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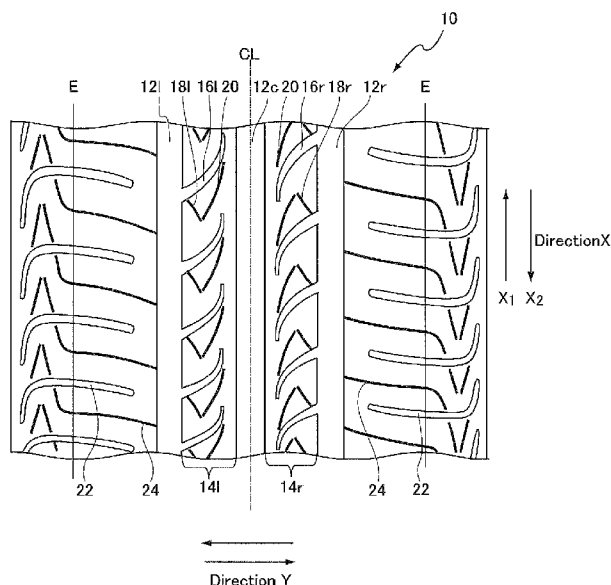
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(54) Title: PNEUMATIC TIRE

[Fig. 1]



(57) Abstract: A tread pattern of a pneumatic tire includes a plurality of inclined lug grooves, each having an opening end open into one of two circumferential grooves and a terminal end closed in a land portion sandwiched between the circumferential grooves. Each of the inclined lug grooves extends in a first direction of the tire circumferential direction from the opening end. The tread pattern further includes narrow grooves, each having a starting end at a midpoint of each of the inclined lug grooves. Each of the narrow grooves extends in a second direction opposite to the first direction, and is closed in the land portion. Each of the inclined lug grooves has a curve portion and a straight portion between the opening end and the terminal end. The straight portion extends parallel to the tire circumferential direction and includes the terminal end. The closed end of the narrow groove is positioned on a side of the second direction of the tire circumferential direction with respect to the terminal end of an inclined lug groove adjacent in the second direction to each of the inclined lug grooves.

Description

Title of Invention: PNEUMATIC TIRE

Technical Field

[0001] The present invention relates to a pneumatic tire having a tread pattern.

Background Art

[0002] In general, a tread pattern of a pneumatic tire for a passenger car includes a plurality of main grooves extending in a tire circumferential direction and a plurality of lug grooves extending in a tire width direction in a tread portion. In such a pneumatic tire, many lug grooves are provided in order to improve wet performance including drainage performance and wet handling and stability (handling and stability on a wet road surface). As a result, a groove area ratio in a contact face of the tread portion increases and edge components in the tread portion increase as well to thereby improve the drainage performance and the wet handling and stability. On the other hand, however, tread rigidity in the tread portion varies in the tire circumferential direction significantly, which may cause partial wear in many cases. Moreover, if many lug grooves are provided, the tread rigidity reduces and therefore the dry handling and stability (handling and stability on a dry road surface) reduces in many cases.

[0003] Under such circumstances, there is a known pneumatic tire having a tread pattern illustrated in FIG. 7 (Patent Document 1). With this pneumatic tire, anti-skid performance can be improved on a snowy road surface as well as on the wet road surface. As illustrated in FIG. 7, three ribs 103 are provided in a center region 100A of a tread face 100. First lug grooves 104 each of which has one end communicating with a main groove 102 and which extends in a tire width direction are disposed at predetermined intervals in a tire circumferential direction T. At least one sipe 105 which has one end communicating with the first lug groove 104 and which extends in the tire circumferential direction T at a position dividing a rib width W_1 or W_2 into substantial equal portions is provided between the respective first lug grooves 104 in each of the ribs 103. A tire circumferential length L_1 of the sipe 105 is 40 to 60% a length L_2 between the first lug grooves 104. In each of shoulder regions 100B and 101B, a rib 107 is defined between an auxiliary groove 106 extending in the tire circumferential direction T and the main groove 102 on an outer side.

Citation List

Patent Literature

[0004] PTL 1: Japanese Patent Application Laid-Open No. 2006-224770

Disclosure of Invention

Technical Problem

[0005] However, with the above-described pneumatic tire, it is difficult to improve the wet performance including the drainage performance and the wet handling and stability and partial wear performance simultaneously, though it is possible to improve the anti-skid performance on the wet road surface and the snowy road surface.

[0006] Therefore, it is an object of the present invention to provide a tread pattern excellently improved in the wet performance and the partial wear performance of a pneumatic tire having the different tire tread pattern from prior-art patterns.

Solution to Problem

[0007] According to an aspect of the invention, there is provided a pneumatic tire including a tread pattern.

The tire tread portion of the pneumatic tire includes:

two circumferential grooves extending continuously in a tire circumferential direction;

a plurality of inclined lug grooves arrayed in the tire circumferential direction, each having an opening end and a terminal end, the opening end being open into one of the circumferential grooves as one end in a land portion sandwiched between the circumferential grooves and extending continuously in the tire circumferential direction, the terminal end being closed in the land portion as the other end, and each of the inclined lug grooves being inclined with respect to a tire width direction and extending in a first direction of the tire circumferential direction from the opening end; and

narrow grooves or sipes extending in a second direction opposite to the first direction, each having a starting end and a closed end in the land portion and having a smaller groove width than each of the inclined lug grooves at a position of the starting end, the a starting end provided at a midpoint of each of the inclined lug grooves.

Each of the inclined lug grooves has a curved portion or a bent portion and a straight portion including the terminal end between the opening end and the terminal end. The straight portion extends substantially parallel to the tire circumferential direction.

The closed end of each of the narrow grooves or sipes connected to each of the inclined lug grooves is positioned on a side of the second direction of the tire circumferential direction with respect to a terminal end of an inclined lug groove adjacent in the second direction to each of the inclined lug grooves.

Advantageous Effects of the Invention

[0008] With the pneumatic tire having the tread pattern in the above-described form, it is possible to simultaneously improve the wet performance and the partial wear performance.

Brief Description of Drawings

[0009] [fig.1]Fig. 1 is a drawing for explaining an embodiment of a tread pattern used for a

pneumatic tire of the present invention.

[fig.2]Figs. 2A and 2B are drawings for explaining a main portion of the tread pattern illustrated in FIG. 1.

[fig.3]Figs. 3A and 3B are drawings for explaining arrangements of inclined lug grooves, closed grooves, and land portions in the embodiment.

[fig.4]Fig. 4 is a drawing of a tread pattern provided as another embodiment of the invention.

[fig.5]Fig. 5 is a drawing of a tread pattern provided as an example to be compared with the invention.

[fig.6]Fig. 6 is a drawing of a tread pattern provided as a prior-art example.

[fig.7]Fig. 7 is a drawing for explaining an example of a prior-art tread pattern.

Description of Embodiments

[0010] A pneumatic tire of the present invention will be described below. The pneumatic tire (hereafter referred to as the tire) which is an embodiment of the invention is a tire for a passenger car. The tire for the passenger car is a tire defined in Chapter A in JATMA YEAR BOOK 2009, a tire defined in SECTION 1 in TRA YEARBOOK (THE TIRE and RIM Association, INC.), and a tire defined in a chapter, PASSENGER CAR TYRES in ETRTO STANDARD MANUAL.

[0011] As illustrated in FIG. 1, a tread pattern 10 is formed in a tread portion of the tire of the embodiment. FIG. 1 is a planar developed view illustrating the tread pattern 10 for easy understanding.

Known structure and rubber member or new ones may be used as a structure and a rubber member of the tire of the embodiment and the structure and the rubber member are not especially limited.

In the following description, a tire circumferential direction refers to a direction in which the tread portion moves when the tire is rotated about a tire rotation axis and a tire width direction refers to a direction parallel to the tire rotation axis. In FIG. 1, the tire circumferential direction is referred to as a direction X (an upward direction (X_1) and a downward direction (X_2) in the drawing) and the tire width direction is referred to as a direction Y (a leftward direction and a rightward direction in the drawing).

[0012] As illustrated in FIG. 1, the tread pattern 10 mainly includes three circumferential grooves 12 (12c, 12l, and 12r), a plurality of inclined lug grooves 16 (16l, 16r), a plurality of sipes 18 (18l, 18r), a plurality of shoulder lug grooves 22, and a plurality of shoulder sipes 24. The shoulder lug grooves 22 and the shoulder sipes 24 are provided in shoulder regions of the tire. The shoulder regions refer to regions beyond the circumferential grooves which are the farthest from a center line CL among the three circumferential grooves in the tire width direction.

The circumferential grooves 12 include the circumferential groove 12c, the circumferential groove 12l, and the circumferential groove 12r, each extending continuously in the tire circumferential direction. Tread wear indicators defined by JIS D4230 are provided to respective groove bottoms of the circumferential grooves 12c, 12l, and 12r. Respective circumferential grooves 12 have groove widths of 5 mm to 15 mm, for example, and groove depths of 4 mm to 8 mm, for example.

In the tread pattern 10, the circumferential groove 12c is provided on the tire center line CL and the two circumferential grooves 12l and 12r are provided on opposite sides at the equal distances from the circumferential groove 12c. The circumferential groove 12l is provided in a half tread portion on a left side of the tire center line CL in FIG. 1 and the circumferential groove 12r is provided in a half tread portion on a right side of the tire center line CL in FIG. 1.

[0013] Although the tread pattern 10 illustrated in FIG. 1 has the three circumferential grooves, it may have four or five circumferential grooves. For example, if it has the four circumferential grooves, the two circumferential grooves are provided on each side of the tire center line CL and the inclined lug grooves (described later) may be provided in a land portion between the two circumferential grooves on each side. The circumferential grooves 12l and 12r are not necessarily disposed at symmetric positions with respect to the tire center line CL but may be disposed asymmetrically.

[0014] In the tread pattern 10, the two land portions 14l and 14r continuously extending in the tire circumferential direction are formed between the circumferential groove 12c on the tire center line CL and the two circumferential grooves 12l and 12r. In other words, one of the two circumferential grooves defining each of the two land portions 14l and 14r is the circumferential groove 12c on the tire center line. In the two land portions 14l and 14r, the inclined lug grooves 16l and 16r are provided.

[0015] FIG. 2A is a drawing for explaining the inclined lug grooves 16r and FIG. 2B is a drawing for explaining the inclined lug grooves 16l.

An opening end 16a of each of the inclined lug grooves 16l and 16r is provided on a side of the circumferential groove 12r or 12l which is farther from the center line CL out of the two circumferential grooves 12l and 12c or 12r and 12c.

In the invention, the opening end of each of the inclined lug grooves 16l and 16r may be provided to the circumferential groove 12c which is closer to the center line CL out of the two circumferential grooves. However, the opening end 16a of each of the inclined lug grooves 16l and 16r is preferably provided to the circumferential groove which is farther from the tire center line CL in terms of partial wear performance. Although it is preferable that no lug grooves are open into the circumferential groove 12 closer to the center line CL in the embodiment, the sipes may open into the groove, for example.

[0016] As illustrated in FIGS. 2A and 2B, each of the inclined lug grooves 16l and 16r has the opening end 16a open into the circumferential groove 12l or 12r at one end and a terminal end 16b closed in the land portion 14l or 14r at the other end and is inclined with respect to the tire width direction to extend in a first direction of the tire circumferential direction from the opening end 16a. Here, the first direction for the inclined lug grooves 16r is the direction X_2 (downward direction). The first direction for the inclined lug grooves 16l is the direction X_1 (upward direction). In this manner, the inclined lug grooves 16l and 16r extending from the opening ends are inclined in the different directions in the tread pattern 10.

Each of the inclined lug grooves 16l and 16r has a curve portion 16c curved between the opening end 16a and the terminal end 16b and a straight portion 16d extending substantially parallel to the tire circumferential direction. The straight portion 16d includes the terminal end 16b. Instead of the curve portion 16c, a partially-bent portion may be used. When the straight portion 16d is substantially parallel to the tire circumferential direction, it means that the straight portion 16d is at an inclination angle of 0 to 5 degrees with respect to the tire circumferential direction.

[0017] The inclined lug grooves 16l and 16r have groove depths of 30 to 80% of the groove depths of the circumferential grooves 12l and 12r, for example, and groove widths of 1.5 to 5 mm, for example. The groove depths and the groove widths of the inclined lug grooves 16l and 16r increase from the terminal ends 16b toward the opening ends 16a. Such groove depths and groove widths are in the above numerical ranges.

[0018] In the land portions 14l and 14r, the sipes 18l and 18r respectively extending from the inclined lug grooves 16l and 16r are provided. The sipes 18l and 18r have smaller groove widths than the inclined lug grooves. Each of the sipes 18l and 18r has a starting end 18a at a midpoint of the inclined lug groove 16l or 16r, extends in a second direction opposite to the first direction, and has a closed end 18b where the sipe 18l or 18r is closed in the land portion 14l or 14r. A direction of a straight line connecting the starting ends 18a and the closed end 18b of each of the sipes 18l and 18r is inclined at 10 to 80 degrees with respect to the tire circumferential direction. As described above, the first direction for the inclined lug grooves 16l and the first direction for the inclined lug grooves 16r are different and therefore the second direction in which the sipes 18l extend and the second direction in which the sipes 18r extend are different. The second direction for the sipes 18r is the direction X_1 (upward direction) and the second direction for the sipe 18l is the direction X_2 (downward direction). In this manner, the inclined lug grooves 16l and 16r and the sipes 18l and 18r in the land portions 14l and 14r are arranged in a point-symmetry.

Although widths of the sipes 18l and 18r are 0.1 mm to 2 mm, narrow grooves having groove widths of 2 mm to 3 mm may be used instead of the sipes 18l and 18r.

[0019] The sipes 18l and 18r will be described in detail. The closed end 18b of each of the sipes 18l and 18r is positioned on a side of the second direction with respect to the terminal end 16b' (see FIGS. 2A and 2B) of the inclined lug groove 16l' or 16r' adjacent to the inclined lug groove 16l or 16r in the second direction. As illustrated in FIG. 2A, a position of the closed end 18b of the sipe 18r is on a side of the direction X_1 with respect to the terminal end 16b' of the adjacent inclined lug groove 16r'. As illustrated in FIG. 2B, a position of the closed end 18b of the sipe 18l is on a side of the direction X_2 with respect to the terminal end 16b' of the adjacent inclined lug groove 16l'. In other words, when the inclined lug grooves 16l' and 16r' and the sipes 18l and 18r are seen from the tire width direction, i.e., from a lateral direction in FIGS. 2A and 2B, the inclined lug grooves 16l' and 16r' and the sipes 18l and 18r overlap each other in the tire circumferential direction. This arrangement is for simultaneously improving the wet performance and the partial wear performance. This point will be described later.

[0020] Furthermore, in the land portions 14l and 14r, shallow grooves 20 having smaller depths than the sipes 18l and 18r are provided. Each of the shallow grooves 20 is preferably provided in a region of the land portion 14 between a tire circumferential position of the closed end 18b of the sipe 18l or 18r and a tire circumferential position of the terminal end 16b of the inclined lug groove and between a position in the tire width direction of the starting end 18a of the sipe 18 extending from the inclined lug groove and a position in the tire width direction of the circumferential groove 12c (the circumferential groove on the tire center line) having no opening end of the inclined lug grooves 16. In this way, it is possible to improve initial wear. The initial wear considerably affects wear performance in a middle stage of wear or after that and therefore, it is possible to improve the partial wear performance by improving the initial wear. The shallow grooves 20 are not open into the circumferential grooves 12l, 12r, and 12c, the inclined lug grooves 16l and 16r, and the sipes 18l and 18r.

[0021] When seen from the tire center line CL, the plurality of shoulder lug grooves 22 and the plurality of shoulder narrow grooves 24 are provided in the shoulder regions of the tread portion on outer sides (sides away from the tire center line CL) of the circumferential grooves 12l and 12r in the tire width direction.

The shoulder lug grooves 22 are open at contact ends in the shoulder regions and are provided on the tire circumference. The contact ends are positioned on contact lines E illustrated in FIG. 1. The contact lines E are defined by edge positions of contact of the shoulder regions when the tire is mounted to a standard rim and the tire is brought into contact with a flat face under conditions of normal internal pressure and normal load.

The standard rim is a "standard rim" defined by JATMA standards, a "Design Rim" defined by TRA standards, or a "Measuring Rim" defined by ETRTO standards. The

normal internal pressure is the "maximum air pressure" defined by JATMA, the maximum value of "tire load limits at various cold inflation pressures" defined by TRA standards, or "inflation pressures" defined by ETRTO standards. The normal load is the "maximum load capacity" defined by JATMA standards, the maximum value of "tire load limits at various cold inflation pressures" defined by TRA standards, or "load capacity" defined by ETRTO standards. However, in the case of the tire for the passenger car, the normal internal pressure is 180 (kPa) and the normal load is 80[%] of the maximum load capacity.

[0022] Each of the shoulder narrow grooves 24 is provided between the shoulder lug grooves 22 adjacent to each other in the tire circumferential direction.

Each of the shoulder lug grooves 22 does not open into either the circumferential groove 12l or 12r and each of the shoulder narrow grooves 24 is open into the circumferential groove 12l or 12r. In other words, each of the circumferential grooves 12l and 12r is provided with shoulder opening ends of the shoulder narrow grooves 24 besides the opening ends 16a of the inclined lug grooves 16l or 16r. Because the shoulder lug grooves 22 do not open into either the circumferential groove 12l or 12r, it is possible to reduce pattern noise caused by the tread pattern while maintaining drainage performance. Moreover, because block rigidity in the shoulder regions increases, it is possible to improve handling and stability on a dry road. Furthermore, by providing the shoulder narrow grooves 24, it is possible to improve the partial wear performance.

Although the shoulder narrow grooves 24 have groove widths of 2 mm to 3 mm, shoulder sipes having widths of 0.1 mm to 2 mm may be used instead of the shoulder narrow grooves 24.

[0023] In the tread pattern 10, by providing the curved inclined lug grooves 16l and 16r in the land portions 14l and 14r, it is possible to increase groove volume to thereby improve drainage performance. Moreover, because the opening ends 16a are provided to the circumferential grooves 12l and 12r, the drainage performance is further improved. Furthermore, by providing the terminal ends 16b closed in the land portions 14l and 14r to the inclined lug grooves 16l and 16r, it is possible to improve the block rigidity and handling and stability on the dry road surface. Because the inclined lug grooves 16l and 16r are inclined with respect to the tire width direction and the tire circumferential direction, they suppress flexibility in movement of the land portions 14l and 14r when the land portions 14l and 14r are regarded as blocks. As a result, the partial wear is suppressed and the pattern noise caused by vibrations of several kilohertz of the blocks can be suppressed.

[0024] As described above, the closed end 18b of each of the sipes 18l and 18r is positioned on the side of the second direction with respect to the terminal end 16b' of each of the inclined lug grooves 16l' and 16r' adjacent to the inclined lug grooves 16l and 16r in

the second directions. By arranging the positions of the closed ends 18b and the terminal ends 16b' in this manner, it is possible to simultaneously improve the wet performance and the partial wear performance.

FIG. 3A is a drawing for explaining a main portion of the tread pattern 10. The shallow grooves 20 are not illustrated in FIG. 3A.

As illustrated in FIG. 3A, when a region of the land portion between the inclined lug grooves is divided into regions S_1 , S_2 , and S_3 along the tire circumferential direction, a position of the inclined lug groove 16 and a position of the sipe 18 overlap each other in the tire circumferential direction, which results in making the block rigidity against displacement of the area S_2 in the tire width direction into a preferable range and reducing variations of the block rigidity in the tire width direction from the area S_1 to the area S_3 .

However, if the position of the inclined lug groove 16 and the position of the sipe 18 do not overlap each other in the tire circumferential direction as illustrated in FIG. 3B, the block rigidity in an area S_5 may be high and the block rigidity in the tire width direction varies significantly from the area S_4 to the area S_6 . At this time, the partial wear is liable to occur in a position where the block rigidity varies significantly.

[0025] In the contact face of the tire, the tread portion wears fast in a center region having the tire center line CL passing therethrough. In the tread pattern 10, by not providing the opening ends 16a of the inclined lug grooves 16l and 16r to the circumferential groove 12c, it is possible to suppress reduction in the rigidity of the portions of the land portions 14l and 14r near the circumferential groove 12c (a region R_1 in FIG. 3A) to thereby reduce the partial wear (center wear).

Moreover, by providing the straight portion 16d parallel to the tire circumferential direction to the inclined lug groove 16 near the terminal end 16b, it is possible to reduce components extending in the tire width direction of the inclined lug groove 16 to thereby simultaneously improve straight traveling performance and wet performance of the tire. The straight traveling performance is stability that allows a traveling vehicle to travel straight even if minute vibrations or the like occur when the tire does not have a slip angle.

Because the groove depth increases from the terminal end 16b toward the opening end 16a of each of the inclined lug grooves 16l and 16r, from a viewpoint of drainage performance, an amount of drainage by the inclined lug grooves 16l and 16r can be obtained corresponding to an amount of water gradually flowing in from each of the land portions 14l and 14r. Moreover, the terminal end 16b is a portion (region R_1 in FIG. 3A) of each of the inclined lug grooves 16l and 16r which is the closest to the circumferential groove 12c. Because the groove depth of each of the inclined lug grooves 16l and 16r at this portion is small, it is possible to enhance the block rigidity in the tire

width direction in the neighborhood of the circumferential groove 12c in each of the land portions 14l and 14r.

Moreover, in the respective land portions 14l and 14r, the plurality of shallow grooves 20 are provided so as not to overlap each other when seen from the tire width direction. By arranging the shallow grooves 20 in this manner, it is possible to maintain high block rigidity of the neighborhood (the region R_1 in FIG. 3A) of the circumferential groove 12c in each of the land portions 14l and 14r while smoothly varying the rigidity toward the other portion of each of the land portions 14l and 14r to thereby suppress the partial wear.

[0026] In such a tread pattern 10, a length L_1 (see FIG. 3A) of the straight portion 16d of each of the inclined lug grooves 16l and 16r is preferably 3 to 75% of a length L_2 (see FIG. 3A) of each of the inclined lug grooves 16l and 16r along the tire circumferential direction. If a ratio of the length L_1 to the length L_2 is lower than 3%, an improvement of the straight traveling performance of the tire reduces. If the ratio is over 75%, an improvement of the drainage performance reduces.

[0027] A distance (width) W_1 between the terminal end 16b and the opening end 16a of each of the inclined lug grooves 16l and 16r is preferably 50 to 90% of a width W_2 of each of the land portions 14l and 14r. If a ratio of the width W_1 to the width W_2 is lower than 50%, the groove volume is insufficient and the wet performance including the drainage performance reduces. If the ratio is over 90%, a margin of improvement of the handling and stability on the dry road surface reduces.

[0028] A distance (width) W_3 between the starting end 18a of each of the sipes 18l and 18r and the opening end 16a of each of the inclined lug grooves 16l and 16r in the tire width direction is preferably 5 to 40% of the width W_2 of each of the land portion 14l and 14r. If a ratio of the width W_3 to the width W_2 is lower than 5%, a distance of a portion sandwiched between each of the circumferential grooves 12l and 12r and each of the sipes 18l and 18r reduces, the block rigidity of this portion reduces to increase a wear rate, and the portion is liable to be a core of the partial wear. If the ratio of the width W_3 to the width W_2 is over 40%, the block rigidity of the portion sandwiched between the circumferential groove 12c and each of the sipes 18l and 18r reduces to increase the wear rate and this portion is liable to be the core of the partial wear. The ratio of the width W_3 to the width W_2 is preferably 15 to 30%.

[0029] A distance (width) W_4 between the closed end 18b of each of the sipes 18l and 18r and the opening end 16a of each of the inclined lug grooves 16l and 16r in the tire width direction is preferably 20 to 60% of the width W_2 of each of the land portions 14l and 14r. If a ratio of the width W_4 to the width W_2 is lower than 20%, the distance of the portion sandwiched between each of the circumferential grooves 12l and 12r and each of the sipes 18l and 18r reduces, the block rigidity of this portion reduces to

increase the wear rate, and this portion is liable to be a core of the partial wear. If the ratio of the width W_4 to the width W_2 is over 60%, the block rigidity of the portion sandwiched between the circumferential groove 12c and each of the sipes 18l and 18r reduces to increase the wear rate and this portion is liable to be a core of the partial wear. The ratio of the width W_4 to the width W_2 is preferably 30 to 50%.

[0030] Each of the sipes 18l and 18r preferably has a depth of 50 to 100% of the groove depth of each of the inclined lug grooves 16l and 16r at a position of the starting end 18a of each of the sipes 18l and 18r. If the depth of each of the sipes 18l and 18r is greater than the groove depth of each of the inclined lug grooves 16l and 16r, the block rigidity of the portion sandwiched between each of the sipes 18l and 18r and each of the circumferential grooves 12l and 12r reduces to increase the wear rate, and this portion is liable to be a core of the partial wear. On the other hand, if the depth of each of the sipes 18l and 18r is less than 50% of the groove depth of each of the inclined lug grooves 16l and 16r, the wet performance including the drainage performance reduces.

[0031] A distance between the one end portion of each of the shallow grooves 20 and the closed end of each of the sipes 18l and 18r in the tire width direction is preferably 2 mm or shorter. A distance between the other end portion of each of the shallow grooves 20 and the terminal end of each of the inclined lug grooves 16l and 16r in the tire width direction is preferably 2 mm or shorter.

The groove depth of each of the shallow grooves 20 is preferably 2 to 10% of the groove depth of each of the circumferential grooves 12l and 12r. Because the shallow grooves 20 are provided at portions of the land portions 14l and 14r having high block rigidity, they improve partial wear performance. Because the shallow grooves 20 are shallow, they disappear and do not work when the wear proceeds. However, the shallow grooves 20 can suppress variations in the block rigidity of the land portions 14l and 14r in the tire circumferential direction in an initial stage of wear which significantly affects the partial wear to thereby suppress the partial wear.

Each of the shallow grooves 20 preferably has a width of 0.2 to 2 mm. If the width is smaller than 0.2 mm, the partial wear is not sufficiently improved. If the width is over 2 mm, the block rigidity in the respective portions varies significantly in the tire circumferential direction and the partial wear is likely to occur. The width of each of the shallow grooves 20 is preferably 0.5 to 1 mm.

[0032] The shoulder opening end of the shoulder sipe 24 is preferably away from a tire circumferential position of the opening end 16a of the inclined lug groove 16l or 16r in a tire circumferential direction at a distance 10% or more and 90% or less of a length between the opening ends 16a of the inclined lug grooves 16l or 16r adjacent to each other. If the distance is smaller than 10% or greater than 90% of the length between the opening ends 16a, the block rigidity in the tire width direction of the shoulder land

portions outside of the respective circumferential grooves 16l and 16r cannot vary in the tire circumferential direction according to variations in the block rigidity of the land portions 14l and 14r. Therefore sound pressure level of the pattern noise may increase.

The shoulder lug grooves 22 are not open into the circumferential grooves 12l and 12r. In this way, the pattern noise can be reduced and the handling and stability on the dry road can be improved while securing the drainage performance.

[0033] By providing the circumferential groove 12c on the tire center line having the longest contact length as in the tread pattern 10, it is possible to efficiently drain water on the wet road having a water film to thereby improve wet performance.

The tread pattern 10 includes the three circumferential grooves and it is possible to improve the drainage performance on the wet road with these three circumferential grooves.

[0034] (Examples, Comparative Examples, and Prior-art Example)

To study effects of this tread pattern 10, tires were produced experimentally. Size of the experimentally produced tires was 196/65R15 91H. On each of patterns 1 to 31 produced as examples, comparative examples 1 and 2, and a prior-art example, the tread pattern having the three circumferential grooves was employed. The experimentally produced tire was mounted to a rim of 15-6JJ, mounted to a 1.8-liter passenger car under a condition of internal pressure of 210 kPa, and tested for wet performance including drainage performance and wet handling and stability, partial wear performance, handling and stability on a dry road (dry handling and stability), and pattern noise (subjective evaluation) with two occupants in the car.

As the partial wear performance, a worn state after traveling 10000 km in a predetermined traveling mode (on a flat road and at an average traveling speed of 80 km/h) was evaluated by a visual inspection. The wet performance, the dry handling and stability, and the pattern noise were evaluated by sensory testing by a driver. The higher the values of evaluation results of the wet performance and the dry handling and stability, the more excellent the wet performance and the dry handling and stability are. The higher the values of evaluation results of the pattern noise, the more the pattern noise reduces. A score 5 of the evaluation of each performance represents an allowable limit level of the performance and the score 5 or a higher score is required of the tire.

[0035] (Patterns)

Evaluation of the performance of the respective patterns including the tread pattern 10 illustrated in FIG. 1 was carried out. The pattern 1 was the pattern of the embodiment illustrated in FIG. 1. The pattern 2 was the pattern of an embodiment illustrated in FIG. 4 in which an opening end of each of inclined grooves was positioned on a side of a circumferential main groove on a tire center line CL. The comparative

example 1 was a pattern illustrated in FIG. 5. In the comparative example 1, a closed end of a narrow groove extending from each of inclined lug grooves was, in a right half tread portion in FIG. 5, positioned not on an upward side but on a downward side with respect to a terminal end of an inclined lug groove adjacent in the upward direction. In a left half tread portion, a closed end of a narrow groove was positioned not on the downward side but on the upward side with respect to a terminal end of an inclined lug groove adjacent in the downward direction in FIG. 5. The prior-art example was a pattern illustrated in FIG. 6. Dimensions and evaluation results of the performance of the respective patterns are shown in the following Table 1.

[0036] [Table 1]

	Pattern 1	Pattern 2	Comparative example 1	Prior-art example
Basic pattern (FIG. No.)	FIG. 1	FIG. 4	FIG. 5	FIG. 6
Circumferential length of straight portion of inclined lug groove (%)	20	20	20	—
Length of inclined lug groove in width direction (%)	80	80	80	100
Position of starting end of narrow groove extending from inclined lug groove (%)	15	15	15	20
Position of closed end of narrow groove extending from inclined lug groove (%)	40	40	40	70
Wet performance	6	6	4.5	5
Partial wear performance	6.5	6	5	5
Dry handling and stability	6	6	6	5
Pattern noise	6	6	6	5

[0037] From Table 1, it can be seen that the patterns 1 and 2 are excellent in the wet performance and the partial wear performance as compared with the comparative example

1 and the prior-art example. In other words, by disposing the closed end 18b of each of the narrow grooves 18 on the side of the second direction with respect to the terminal end 16b of the inclined lug groove 16 adjacent in the second direction to each of the inclined lug grooves 16, it is possible to simultaneously improve the wet performance including the drainage performance and the wet handling and stability and the partial wear performance.

[0038] (Straight Portion of Inclined Lug Groove)

Next, tires of the patterns 3 to 9 and the comparative example 2, in each of which only the length of the straight portion was modified, were produced and underwent various performance evaluations. In Table 2 and Table 3, the length of the straight portion is expressed as the ratio of the length L_1 to the length L_2 in FIG. 3A.

[0039] [Table 2]

	Pattern 3	Pattern 4	Pattern 5	Pattern 6
Basic pattern (FIG. No.)	FIG. 1	FIG. 1	FIG. 1	FIG. 1
Circumferential length of straight portion of inclined lug groove (%)	2	3	5	10
Length of inclined lug groove in width direction (%)	80	80	80	80
Position of starting end of narrow groove extending from inclined lug groove (%)	15	15	15	15
Position of closed end of narrow groove extending from inclined lug groove (%)	40	40	40	40
Wet performance	5.5	5.5	5.75	6
Partial wear performance	5	5	6	6.5
Dry handling and stability	5.5	5.75	6	6
Pattern noise	5.75	5.75	6	6

[Table 3]

	Pattern 7	Pattern 8	Pattern 9	Comparative example 2
Basic pattern (FIG. No.)	FIG. 1	FIG. 1	FIG. 1	FIG. 1
Circumferential length of straight portion of inclined lug groove (%)	70	75	80	0
Length of inclined lug groove in width direction (%)	80	80	80	80
Position of starting end of narrow groove extending from inclined lug groove (%)	15	15	15	15
Position of closed end of narrow groove extending from inclined lug groove (%)	40	40	40	40
Wet performance	5.75	5.75	5.5	4.5
Partial wear performance	6.5	6.25	6.25	4.5
Dry handling and stability	6	6	6	5.5
Pattern noise	6	6	6	5.5

[0040] From Table 2 and Table 3, the patterns 3 to 9 are excellent in the wet performance and the partial wear performance as compared with the comparative example 2 (the length of the straight portion of 0%). If the ratio of the straight portion is lower than 3%, the straight traveling performance of the tire in the dry handling and stability reduces. If the ratio is over 75%, the drainage performance reduces and the wet performance reduces. Therefore, the straight portion is preferably 3 to 75% of the length of the inclined lug groove along the tire circumferential direction.

[0041] (Length of Inclined Lug Groove in Tire Width Direction)

Next, as shown in the following Table 4, the patterns 10 to 14, in each of which only the length of the inclined lug groove in the tire width direction was modified, were produced and underwent various performance evaluations. In Table 4, the length of the

inclined lug groove in the tire width direction is expressed as the ratio of the width W_1 to the width W_2 illustrated in FIG. 3A.

[0042] [Table 4]

	Pattern 10	Pattern 11	Pattern 12	Pattern 13	Pattern 14
Basic pattern (FIG. No.)	FIG. 1	FIG. 1	FIG. 1	FIG. 1	FIG. 1
Circumferential length of straight portion of inclined lug groove (%)	20	20	20	20	20
Length of inclined lug groove in width direction (%)	40	50	70	90	95
Position of starting end of narrow groove extending from inclined lug groove (%)	15	15	15	15	15
Position of closed end of narrow groove extending from inclined lug groove (%)	40	40	40	40	40
Wet performance	5.5	5.75	6	6.5	6.5
Partial wear performance	6.5	6.5	6.5	6.5	6.5
Dry handling and stability	6.5	6	6	5.75	5.5
Pattern noise	6	6	6	6	6

[0043] From Table 4, the patterns 11 to 14 are excellent in the wet performance as compared with the pattern 10. On the other hand, the patterns 10 to 13 are excellent in the dry handling and stability as compared with the pattern 14. Therefore, the length of the inclined lug groove in the tire width direction is preferably 50 to 90% of the width of the land portion.

[0044] (Starting End Position of Narrow Groove Extending from Inclined Lug Groove)

Next, as shown in the following Table 5, the patterns 15 to 19, in each of which only the starting end position of the narrow groove extending from the inclined lug groove was modified, were produced and underwent various performance evaluations. In Table 5, the starting end position of the narrow groove extending from the inclined lug groove is expressed as the ratio of the width W_3 to the width W_2 illustrated in FIG. 3A.

[0045] [Table 5]

	Pattern 15	Pattern 16	Pattern 1	Pattern 17	Pattern 18	Pattern 19
Basic pattern (FIG. No.)	FIG. 1	FIG. 1	FIG. 1	FIG. 1	FIG. 1	FIG. 1
Circumferential length of straight portion of inclined lug groove (%)	20	20	20	20	20	20
Length of inclined lug groove in width direction (%)	80	80	80	80	80	80
Position of starting end of narrow groove extending from inclined lug groove (%)	3	5	10	20	40	50
Position of closed end of narrow groove extending from inclined lug groove (%)	40	40	40	40	40	40
Wet performance	5.75	6	6	6	6	5.75
Partial wear performance	5.5	6	6.5	6.5	6.25	5.75
Dry handling and stability	5.75	6	6	6	6	5.75
Pattern noise	6	6	6	6	6	6

[0046] From Table 5, in the patterns 15 to 19, the patterns 16, 17, and 18 are excellent in the wet performance and the dry handling and stability as compared with the patterns 15 and 19. Therefore, the distance between the starting end of the narrow groove and the opening end of the inclined lug groove in the tire width direction is preferably 5 to 40% of the width of the land portion.

[0047] (Position of Closed End of Narrow Groove Extending from Inclined Lug Groove)

Next, as shown in the following Table 6 and Table 7, the patterns 20 to 25, in each of which only the position of the closed end of the narrow groove extending from the inclined lug groove was modified, were produced and underwent various performance evaluations. In Table 6 and Table 7, the position of the closed end of the narrow groove is expressed as the ratio of the width W_4 to the width W_2 illustrated in FIG. 3A.

[0048]

[Table 6]

	Pattern 20	Pattern 21	Pattern 22	Pattern 1
Basic pattern (FIG. No.)	FIG. 1	FIG. 1	FIG. 1	FIG. 1
Circumferential length of straight portion of inclined lug groove (%)	20	20	20	20
Length of inclined lug groove in width direction (%)	80	80	80	80
Position of starting end of narrow groove extending from inclined lug groove (%)	10	10	10	10
Position of closed end of narrow groove extending from inclined lug groove (%)	15	20	30	40
Wet performance	6	6	6	6
Partial wear performance	5.75	6.25	6.5	6.5
Dry handling and stability	6	6	6	6
Pattern noise	6	6	6	6

[Table 7]

	Pattern 23	Pattern 24	Pattern 25
Basic pattern (FIG. No.)	FIG. 1	FIG. 1	FIG. 1
Circumferential length of straight portion of inclined lug groove (%)	20	20	20
Length of inclined lug groove in width direction (%)	80	80	80
Position of starting end of narrow groove extending from inclined lug groove (%)	10	10	10
Position of closed end of narrow groove extending from inclined lug groove (%)	50	60	65
Wet performance	6	6	6
Partial wear performance	6.5	6.25	5.75
Dry handling and stability	6	6	6
Pattern noise	6	6	6

[0049] From Table 6 and Table 7, in the patterns 20 to 25, the patterns 21, 22, 1, 23, and 24 are excellent in the partial wear performance as compared with the patterns 20 and 25. Therefore, the distance between the closed end of the narrow groove and the opening end of the inclined lug groove in the tire width direction is preferably 20 to 60% of the width of the land portion. Moreover, because the patterns 22, 1, and 23 have high partial wear performance, the distances are more preferably 30 to 50%.

[0050] (Depth of Narrow Groove)

Next, as shown in the following Table 8, the patterns 26, 27, and 1, in each of which only the groove depth of the narrow groove extending from the inclined lug groove was modified, were produced and underwent various performance evaluations.

[0051] [Table 8]

	Pattern 26	Pattern 27	Pattern 1
Basic pattern (FIG. No.)	FIG. 1	FIG. 1	FIG. 1
Circumferential length of straight portion of inclined lug groove (%)	20	20	20
Length of inclined lug groove in width direction (%)	80	80	80
Position of starting end of narrow groove extending from inclined lug groove (%)	40	40	40
Position of closed end of narrow groove extending from inclined lug groove (%)	40	40	40
Narrow groove depth (%)	110	40	90
Wet performance	6.5	5.5	6
Partial wear performance	5.5	6.5	6.5
Dry handling and stability	5.5	6.5	6
Pattern noise	6	6	6

[0052] From Table 8, in the patterns 26, 27, and 1, the pattern 27 is inferior in the wet performance. On the other hand, the pattern 26 is inferior in the partial wear performance. The pattern 1 in which the narrow groove has the depth of 50 to 100% of the groove depth of the inclined lug groove at the position of the starting end of the narrow groove is excellent in both the wet performance and the partial wear performance.

[0053] (Depth of Shallow Groove)

Next, as shown in the following Table 9, the patterns 28, 29, and 1, in each of which only the groove depth of the shallow groove (the portion designated by the reference

numeral 20 in FIGS. 2A and 2B) was modified, were produced and underwent various performance evaluations.

[0054] [Table 9]

	Pattern 28	Pattern 29	Pattern 1
Basic pattern (FIG. No.)	FIG. 1	FIG. 1	FIG. 1
Circumferential length of straight portion of inclined lug groove (%)	20	20	20
Length of inclined lug groove in width direction (%)	80	80	80
Position of starting end of narrow groove extending from inclined lug groove (%)	40	40	40
Position of closed end of narrow groove extending from inclined lug groove (%)	40	40	40
Narrow groove depth (%)	1	15	5
Wet performance	6	6	6
Partial wear performance	6	6.5	6.5
Dry handling and stability	6	5.5	6
Pattern noise	6	6	6

[0055] From Table 9, in the patterns 28, 29, and 1, the pattern 28 is inferior in the partial wear performance. On the other hand, the pattern 29 is inferior in the dry handling and stability. The pattern 1 in which the shallow groove has the depth of 2 to 10% of the depth of the circumferential groove is excellent in the dry handling and stability as well as in the wet performance and the partial wear performance.

[0056] (Position of Shoulder Sipe)

Next, as shown in the following Table 10, the patterns 30, 31, and 1, in each of which only the position of the shoulder sipe was modified, were produced and underwent various performance evaluations. The position of the shoulder sipe is the position of the opening end of the shoulder sipe in the tire circumferential direction. This position is expressed as what percentage of the distance between the opening ends of the adjacent inclined lug grooves, the position of the opening end of the shoulder sipe is away from the position of the opening end of the inclined lug groove.

[0057] [Table 10]

	Pattern 30	Pattern 31	Pattern 1
Basic pattern (FIG. No.)	FIG. 1	FIG. 1	FIG. 1
Circumferential length of straight portion of inclined lug groove (%)	20	20	20
Length of inclined lug groove in width direction (%)	80	80	80
Position of starting end of narrow groove extending from inclined lug groove (%)	40	40	40
Position of closed end of narrow groove extending from inclined lug groove (%)	40	40	40
Shoulder sipe position (%)	5	95	50
Wet performance	6	6	6
Partial wear performance	6.5	6.5	6.5
Dry handling and stability	6	6	6
Pattern noise	5.5	5.5	6

[0058] From Table 10, in the patterns 30, 31, and 1, the patterns 30 and 31 are equivalent to

the pattern 1 in the wet performance, the partial wear performance, and the dry handling and stability but are inferior to the pattern 1 in the pattern noise. The pattern 1, in which the distance of the position of the opening end of the shoulder sipe in the tire circumferential direction away from the opening end of the inclined lug groove is 10% or more and 90% or less of the length between the opening ends of the adjacent inclined lug grooves, is excellent in the wet performance and the partial wear performance and generates low pattern noise.

[0059] Although the pneumatic tire of the invention has been described above in detail, it is needless to say that the invention is not limited to the above embodiment and can be improved or changed in various ways without departing from the gist of the invention.

Reference Signs List

[0060] 10 tread pattern
 12, 12c, 12r, 12l circumferential groove
 14, 14r, 14l land portion
 16, 16r, 16l inclined lug groove
 16a opening end
 16b terminal end
 16c curve portion
 16d straight portion
 18, 18r, 18l sipe
 18a starting end
 18b closed end
 20 shallow groove
 22 shoulder lug groove
 24 shoulder narrow groove
 100 tread face
 100A center region
 100B, 101B shoulder region
 102 main groove
 103 rib
 104 first lug groove
 105 sipe
 106 auxiliary groove
 107 rib

Claims

[Claim 1]

A pneumatic tire including a tread pattern, the tire comprising, in a tire tread portion:

two circumferential grooves extending continuously in a tire circumferential direction;

a plurality of inclined lug grooves arrayed in the tire circumferential direction, each having an opening end and a terminal end, the opening end being open into one of the circumferential grooves as one end in a land portion sandwiched between the circumferential grooves and extending continuously in the tire circumferential direction, the terminal end being closed in the land portion as the other end, and each of the inclined lug grooves being inclined with respect to a tire width direction and extending in a first direction of the tire circumferential direction from the opening end; and

narrow grooves or sipes extending in a second direction opposite to the first direction, each having a starting end and a closed end in the land portion and having a smaller groove width than each of the inclined lug grooves at a position of the starting end, the a starting end provided at a midpoint of each of the inclined lug grooves,

wherein each of the inclined lug grooves has a curved portion or a bent portion and a straight portion including the terminal end between the opening end and the terminal end, the straight portion extending substantially parallel to the tire circumferential direction, and

the closed end of each of the narrow grooves or sipes connected to each of the inclined lug grooves is positioned on a side of the second direction of the tire circumferential direction with respect to a terminal end of an inclined lug groove adjacent in the second direction to each of the inclined lug grooves.

[Claim 2]

The pneumatic tire according to claim 1,

wherein each of two half tread portions of the tread portion across a tire center line includes the inclined lug grooves and the narrow grooves or sipes,

a third direction and a fourth direction are directions opposite to each other when the first direction for the inclined lug grooves in one of the two half tread portions is referred to as the third direction and the first direction for the inclined lug grooves in the other of the two half tread portions is referred to as the fourth direction, and

a fifth direction and a sixth direction are directions opposite to each other when the second direction of the narrow grooves or sipes in one of the two half tread portions is referred to as the fifth direction and the second direction of the narrow grooves or sipes in the other of the two half tread portions is referred to as the sixth direction.

- [Claim 3] The pneumatic tire according to claim 1 or 2, wherein the opening ends of the inclined lug grooves are provided to a circumferential groove of the two circumferential grooves positioned farther from the tire center line of the tread portion.
- [Claim 4] The pneumatic tire according to claim 3, wherein any lug groove is not open into a circumferential groove of the two circumferential grooves closer to the tire center line of the tread portion.
- [Claim 5] The pneumatic tire according to any one of claims 1 to 4, wherein a depth of each of the inclined lug grooves reduces from the opening end toward the terminal end.
- [Claim 6] The pneumatic tire according to any one of claims 1 to 5, wherein a length of the straight portion of each of the inclined lug grooves is 3 to 75% a length of each of the inclined lug grooves in the tire circumferential direction.
- [Claim 7] The pneumatic tire according to any one of claims 1 to 6, wherein a distance between the terminal end and the opening end of each of the inclined lug grooves in the tire width direction is 50 to 90% of a width of the land portion.
- [Claim 8] The pneumatic tire according to any one of claims 1 to 7, wherein a distance between the starting end of each of the narrow grooves or sipes and the opening end of each of the inclined lug grooves in the tire width direction is 5 to 40% of the width of the land portion.
- [Claim 9] The pneumatic tire according to any one of claims 1 to 8, wherein a distance between the closed end of each of the narrow grooves or sipes and the opening end of each of the inclined lug grooves in the tire width direction is 20 to 60% of the width of the land portion.
- [Claim 10] The pneumatic tire according to any one of claims 1 to 9, wherein each of the narrow grooves or sipes has a depth of 50 to 100% of a groove depth of each of the inclined lug grooves at a position of the opening end of each of the narrow grooves or sipes.
- [Claim 11] The pneumatic tire according to any one of claims 1 to 10, further comprising shallow grooves having smaller depths than the narrow grooves or sipes in the land portion,

wherein each of the shallow grooves is provided in a region of the land portion between a tire circumferential position of the closed end and a tire circumferential position of the terminal end of each of the inclined lug grooves and between a position in the tire width direction of the opening end of each of the narrow grooves or sipes extending from each of the inclined lug grooves and a position in the tire width direction of a circumferential groove of the two circumferential grooves which has no opening end of each of the inclined lug grooves.

[Claim 12] The pneumatic tire according to claim 11, wherein a distance between an end portion of each of the shallow grooves and the closed end of each of the narrow grooves or sipes in the tire width direction is 2 mm or shorter.

[Claim 13] The pneumatic tire according to claim 11 or 12, wherein a distance between an end portion of each of the shallow grooves and the terminal end of each of the inclined lug grooves in the tire width direction is 2 mm or shorter.

[Claim 14] The pneumatic tire according to any one of claims 11 to 13, wherein a depth of each of the shallow grooves is 2 to 10% of a depth of each of the circumferential grooves.

[Claim 15] The pneumatic tire according to any one of claims 1 to 14, comprising, in shoulder regions of the tread portion, a plurality of shoulder lug grooves open at contact ends of the shoulder regions and arrayed in the tire circumferential direction and a plurality of shoulder narrow grooves or shoulder sipes each provided between the shoulder lug grooves adjacent to each other, and each of the shoulder lug grooves is open to none of the circumferential grooves and each of the shoulder narrow grooves or shoulder sipes is open into one of the circumferential grooves.

[Claim 16] The pneumatic tire according to claim 15, wherein one of the circumferential grooves is provided with the opening ends of the inclined lug grooves and the opening ends of the shoulder narrow grooves or shoulder sipes, and a tire circumferential position of a shoulder opening end of each of the shoulder narrow grooves or shoulder sipes is away from a tire circumferential position of the opening end of each of the inclined lug grooves, and a distance in the tire circumferential direction between the opening end of each of the inclined lug grooves and the shoulder opening end is 10% or more and 90% or less of a length between the

opening end of each of the inclined lug grooves and an opening end of an adjacent inclined lug groove of the inclined lug grooves in the tire circumferential direction.

[Claim 17]

The pneumatic tire according to any one of claims 1 to 16, wherein the land portion provided with the inclined lug grooves and the narrow grooves or sipes is provided to each of half tread portions across the tire center line of the tread portion and one or more circumferential grooves are provided between a circumferential groove of the two circumferential grooves closer to the tire center line and the tire center line of the tread portion.

[Claim 18]

The pneumatic tire according to any one of claims 1 to 16, wherein the land portion provided with the inclined lug grooves and the narrow grooves or sipes is provided to each of half tread portions across the tire center line of the tread portion and one of the two circumferential grooves is provided on the tire center line.

[Fig. 1]

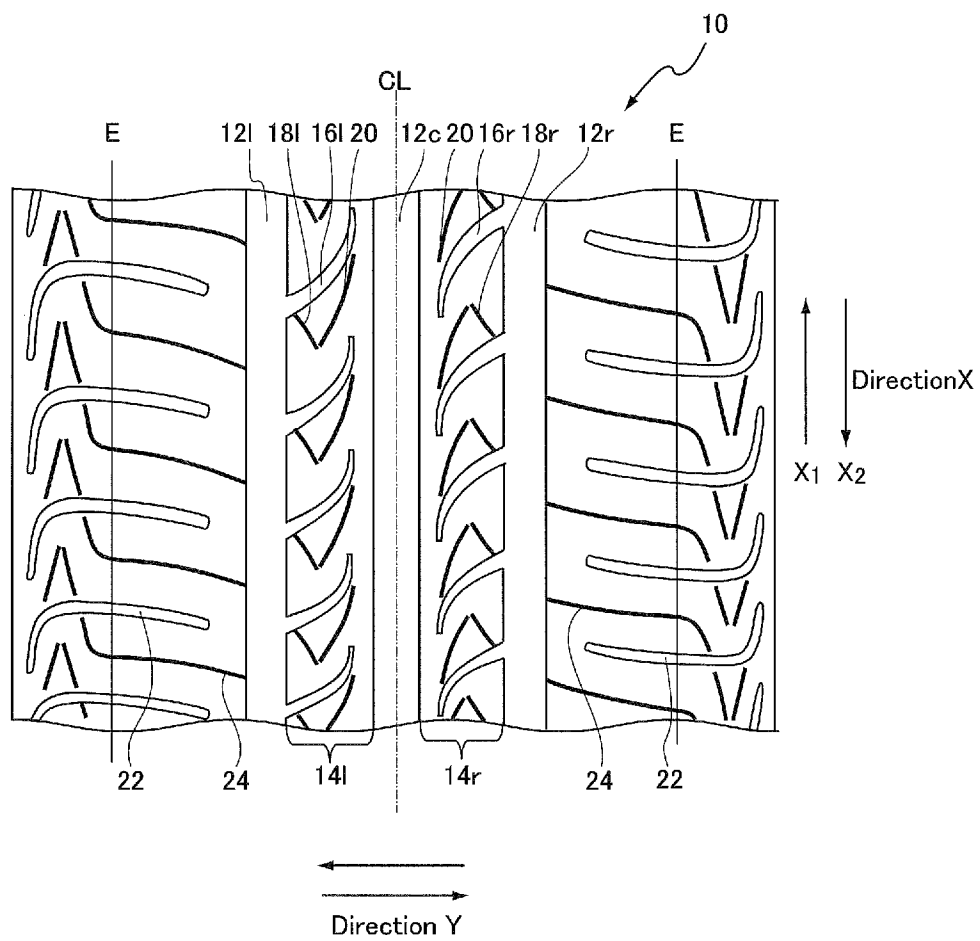


Fig. 1 is a schematic diagram of a cross-section of a device. It shows a central vertical structure with two curved, blade-like components (16a, 16a') on the right and two curved, blade-like components (16b, 16b') on the left. A central vertical line (14r) runs through the middle. A horizontal line (20) is shown. A coordinate system (X1, X2) is indicated on the right. Arrows at the bottom point to 12c and 12r.

FIG. 2B

[Fig. 3]

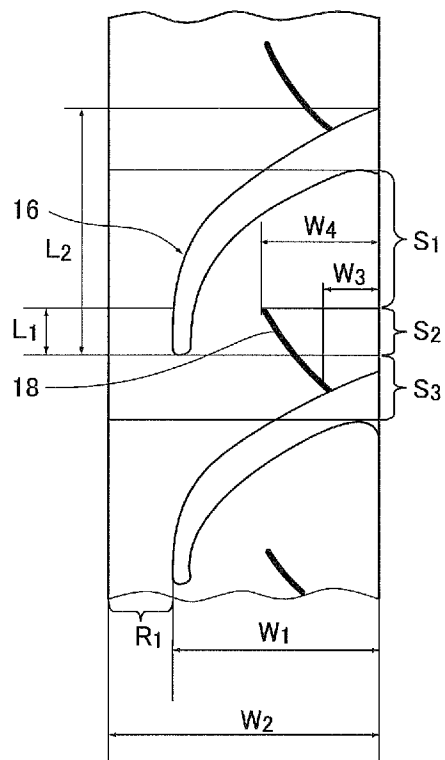


FIG.3A

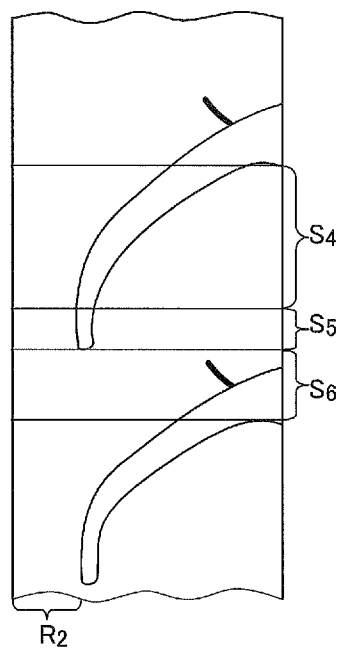
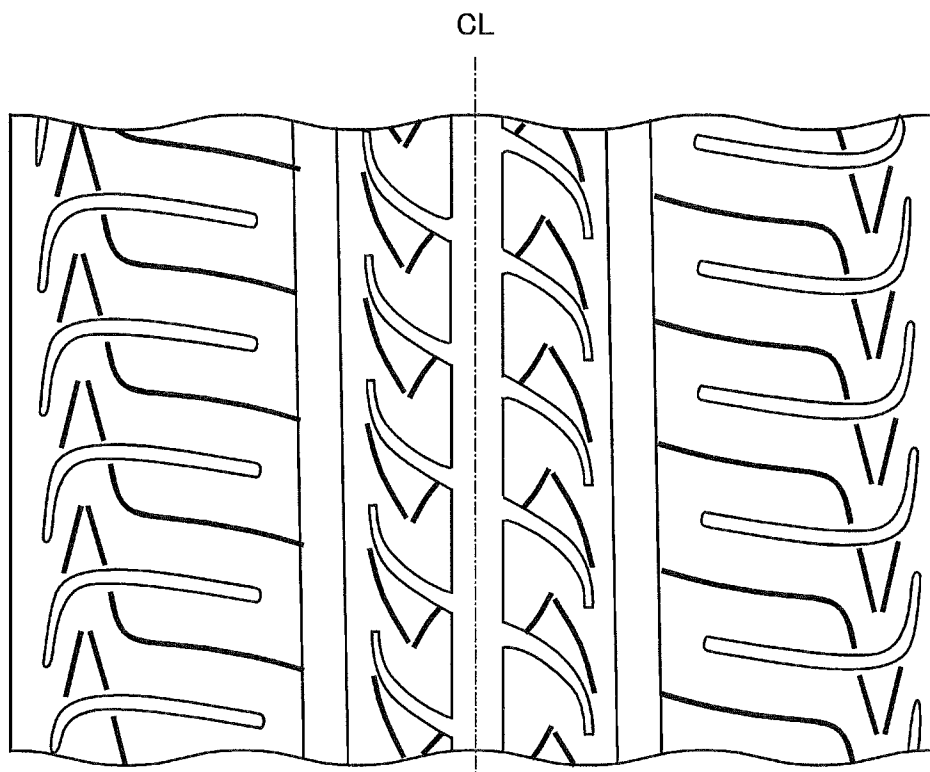
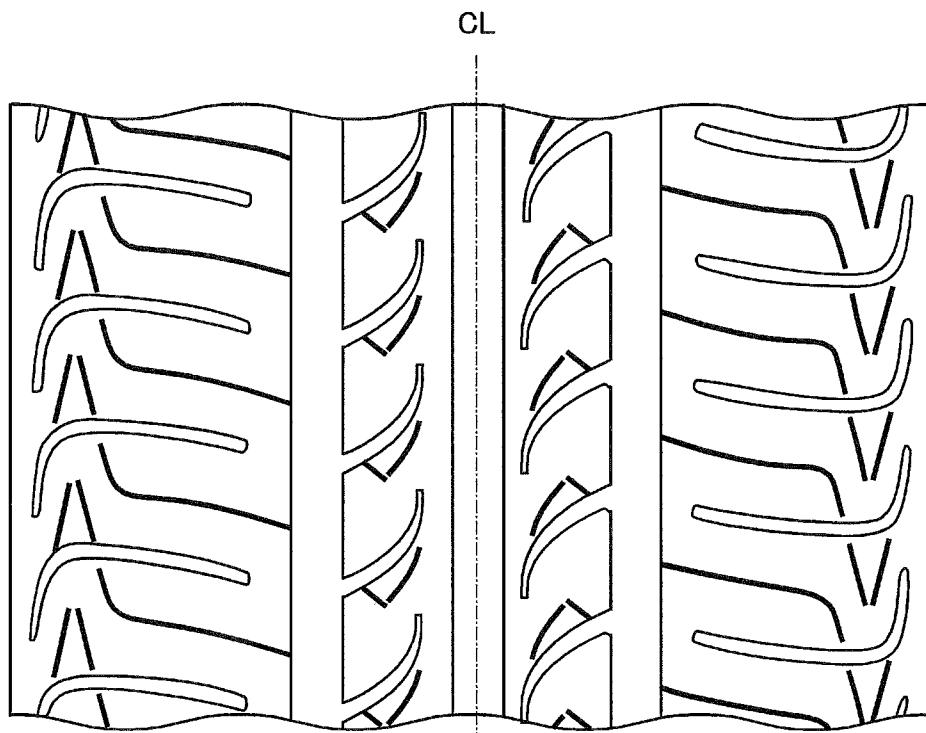


FIG.3B

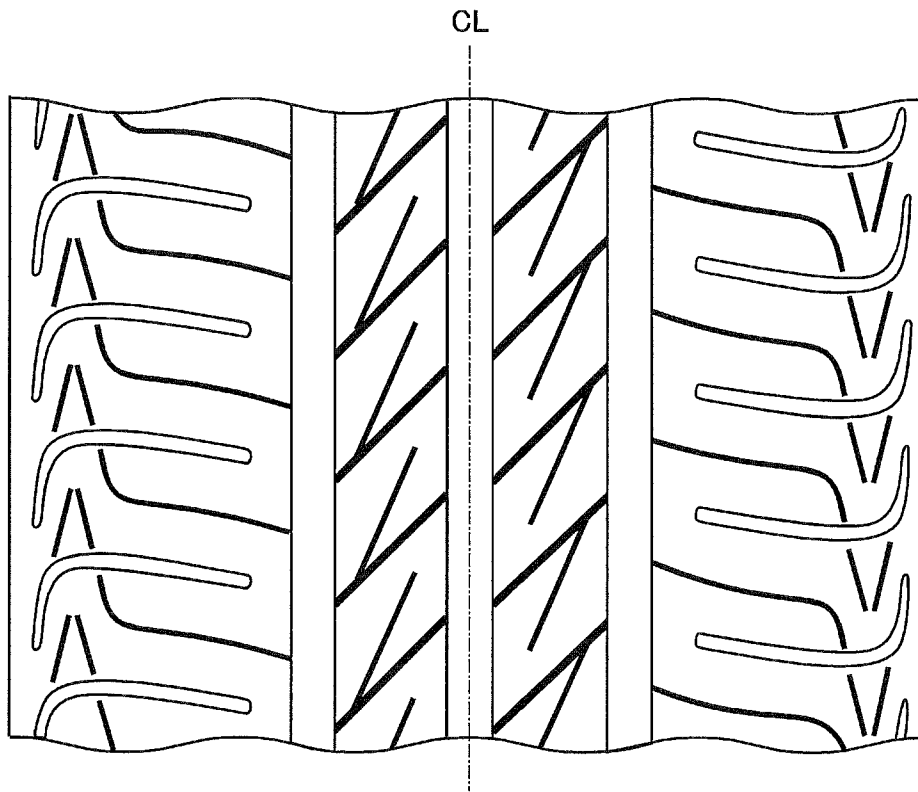
[Fig. 4]



[Fig. 5]



[Fig. 6]



INTERNATIONAL SEARCH REPORT

International application No

PCT/JP2011/001587

A. CLASSIFICATION OF SUBJECT MATTER

INV. B60C11/04 B60C11/12 B60C11/13
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B60C

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 4 407765 B (YOKOHAMA RUBBER CO LTD) 3 February 2010 (2010-02-03) paragraphs [0017], [0018]; figures 1,2 -----	1-18
Y,P	JP 2010 064514 A (YOKOHAMA RUBBER CO LTD) 25 March 2010 (2010-03-25) paragraphs [0017], [0018]; figures 1,2 -----	1-18
Y	JP 2007 302112 A (BRIDGESTONE CORP) 22 November 2007 (2007-11-22) figure 2 -----	1-18

☐

Further documents are listed in the continuation of Box C.

☒

See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/JP2011/001587

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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