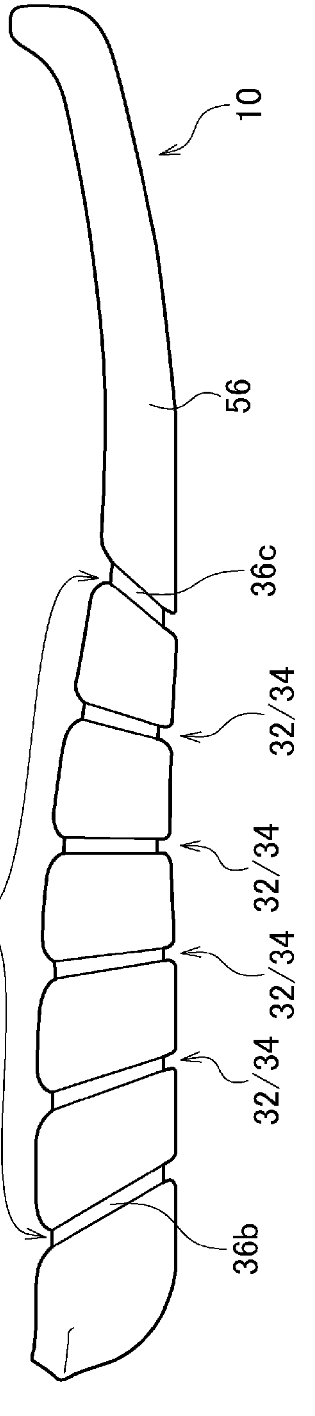


FIG. 18A

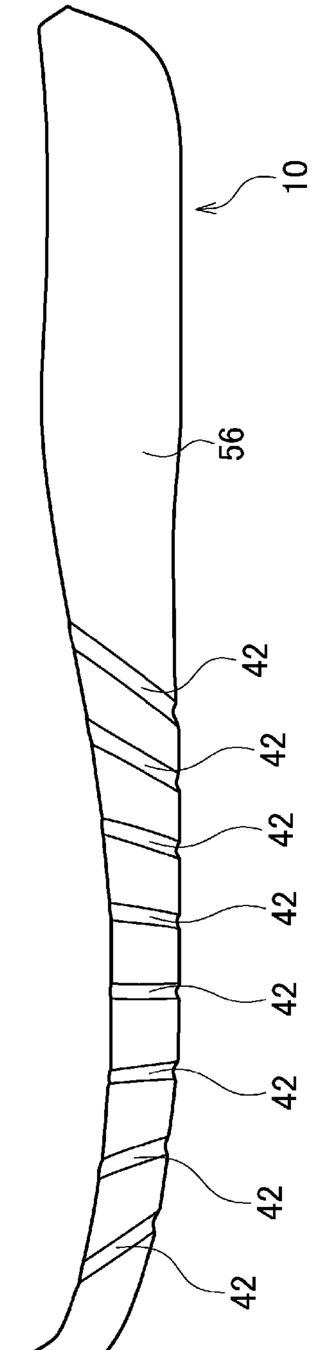


FIG. 18B

FIG. 19A

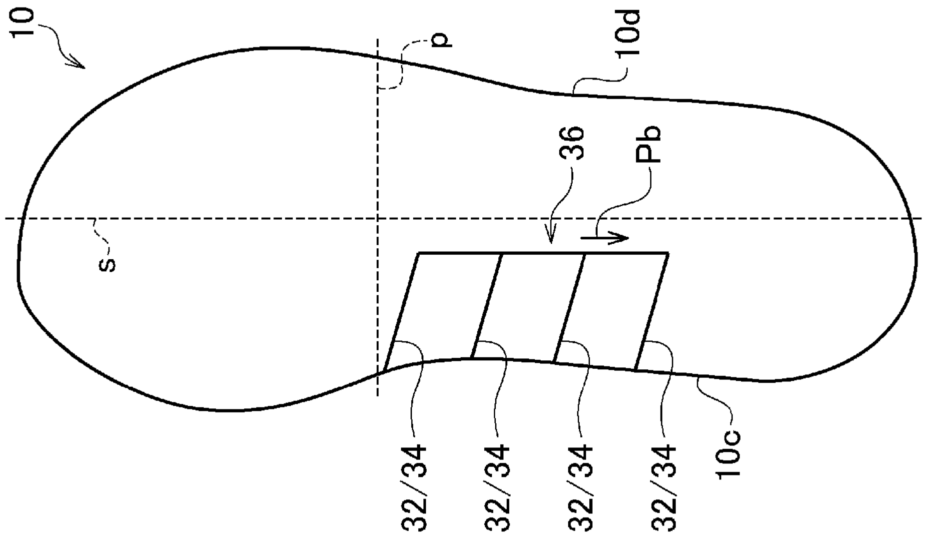


FIG. 19B

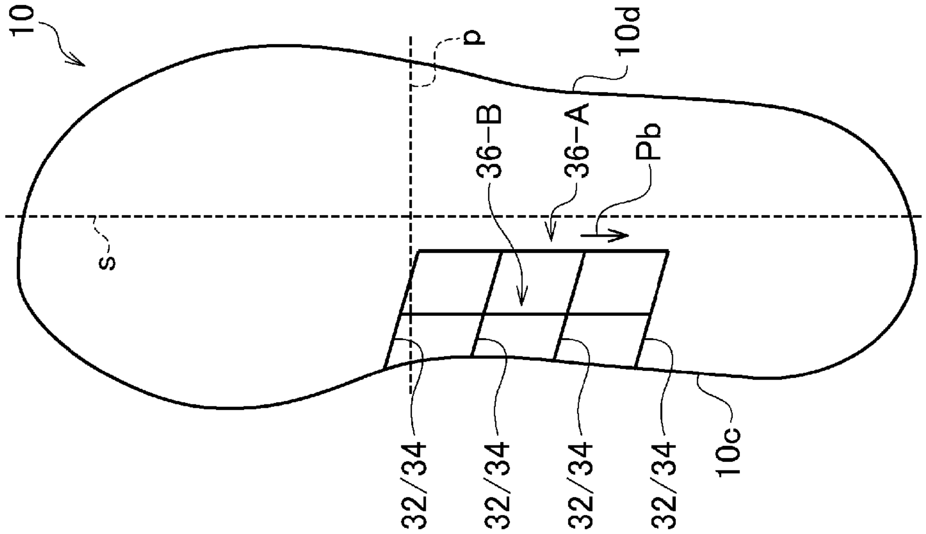


FIG. 19C

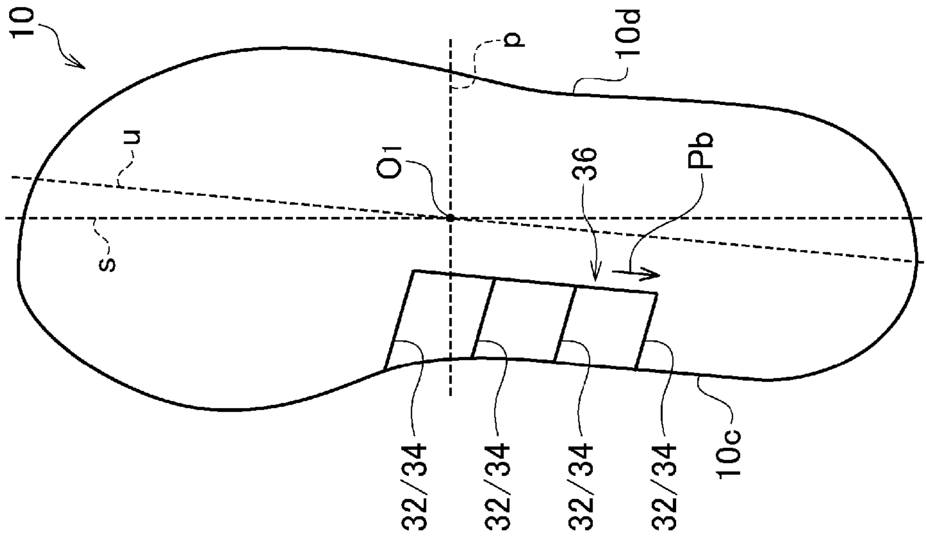
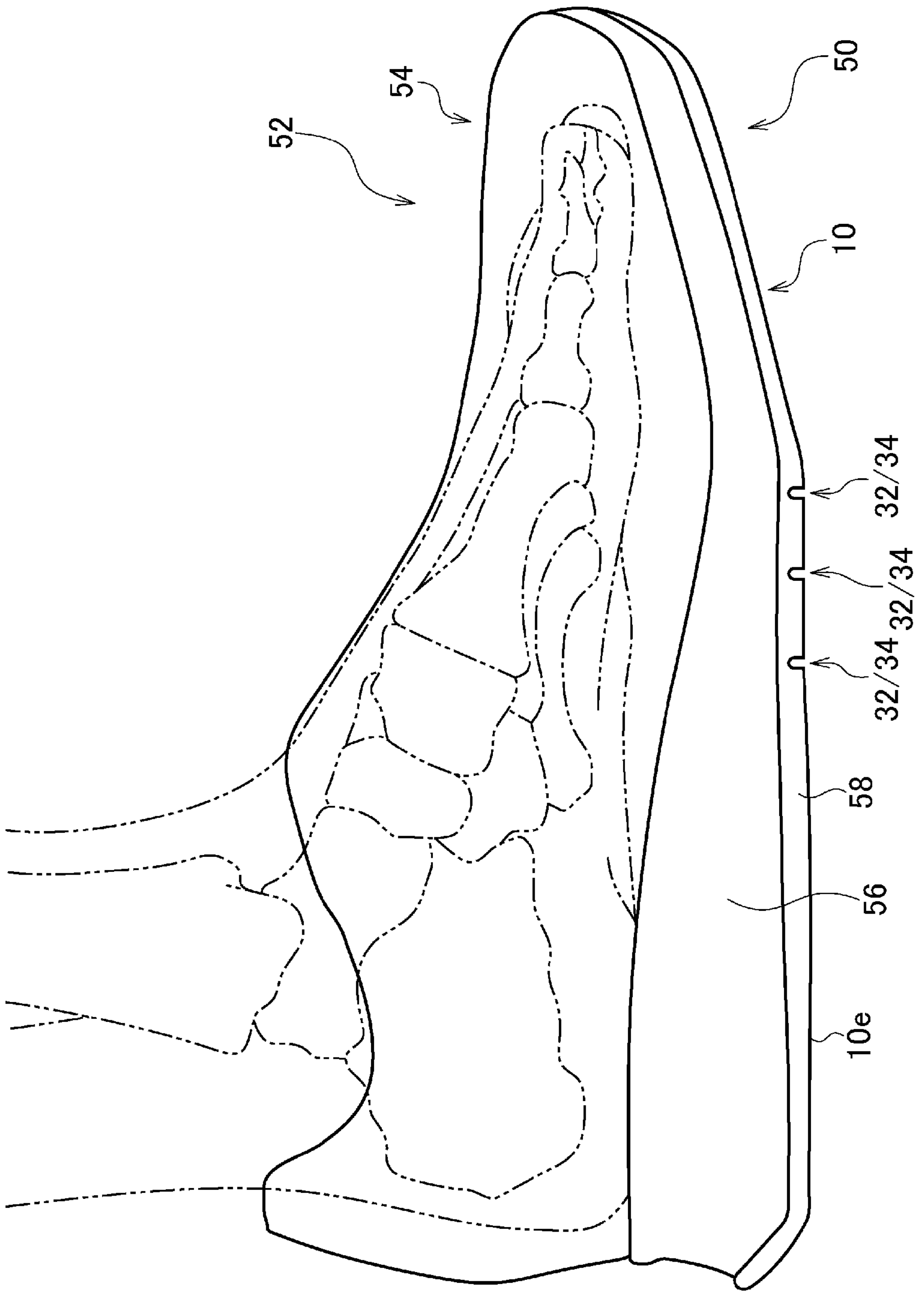


FIG. 20



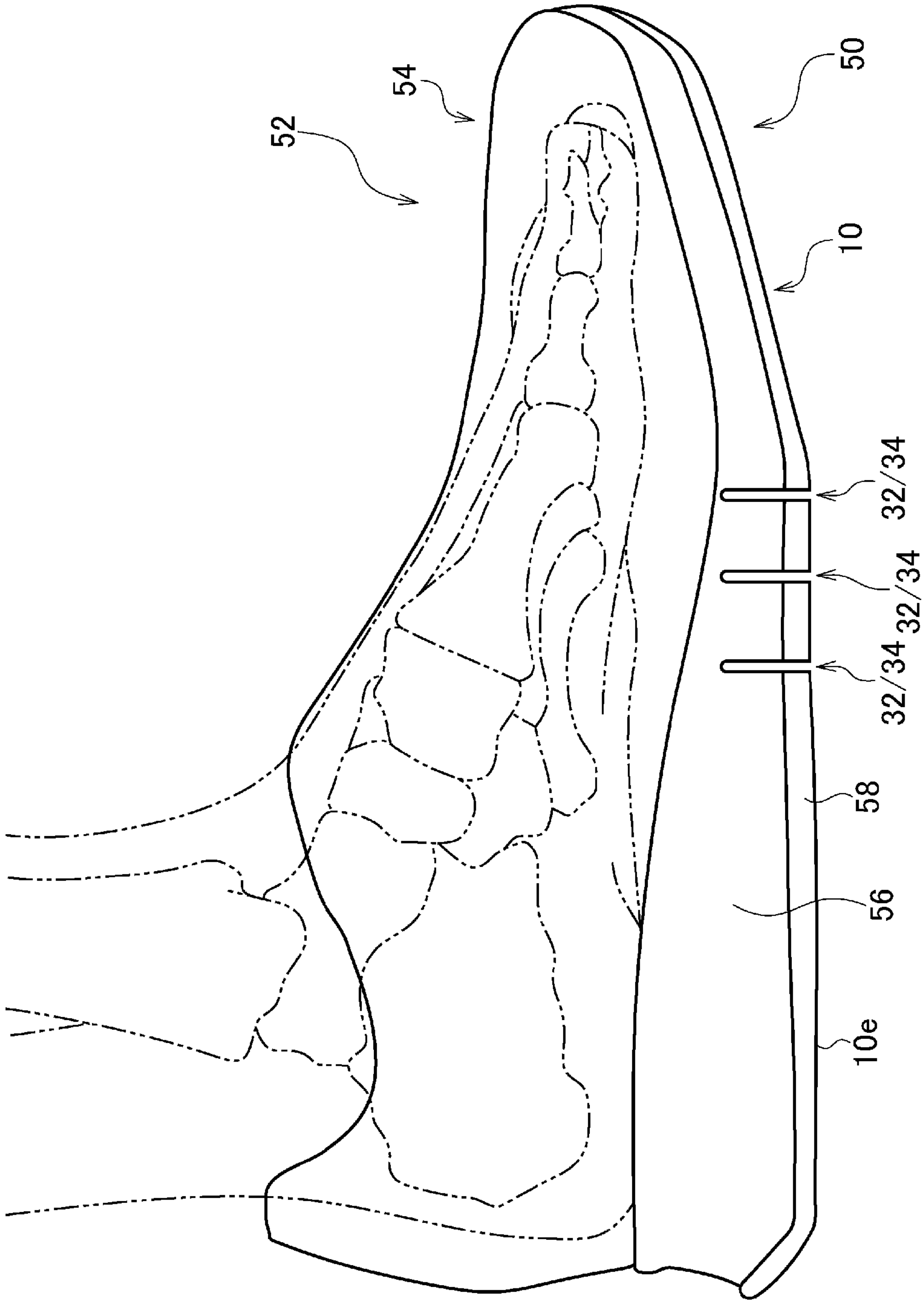


FIG. 21

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/037255

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. A43B13/14(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)
Int. Cl. A43B13/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2017
Registered utility model specifications of Japan 1996-2017
Published registered utility model applications of Japan 1994-2017

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	WO 2015/052813 A1 (ASICS CORPORATION) 16 April 2015, paragraphs [0008]-[0023], fig. 1, 2 & US 2016/0302523 A1, paragraphs [0017]-[0051], fig. 1-3 & EP 3056103 A1	1-11
A	JP 2010-504839 A (RUSH UNIVERSITY MEDICAL CENTER) 18 February 2010, paragraphs [0017]-[0051], fig. 1-5 & US 2008/0072457 A1, paragraphs [0021]-[0034], fig. 1-5 & WO 2008/039883 A2 & EP 3130246 A1 & HK 1131732 A	1-11

☒ Further documents are listed in the continuation of Box C.
☐ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12.12.2017	26.12.2017

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/037255

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2016-221232 A (TAYLOR MADE GOLF COMPANY, INC.) 28 December 2016, paragraphs [0014]-[0048], fig. 3-5 & US 2016/0353835 A1, paragraphs [0033]-[0052], fig. 3-5 & WO 2016/196900 A1 & EP 3100629 A1	1-11

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REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- WO 2017046959 A **[0003]**