(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 338 371 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.06.2011 Bulletin 2011/26

(51) Int Cl.:
A43B 23/00 *(2006.01)* ***A43B 5/02*** *(2006.01)*

(21) Application number: **10251638.2**

(22) Date of filing: **23.09.2010**

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

(30) Priority: **28.09.2009 JP 2009222917**
27.08.2010 JP 2010190518

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

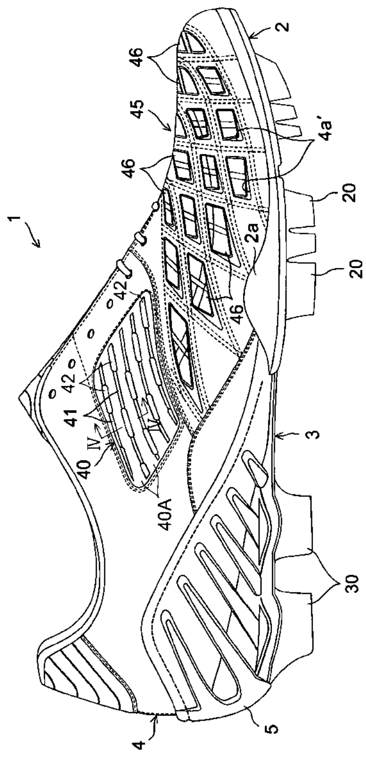
(72) Inventors:
- **Naruo, Takehsi**
  Osaka-shi
  Osaka 559-8510 (JP)
- **Tabuchi, Noriyuki**
  Osaka-shi
  Osaka 559-8510 (JP)
- **Goto, Yoshihiro**
  Osaka-shi
  Osaka 559-8510 (JP)
- **Kuwabara, Takuro**
  Osaka-shi
  Osaka 559-8510 (JP)

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

(54) **Upper structure for a football shoe**

(57) An upper structure for a soccer shoe 1 includes an upper 4. Upper material for covering a medial upper side region 40 of the upper 4 disposed at the upper position of the medial side of the upper 4 is formed of material M such that the ball speed V_2 is less than or equal to 950 rpm immediately after rebound of the ball B when the diagonal impact test is conducted in which the ball B impacts the material M diagonally. The medial upper side region 40 is preferably located at the minimal spin shot area NR that covers the navicular bone NB, the medial cuneiform bone MC and the middle cunei form bone IC of the foot of the wearer. The diagonal impact test is conducted in such a way that the ball B impacts the material M at a speed V_1 of 23.0 to 25.0m/s, at a revolution of 0 to 25rpm and at an angle α of 29 to 33 degrees relative to the surface of the material M with the material M attached to the flat plate HB. The upper material at the medial upper side region 40 is formed of soft polyurethane of a lower hardness of 30 to 50 degrees at Asker A scale.

FIG. 1



EP 2 338 371 A1

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to an upper structure suitable for football shoes, especially for soccer shoes, and is more particularly related to an improved upper structure that can control spin properties of a ball after kick and that can easily make an ordinary player kick a minimal spin shot.

[0002] A soccer shoe is generally composed of a sole having a plurality of studs fitted on a bottom surface of the sole and an upper fixedly attached on the sole. The upper of the soccer shoe is very important because the upper not only receives and protects a foot of a shoe wearer like other sports shoes but also plays the role of kicking a ball.

[0003] Therefore, various efforts have been made to improve uppers of soccer shoes. For example, Japanese patent application publications No. 8-332101, 9-28412, and 2004-520113 show soccer shoes in which multiple projections, recesses, resin protrusions, or ridges are formed on upper surfaces to increase friction of the upper surfaces relative to a ball thereby increasing ball spin rate after kick to enhance curving of the ball.

[0004] Japanese patent application publication No. 10-501725 shows a shoe having a ball contact pad provided on an upper surface and formed of expandable friction materials. The ball contact pad is composed of a top layer and a bottom layer spaced away from each other via a web. The ball contact pad causes a ball to spin by utilizing motion of the top layer and the web deformed at ball impact to return to their original positions after ball impact.

[0005] Japanese patent application publication No. 2007-509655 shows a shoe having a coating on an upper surface to improve coefficient of dry friction of the upper surface to enhance grip properties.

[0006] Japanese patent application publication No. 2001-523499 shows a shoe having an insert provided on an upper surface to form a concaved ball kick surface on the upper surface. A radius of curvature of the concaved ball kick surface is substantially the same as or slightly greater than a radius of a ball. In this case, since the concaved ball kick surface coincides with a shape of a ball, a contact area of the concaved ball kick surface with the ball is increased to enhance the accuracy of a ball kick.

[0007] The above-mentioned JP references 8-332101, 9-28412, 2004-520113, 10-501725, and 2007-509655 are all directed to spinning a ball and the above-mentioned JP reference 2001-523499 is directed to increasing a ball contact area of a shoe.

[0008] On the other hand, top-ranking soccer players recently have begun to use a so-called "minimal spin shot". Such a minimal spin shot is the way to kick a ball with as less spin as possible. A ball kicked by the minimal spin shot sways during flight and behaves unpredictably in the air, and a goalkeeper thus hardly catches the ball. Here, the term "minimal spin shot" used in the specification is defined as a shot that sways during flight at the ball spin rate less than a certain amount of ball spin rate and that describes unpredictable trajectory.

[0009] Such a minimal spin shot has been dependent on the skills of players. There was no one who addressed the minimal spin shot in the light of soccer shoes. None of the shoes disclosed in the above-mentioned JP references have been improved so as to give a ball as little spin as possible.

[0010] The present invention has been made in view of these circumstances and is directed to providing an upper structure for a shoe that can control spin properties of a ball after kick and that can make the ordinary soccer players kick a minimal spin shot easily. The present invention is also directed to providing an upper structure for a shoe that can easily make the ordinary players kick not only a spin shot such as a curving shot, an instep kick and the like but also a minimal spin shot.

[0011] Other objects and advantages of the present invention will be obvious and appear hereinafter.

SUMMARY OF THE INVENTION

[0012] First, inventors of the present invention started with examining minimal spin shots. They had a top-ranking player kick minimal spin shots to see in what conditions the minimal spin shots are achieved.

[0013] A first observer stays at a kick point in which the player is going to kick a ball and a second observer stays at a target point located 50 meters away from the kick point.. After the player has kicked the ball toward the target point, the first and second observers watch the ball during flight. When both of the first and second observers consider it a minimal spin shot the shot is finally regarded as the minimal spin shot. In this test, whether the shot is a minimal spin shot or not is judged by the ball trajectory. That is, when the kickedball describes a swaying trajectory without curving in one direction, in other words, when the kicked ball describes an unpredictable trajectory during flight, it is regarded as a minimal spin shot.

[0014] FIG. 10A is a table showing the results of the tests in which the player kicked minimal spin shots eleven times. In the table of FIG. 10A, "Foot" includes data related to a foot of the player immediately before impact on the ball, and "Ball" includes data related to the ball immediately after foot impact. The extreme right column shows the decision whether a minimal spin shot is achieved or not. Blanks in the table of FIG. 10A mean that no data was obtained. Also,

FIG. 10(a) is a top plan view of the ball immediately before and after impact and FIG. 10(b) is a side view of the ball immediately before and after impact. Reference numerals in FIGS. 10(a) and 10(b) correspond to those in FIG.10A.

[0015] In FIGS. 10A, 10(a) and 10(b), V_F (m/s) is the speed (Velocity) of the foot immediately before impact on the ball, and V_B (m/s) is the speed (Velocity) of the ball B' immediately after foot impact. S_A (deg) is an angle (Side Angle) formed by the direction of the movement of the foot and the direction (X-coordinate) of the target point of the ball B when the direction of the movement of the foot immediately after impact is projected on the horizontal plane (X-Y plane). $S_{A'}$ (deg) is an angle (Side Angle) formed by the direction of the movement of the ball B' and the direction (X-coordinate) of the target point of the ball B' when the direction of the movement of the ball B' immediately after impact is projected on the horizontal plane (X-Y plane). B_A (deg) is an angle (Blow Angle) formed by the direction of the movement of the foot and the horizontal plane when the direction of the movement of the foot immediately before impact is projected on the vertical plane (X-Z plane). L_A (deg) is an angle (Launch Angle) formed by the direction of the movement of the ball B' and the horizontal plane when the direction of the movement of the ball B' immediately after impact is projected on the vertical plane (X-Z plane). In the table of FIG. 10A, all the data of B_A are negative. It is because when the player kicks the ball he lowers his foot downwardly. Also, in the table of FIG. 10, R (rpm) is a rotational speed (Spin Rate) of the ball B' immediately after impact.

[0016] Judging from the decision on the extreme right column whether the minimal spin shots were achieved or not, it is found that the maximum ball spin rate to obtain the minimal spin shot is 111 (rpm). However, considering measurement errors or dispersions of the observers the inventors decided to employ the superior two digits of the significant figures. Therefore, the ball spin rate to obtain the minimal spin shot is found to be less than or equal to 110 rpm.

[0017] Then, the inventors of the present invention examined that when the player kicks the minimal spin shot which region of the upper of the shoe comes into contact with the ball. Top-ranking ten soccer players were got together. Sensors were attached on the medial side of the foot and first to fifth toes of the foot of each of the players. They put on socks with the sensors attached on their feet and kicked minimum spin shots. At this juncture, pressures on the foot of each of the players were measured.

[0018] FIG. 7 is a foot pressure distribution diagram to show how much averaged pressures are applied to which regions of the foot. In these drawings, inner darker areas of the contour lines indicate higher pressure areas.

[0019] FIG. 7(a) is a medial side view to show a foot pressure distribution diagram of the medial side of the left foot. FIG. 7(b) is a top plan view to show a foot pressure distribution diagram of the instep of the left foot.

[0020] As shown in FIG. 7, it is found that the minimal spin shots were kicked mainly by the medial upper side region disposed at the upper position and longitudinally central position of the medial side region of the foot. When this medial upper side region is overlapped with the bone structures illustrated in FIGS. 5 and 6, it is found that a minimal spin shot area NR of relatively higher foot pressure at the time of kicking the minimal spin shots is located at the regions extending from a navicular bone NB to a medial cuneiform bone MC and a middle cuneiform bone IC of the foot. In FIGS. 5 and 6, LC is a lateral cuneiform bone, TA is a talus, and CA is a calcaneus.

[0021] For comparison, the above-mentioned top soccer players also kicked curving shots and instep shots. In these shots as well, pressures on the foot of each of the players were measured.

[0022] FIGS. 8 and 9 show foot pressure distribution diagrams of the curving shots and the instep shots, respectively. In these drawings too, inner darker areas of the contour lines indicate higher pressure areas.

[0023] FIG. 8(a) is a medial side view to show a foot pressure distribution diagram of the medial side of the left foot at the time of kicking the curving shots. FIG. 8(b) is a top plan view to show a foot pressure distribution diagram of the instep of the left foot at the time of kicking the curving shots. FIG. 9(a) is a medial side view to show a foot pressure distribution diagram of the medial side of the left foot at the time of kicking the instep shots. FIG. 9(b) is a top plan view to show a foot pressure distribution diagram of the instep of the left foot at the time of kicking the instep shots.

[0024] As shown in FIGS. 8 and 9, it is found that the curving shots and instep shots were kicked by the medial side regions of toes of the foot and in the case of the curving shots ball contact areas extend farther rearward on the medial side regions relative to the case of the instep shots.

[0025] When these medial side regions are overlapped with the bone structures shown in FIGS. 5 and 6, it is found that an instep shot area IK is located at the a region extending from the base portion of the first distal phalanx DP_1 to the first proximal phalanx PP_1 and the central portion of the first metatarsus ME_1 and a curving shot area C is located at a region to include the instep shot area IK and to extend immediately before the base portion of the first metatarsus ME_1 .

[0026] Then the inventors of the present invention reviewed the relationship between the ball spin rate after impact at the "diagonal impact test" and the upper limit value of the ball spin rate of 110 rpm at the time of the minimal spin shots. The diagonal impact test is thought to correlate very closely with the phenomenon that the player actually kicks a ball.

[0027] FIG. 11 is a schematic illustrating the diagonal impact test. As shown in FIG. 11, a human body hardness plate HB is fixedly attached to an iron plate IB and a material sheet M as an upper material is attached on the human body hardness plate HB. Here, the human body hardness plate HB is a plate formed of vinyl chloride of 10 mm in thickness and of hardness corresponding to the hardness of the human body. The human body hardness plate HB has a hardness of 60 degrees at Asker A scale. That is, its harness is 60A. The reason why the human body hardness plate HB is interposed between the material sheet M and the iron plate IB is that at the time of actually kicking a ball the human body receives an impact load acted upon the upper of the shoe.

[0028] Also, in FIG. 11, the angle α is an impact angle of the direction of the soccer ball B launched by a soccer ball launch device (not shown) relative to the surface of the material sheet M when the soccer ball B impacts the material sheet M; the angle β is a rebound angle of the direction of the soccer ball B rebounded from the surface of the material sheet M relative to the surface of the material sheet M after ball impact; V_1 is an impact velocity of the ball B; and V_2 is a rebound velocity of the ball B immediately after impact. The reason why the soccer ball B impacts the material sheet M diagonally with an acute impact angle α is that the smaller the impact angle is the larger the number of rotation of the ball after impact is and thus the difference between the materials becomes remarkable. However, when the impact angle α is too small the vertical component of the force at the time of ball impact becomes small and each of the materials cannot display resilient properties. Therefore, considering these two matters the impact angle α is determined as follows and other conditions of the diagonal impact test are also shown as follows:

$$V_1=23.0\text{-}25.0\,\mathrm{m/s}$$

$$\alpha=29\text{-}33°$$

Ball spin rate before impact; 0-25rpm
Air pressure of the ball; 0.81kg/cm^2

[0029] Also, the soccer ball used in the test is the official football for the 2006 FIFA World Cup in Germany. Its name is the "+Teamgeist" made by Adidas.

[0030] Here, the reason why the value of V_1 is set in the above range is that such a value corresponds to the average speed of the foot of professional players and top amateur players before impact.

[0031] In the diagonal impact test, the ball B is launched toward the stationary material sheet M, but as long as the impact speed V_1 of the ball B coincides with the relative speed of the ball and the foot of the wearer at the time of actual kick the diagonal impact test can reproduce the impact phenomenon at the time of actual ball kick.

[0032] As the material sheet M, PU40A, or soft polyurethane of 38 degrees in Asker A hardness (i.e. 38A), and natural leather were prepared. At the impact velocity of V_1=24.1m/s, the velocity component parallel to the material sheet M was 20. 7m/s and the velocity component perpendicular to the material sheet M was 12.4m/s. At this juncture, the ball spin rate after impact was 911.5rpm, 1045.5rpm, respectively. On the other hand, when the ordinary player actually hit the soccer ball wearing the shoe having the same material at the minimal spin shot area of the upper of the shoe, the ball spin rate after kick was 103.1rpm, 128.6rpm, respectively.

[0033] When the materials are the same, the ball spin rate after impact in the diagonal impact test should coincide with the ball spin rate after actual ball kick. As shown in FIG. 12, the ball spin rate after actual kick is taken in the horizontal axis and the ball spin rate after impact in the diagonal impact test is taken in the vertical axis. Points (103.1, 911.5) and (128.6, 1045.5) were plotted in FIG. 12. Then, these two points were joined by a straight line L'. The straight line L' is a graph showing the relation between the ball spin rate after the ordinary player actually kicked the ball and the ball spin rate after impact in the diagonal impact test.

[0034] With regard to the graph L', the ordinate corresponding to the upper limit value of 110rpm (the abscissa) of the ball spin rate at the time of the minimal spin shot is 947.8rpm. By employing the upper two digits of the significant figure, the conversion value of the ball spin rate in the diagonal impact test corresponding to 110rpm of the abscissa is 950rpm. In this way, it is found that the upper limit value of the ball spin rate in the diagonal impact test which causes a minimal spin shot after actual ball kick is 950rpm. It is also found that when the ball spin rate exceeds 950rpm the shot will be a spin shot such as a curving shot, instep shot or the like.

[0035] Then, different natural leather was prepared as the material sheet M and the diagonal impact test was conducted similarly. In this case, the ball spin rate after impact was 1044rpm. On the other hand, when the top player kicked a minimal spin shot wearing a shoe having this natural leather at the minimal spin shot area of the upper, the ball spin rate after kick was 100rpm.

[0036] In this case as well, when the materials are the same, the ball spin rate after impact in the diagonal impact test should coincide with the ball spin rate after actual ball kick. Point (100, 1044) was plotted in FIG. 12 and a straight line L was drawn through the point (100, 1044) . The ordinate of 1044rpm is a value of very close proximity to the ordinate of 1045.5rpm, but in FIG. 12, a span of these ordinates is enlarged for the purpose of illustration.

[0037] Here, the reason why the gradient of the straight line L is made greater than the gradient of the straight line L' is described below:

[0038] When a soccer player actually kicks a minimal spin shot, it is preferable that the angle of the direction of the motion of the foot relative to the normal line dropped at the foot contact area on the ball is as small as possible. That is, the impact angle α in FIG. 11 is preferable as close to 90 degrees as possible. That is because kicking a ball toward the center of the ball causes less spin of the ball after ball kick. However, the action of kicking the ball is commonly associated with the dorsal flexion of the foot. Thereby, the absolute value of the angle of the direction of the motion of the foot relative to the normal line on the ball at the time ball kick tends to become large. That is, the impact angle α in FIG. 11 tends to be small. In contrast, top-ranking soccer players can kick a ball with his foot maintained straight to some degree and without dorsal flexion of the foot and thus it is possible that the absolute value of the angle of the direction of the foot relative to the normal line on the ball at the time ball kick becomes small. In such a manner, the impact angle becomes small in the case of bad players and approaches the impact angle α in the above-mentioned diagonal impact test, whereas the impact angle becomes great in the case of good players and they can kick a ball at an angle greater than the impact angle α in the diagonal impact test. Additionally, even in the case of the upper materials having the same ball spin rate after impact in the diagonal impact test, when the ordinary player kicks the ball the ball spin rate after kick tends to become high but when the top player kicks the ball the ball spin rate after kick tends to become low. Such tendency is remarkable in the case of the upper material having a higher ball spin rate after kick in the diagonal impact test.

[0039] As can be seen from FIG. 12, when the ordinary player kicks the ball wearing a shoe with the upper material having a ball spin rate of 1045.5rpm after impact in the diagonal impact test, the ball spin rate after ball kick is 128.6rpm (>110rpm) and it is not a minimal spin shot. However, when the ordinary player kicks the ball wearing a shoe with the upper material having a ball spin rate of 950rpm after impact in the diagonal impact test, the ball spin rate after ball kick is 110rpm and it is a minimal spin shot.

[0040] Next, Table 1 shows the relation between the hardness A at Asker A scale of the various kinds of material sheets M and the ball spin rate after impact in the diagonal impact test using these material sheets. M. The Asker A scale is a hardness measured by the type A durometer prescribed in JIS (Japanese Industrial Standard) K 6253 and ISO 7619.

TABLE 1

Material	Hardness A	Ball Spin Rate (rpm)
Prior Art	64	1044
PU75A	75	1111
Highly Elastic PU-1	60	1051
Highly Elastic PU-2	45	997
PU40A	38	863
PU60A	63	963
PU80A	80	1129

[0041] By taking the hardness A in the horizontal axis and the ball spin rate in the vertical axis in FIG. 13 and plotting data of Table 1, a correlation between the hardness A and the ball spin rate can be represented by a graph of linear function in FIG. 13.

[0042] The equation of the graph in FIG. 13 is represented as follows:

$$Y=5.359x+697.2$$

X: abscissa
Y: ordinate
if y=950 then,
X=47.17≈47

[0043] Consequently, it is found that the hardness A corresponding to the ball spin rate of 950rpm after impact in the diagonal impact test is 47 degrees. However, considering dispersions of measured values the upper limit value of the hardness A is determined at 50 degrees.

[0044] The present invention has been made based on the results of the above-mentioned various reviews. A first invention according to the present invention is an upper structure for a football shoe composed of an upper for receiving a foot of a shoe wearer. The upper covers a medial side region, a lateral side region, an instep region, and a heel region of the foot. Upper material for covering a medial upper side region disposed at an upper position of the medial side region is formed of material such that the ball spin rate is less than or equal to 950rpm immediately after rebound of the ball when the diagonal impact test is conducted in which the ball impacts the material diagonally.

[0045] In this case, as mentioned above, the ball spin rate less than or equal to 950rpm after impact in the diagonal impact test corresponds to the ball spin rate less than or equal to 110rpm after actual ball kick by the ordinary player. Therefore, if the ordinary player kicks a ball at the medial upper side region of the upper structure recited in Claim 1 a minimal spin shot can be achieved. In this way, according to the invention of Claim 1, even the ordinary can control the spin properties of the ball after kick and easily kick a minimal spin shot.

[0046] The medial upper side region may be a region extending from the navicular bone to the medial cuneiform bone and the middle cuneiform bone of the foot of the wearer.

[0047] As above-mentioned, this is obtained by examining the results of the foot pressure measurement when players actually kicked the minimal spin shots.

[0048] The medial upper side region may extend substantially in a longitudinal direction of the shoe.

[0049] This is obtained by examining the results of the foot pressure measurement shown in FIG. 7(a) when players actually kicked the minimal spin shots.

[0050] Additionally, in this specification, the term "extend substantially in a longitudinal direction of the shoe" means not only extending along the longitudinal direction or the length of the shoe but also extending in the diagonal direction intersecting the longitudinal direction (i.e. the combined direction of the longitudinal direction and the lateral direction) of the shoe.

[0051] The upper material at the medial upper side region may include a plurality of protrusions extending substantially in a longitudinal direction of the shoe, and the protrusions protrude upwardly from an upper region that surrounds the protrusions.

[0052] In this case, when kicking the ball at the medial upper side region, the protrusions elastically deform, so that the ball contact time becomes long. As a result, a shearing force is easy to occur to restrict a spin of the ball in the latter half of the rebound of the ball.

[0053] The diagonal impact test is conducted in such a way such that the ball impacts the material at a speed of 23.0-25.0m/s, at a revolution of 0-25rpm and at an angle of 29 to 33 degrees relative to a surface of the material with the material attached to a flat plate.

[0054] As above-mentioned, the reason why the soccer ball impacts the material sheet diagonally with a relatively small impact angle of 29 to 33 degrees is that the difference between the ball spin rates after impacts onto each of the materials is made remarkable. However, when the impact angle is too small the vertical component of the force at the time of ball impact becomes small and each of the materials thus cannot display resilient properties. Therefore, considering these two matters the impact angle was determined at the aforesaid values.

[0055] The upper material at the medial upper side region may be formed of material of a low hardness less than 50 degrees at Asker A scale. The lower hardness of the upper material may be 30 to 50 degrees at Asker A scale.

[0056] This is because there is a tendency that the harness of the upper material lowers the ball spin rate after impact in the diagonal impact test decreases (see FIG. 13). Also, this is because the hardness of the upper material corresponding to the ball spin rate of 950rpm after impact in the diagonal impact test is approximately 47 degrees at AskerAscale. The lower limit value of 30 degrees is determined mainly by consider ing an aspect of manufacture and durability.

[0057] The upper material of a low hardness may be formed of soft polyurethane.

[0058] The upper material for covering a front side region of the upper disposed in front of the medial upper side region may be formed of material such that the ball spin rate is more than 950rpm immediately after rebound when the diagonal impact test is conducted in which the ball impacts the material diagonally.

[0059] In this case, as mentioned above, when the player kicks the ball through the upper material such that the ball spin rate after ball rebound in the diagonal impact test using this upper material is more than 950rpm, a spin shot such as a curving kick, an instep kick or the like is achieved. Therefore, the upper material such that the ball spin rate after rebound in the diagonal impact test is more than 950rpm is provided at the front side region where the spin shots should be kicked.

[0060] Also, in this case, when the player kicks a minimal spin shot he has only to use the medial upper side region of the upper. On the other hand, when the player kicks a spin shot such as a curving shot, an instep shot or the like he has only to use the front side region in front of the medial upper side region of the upper. In such a manner, even the ordinary player can kick a minimal spin shot as well as a spin shot distinctively with ease.

[0061] The front side region of the upper disposed in front of the medial upper side region is a region extending from a first metatarsus to a first proximal phalanx of the foot.

[0062] This is based on the review of the result of the foot pressure measurement when the player actually kicked a spin shot such as a curving shot, an instep shot or the like.

[0063] The upper material for covering the front side region disposed in front of the medial upper side region may be formed of material of a hardness higher than a hardness of the upper material for covering the medial upper side region.

[0064] This is because the front side region of the upper is one for kicking a spin shot like a curving shot or an instep shot and also there is a tendency that the higher the hardness of the upper material is the higher the spin rate of the ball is after impact in the diagonal impact test as illustrated in FIG. 13.

[0065] The upper material of a higher hardness may be formed of hard polyurethane.

[0066] The upper material at the medial upper side region may be formed of material of a low modulus of storage elasticity.

[0067] FIG. 14 is a graph illustrating differences of the modulus of storage elasticity E' according to differences of materials. In FIG. 14, PU80A indicates polyurethane with a hardness of 80A at Asker A scale; prior art polyurethane with a hardness of 64A; PU40A polyurethane with a hardness of 38A. The horizontal axis depicts frequency (Hz) of oscillation implied to the material and the vertical axis depicts the modulus of storage elasticity E' (Pa). Measurement of the modulus of storage elasticity is conducted based on the tensile oscillation according to the non-resonance forced vibration prescribed in JIS K 7244-4. As can be seen from FIG. 14, as the hardness lowers the modulus of storage elasticity decreases.

[0068] In view of the above, material with a low modulus of storage elasticity is provided at the medial upper side region where material with a low hardness should be provided. In addition, a low modulus of storage elasticity means being dynamically soft. Therefore, when the diagonal impact test using material with a low modulus of storage elasticity is conducted ball contact time during impacting the material becomes longer. As a result of this, shearing force is imparted such that the material restrains the ball spin in the latter half of the rebound of the ball.

[0069] The upper material for covering an front side region disposed in front of the medial upper side region is formed of material of a higher modulus of storage elasticity than the modulus of storage elasticity of the upper material at the medial upper side region.

[0070] As shown in FIG. 14, as the hardness rises the modulus of storage elasticity increases. Therefore, material with a higher modulus of storage elasticity is provided at the front side region of the upper where higher hardness is required than the medial upper side region of the upper.

[0071] The upper may be composed of an outside member disposed outside the shoe and an inside member disposed inside the shoe. Also, the outside member may be cut-out along a periphery of the medial upper side region and the upper material for covering the medial upper side region may be provided over the inside member at a cutout region of the outside member.

[0072] In this case, since the bottom portion of the upper material that covers the medial upper side region of the upper is disposed in the cutout region of the outside member, the upper material is restricted from protruding excessively outwardly from the surrounding outside member and at the same time a certain degree of thickness as the upper material can be secured and can prevent separation of the upper material.

[0073] The upper material for covering the medial upper side region may protrude upwardly from the outside member disposed around the medial upper side region.

[0074] In this case, by adjusting the protruding amount of the upper material from the outside member, impact to the foot at the time of a minimal spin shot can be attenuated.

[0075] A second invention according to the present invention is an upper structure for a football shoe composed of an upper for receiving a foot of a shoe wearer. The upper material for covering a medial upper side region disposed at the upper position of a medial side region of the shoe is formed of material such that a modulus of storage elasticity is less than or equal to 1.0×10^7Pa when oscillation of 35Hz is implied to the material. The upper material for covering a front side region disposed in front of the medial upper side region may be formed of material such that a modulus of storage elasticity is more than 1.0×10^7Pa when oscillation of 35 Hz is implied to the material. Here, "35 Hz" is a frequency calculated from natural frequency of a soccer ball.

[0076] Now, three kinds of polyurethane with different hardness are prepared. These are PU64A (64A in hardness A; prior art), PU40A (38A in hardness A), and PU80A (80A in hardness A). The above-mentioned diagonal impact test was conducted using the three polyurethane and the ball spin rate after impact was measured. Also, the tensile oscillation test based on JIS K 7244-4 was conducted and the modulus of storage elasticity E' (Pa) at the frequency of 35Hz was measured. The measurement results are shown in Table 2.

TABLE 2

	Hardness A	E'(Pa)	Ball Spin Rate (rpm)
Prior Art	64	12868572	1044
PU40A	38	6818400	863
PU80A	80	18872403	1129

[0077] Next, E' (Pa) is taken in the horizontal axis and ball spin rate (rpm) in the vertical axis and then the measurement values of Table 2 were plotted. The correlation between these measurement values is shown as a graph in a linear function in FIG. 15.

[0078] The equation of the graph in FIG. 15 is as follows:

$$Y=2.211E-05x+727.9 \text{ (x: abscissa; y: ordinate)}$$

If y=950 then
x≈1.0E+07

[0079] It is found that the modulus of storage elasticity E' corresponding to the ball spin rate of 950 rpm after impact in the diagonal impact test is 1.0E+07 (Pa), i.e. 1.0×10^7 (Pa). Therefore, the modulus of storage elasticity E' corresponding to the ball spin rate of 950 rpm or less after impact in the diagonal impact test is 1.0×10^7 (Pa) or less. One of the materials that satisfy this condition is PU40A judging from FIG. 15. This also conforms to the graph of FIG. 14 in that the material whose modulus of storage elasticity E' at the frequency of 35Hz is 1.0×10^7 (i.e. 1.0E+07) (Pa) or less is PU40A.

[0080] According to the second invention of the present invention, even the ordinary player can control the ball spin properties after kick and also he can kick a minimal spin shot easily. In the case that the upper material at the front side region in front of the medial upper side region is one such that the modulus of storage elasticity is more than 1.0×10^7Pa at the oscillation of 35 Hz, if the player wants to kick a minimal spin shot he has only to use the medial upper side region of the upper and if he wants to kick a spin shot such as a curving shot, an instep shot or the like he has only to use the front side region of the upper. In such a manner, even the ordinary player can kick a minimal spin shot as well as a spin shot distinctively with ease.

[0081] The upper material at the medial upper side region may be formed of material of a low hardness of 30 to 50 degrees at Asker A scale.

[0082] This is because there is a tendency that the hardness of the upper material lowers the spin rate of the ball decreases after impact in the diagonal impact test as shown in FIG. 13. This is also because the hardness of the upper material corresponding to the ball spin rate of 950 rpm after impact in the diagonal impact test is approximately 47 degrees at Asker A scale. In addition, the reason why the lower limit value is set at 30 degrees is mainly due to the aspect of manufacturing and durability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0083] For a more complete understanding of the invention, reference should be made to the embodiments illustrated in greater detail in the accompanying drawings and described below by way of examples of the invention. In the drawings, which are not to scale:

FIG. 1 is a medial side view of a soccer shoe (for a left foot) employing an upper structure according to an embodiment of the present invention;
Fig. 2 is a lateral side view of the soccer shoe of FIG. 1;
FIG. 3 is a top plan view of a forefoot region of the soccer shoe of FIG. 1;
Fig. 4 is a sectional view of FIG. 1 taken along line IV-IV;
FIG. 5 is a medial side view illustrating a minimal spin shot area, a curving shot area and an instep shot area as well as the skeletal structure of the left foot;
Fig. 6 is a top plan view illustrating the minimal spin shot area, the curving shot area and the instep shot area as well as the skeletal structure of the left foot;
FIG. 7(a) is a foot pressure diagram at the time of the minimal spin shot viewed from the medial side of the left foot;
FIG. 7(b) is a foot pressure diagram at the time of the minimal spin shot viewed from the top side of the left foot;
FIG. 8(a) is a foot pressure diagram at the time of the curving kick viewed from the medial side of the left foot;
FIG. 8(b) is a foot pressure diagram at the time of the curving kick viewed from the top side of the left foot;
FIG. 9(a) is a foot pressure diagram at the time of the instep kick viewed from the medial side of the left foot;
FIG. 9(b) is a foot pressure diagram at the time of the instep kick viewed from the top side of the left foot;
FIG. 10(a) is a top plan view of a ball before and after impact at the time of the minimal spin shot;
FIG. 10(b) is a side view of the ball before and after impact at the time of the minimal spin shot;
FIG. 10A is a table that indicates data relating to the Foot immediately before.impact on the ball, data relating to the Ball immediately after foot impact, and a result of the judgment as to whether the minimal spin shot was achieved or not when the player kicked the minimal spin shots eleven times;

FIG. 11 illustrates an outline of a diagonal impact test;
FIG. 12 is a graph showing the relation between the ball spin rate after actual ball kick and the ball spin rate after impact in the diagonal impact test;
FIG. 13 is a graph showing the relation between the hardness A of the materials and the ball spin rate after impact in the diagonal impact test;
FIG. 14 is a graph showing the relation between the modulus of storage elasticity of the materials and the frequency;
FIG. 15 is a graph showing the relation between the modulus of storage elasticity of the materials and the ball spin rate after impact in the diagonal impact test using the materials;
FIG. 16 is a graph showing the relation between the ball contact time and the modulus of storage elasticity of the materials when the diagonal impact test using the materials was conducted;
FIG. 17 illustrates an outline of a simulation test inwhichaball model impacts a panel model with a plurality of protrusions;
FIG. 18 is a histogram showing the relation between the width of the protrusion of the panel model and the ball spin rate;
FIG. 19 is a medial side view of a soccer shoe (for a left foot) employing an upper structure according to another embodiment of the present invention;
Fig. 20 is a lateral side view of the soccer shoe of FIG. 19;
FIG. 21 is a top plan view of a forefoot region of the soccer shoe of FIG. 19;
FIG. 22 is an enlarged view of a minimal spin shot panel part constituting the minimal spin shot area of the soccer shoe of FIG. 19; and
FIG. 23 is a cross sectional view of FIG. 22 taken along line XXIII-XXIII.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0084] Referring now to the drawings, FIGS. 1 to 4 show an upper structure for a soccer shoe according to a first embodiment of the present invention. In these drawings, like reference numbers indicate identical or functionally similar elements.

[0085] As shown in FIGS. 1 to 3, a soccer shoe 1 includes a forefoot-side sole 2 disposed at a forefoot region of the shoe 1, a rear-foot-side sole 3 disposed at a rear-foot region of the shoe 1 with a front end portion of the rear-foot -side sole 3 overlapped with a rear end portion of the forefoot - side sole 2, and an upper 4 fixedly attached on the forefoot-side sole 2 and the rear-foot-side sole 3.

[0086] The rear end portion of the forefoot-side sole 2 has a pair of upraised portions 2a formed on opposite sides of the shoe 1 and extending slightly upwardly along the outer surface of the upper 4. The upraised portion 2a covers the front end portion of the rear-foot-side sole 3. There are provided a plurality of cleats or studs 20, 30 on the bottom surfaces of the forefoot-side sole 2 and rear-foot-side sole 3, respectively. At a heel region of the upper 4 is provided a heel counter 5 to maintain the shape of the heel region of the upper 4.

[0087] The upper 4 includes a medial upper side region 40 disposed at the upper position of the medial side region of the upper 4 and a front side region 45 disposed in front of the medial upper side region 40. The medial upper side region 40 is a region for kicking a minimal spin shot and the front side region 45 is a region for kicking a spin shot such as a curving shot, an instep shot or the like. The medial upper side region 40 has an elongated square shape such as a general parallelogram that extends substantially along the length of the shoe 1. The medial upper side region 40 is preferably formed of soft polyurethane having a relatively lower hardness. In other words, soft polyurethane covers the medial upper side region 40 as a part of the upper material. As soft polyurethane, for example, PU40A at Asker A scale is preferable. In addition, rubber with a lower hardness or soft rubber may be substituted for the soft polyurethane.

[0088] The medial upper side region 40 of the upper 4, shown in FIG. 4, includes an outer member 4A disposed outside the shoe 1 and an inner member 4B disposed inside the shoe 1. The outer member 4A has a cut-out portion 4a that is cut out along the outer periphery of the medial upper side region 40. The soft polyurethane of the medial upper side region 40 is provided on an interior member 4C disposed on the inner member 4B at the cut-out portion 4a.

[0089] Also, the soft polyurethane of the medial upper side region 40 of the upper 4 has a plurality of grooves 41 extending intermittently along the substantially longitudinal direction of the shoe 1 and a plurality of elongated through holes 42 formed between the longitudinally adjacent grooves 41. A plurality of grooves 41 and elongated through holes 42 longitudinally aligned with each other forms a longitudinal row. A plurality of longitudinal rows each composed of the grooves 40 and the elongated through holes 42 are disposed side by side and spaced away from each other in the substantially lateral direction of the shoe 1 (see FIG. 1). In the rows adjacent to each other in the lateral direction, the grooves 41 and through holes 42 are not aligned with each other in the lateral direction and alternate with each other. The top surface 40A of the soft polyurethane projects upwardly from the surrounding outer member 4A. Stated differently, the top surface 40A of the soft polyurethane at the medial upper side region 40 are formed of a plurality of protrusions that extend substantially in the longitudinal direction and that project upwardly from the surrounding upper regions.

[0090] The width of the top surface 40A of the soft polyurethane at the medial upper side region 40, that is, the length of the top surface 40A extending from edge of the groove 41 to the edge of the through hole 42, is set at 2mm or more preferably. By forming a plurality of grooves 41 and through holes 42, the medial upper side region 40 of the upper 4 can be made lighter in weight and can be made follow the shape of the upper portion of the medial side region of the foot of the wearer.

[0091] The front side region 45 of the upper 4 is formed of a plurality of pieces of hard polyurethane 46 each having a relatively higher hardness than the hardness of the soft polyurethane at the medial upper side region 40. In other words, the hard polyurethane 46 substantially covers the front side region 45 as apart of the upper 4. As the hard polyurethane 46, for example, PU80A at Asker A scale is preferable. Hard rubber may be substituted for the hard polyurethane.

[0092] At the front side region 45 is formed a plurality of cut-out portions 4a' in which the outer member 4A of the upper 4 is cut out along the outer periphery of each of the plurality of pieces of the hard polyurethane 46. Each of the pieces of the hard polyurethane 46 is provided on an interior member (not shown) disposed on the inner member 4B of the upper 4 at the cut-out portion 4a' . The top surface of each of the pieces of the hard polyurethane 46 projects upwardly from the surrounding outer member 4A as with the soft polyurethane at the medial upper side region 40 of the upper 4.

[0093] The medial upper side region 40, as can be seen when it is overlapped with the bone structures shown in FIGS. 5 and 6, is a region (or a minimal spin shot area) NR that covers from the navicular bone NB to the medial cuneiform bone MC and the middle cuneiform bone IC of the foot. Also, the front side region 45 of the upper 4, as can be seen when it is overlapped with the bone structures shown in FIGS. 5 and 6, includes a region (or an instep shot area) IK that extends from the base portion of the first distal phalanx DP_1 to the first proximal phalanx PP_1 and the central portion of the first metatarsus ME_1, and a region (or a curving shot area) CK that covers the instep shot area IK and that extends immediately before the base portion of the first metatarsus ME_1. In FIGS. 5 and 6, LC is a lateral cuneiform bone, TA is a talus, and CA is a calcaneus.

[0094] The above-mentioned positions of the minimal spin shot area NR, the instep shot area IK and the curving shot area CK are based on the foot pressure distribution diagram when top-ranking ten soccer players actually kicked the minimal spin shot, the curving shot and then instep shot.

[0095] FIG. 7 shows a foot pressure distribution diagram at the minimal spin shot, FIG. 8 a foot pressure distribution diagram at the curving shot, and FIG. 9 a foot pressure distribution diagram at the instep shot. These diagrams show averaged data of the measured values. In each of the diagrams, (a) shows a foot pressure distribution on the medial side of the left foot, and (b) shows a foot pressure distribution on the instep of the left foot. At the foot pressure measurement, sensors were attached on the medial side region of the foot and first to fifth toes of the foot of each of the players. They put on socks with the sensors attached on their feet and kicked shots. At this juncture, pressures on the foot of each of the players were measured.

[0096] As shown in FIG. 7, it is found that the minimal spin shots were kicked mainly by the medial upper side region disposed at the upper position of the medial side region of the foot. As can been seen when this medial upper side region is overlapped with the bone structure of the left foot in FIGS. 5 and 6, the minimal spin shot area NR that is a region of a relatively high foot pressure at the minimal spin shot extends from the position of a navicular bone NB to the positions of a medial cuneiform bone MC and a middle cuneiform bone IC of the foot. As can be seen from FIGS. 8 and FIGS. 5 and 6, the curving shot area CK that is a region of a relatively high foot pressure at the curving shot extends from the position of the base portion of the first distal phalanx DP_1 to the positions of the first proximal phalanx PP_1 and immediately before the base portion of the first metatarsus ME_1. Similarly, as can be seen from FIG. 9 and FIGS. 5 and 6, the instep shot area IK of a relatively high foot pressure at the instep shot extends from the position of the base portion of the first distal phalanx DP_1 to the positions of the first proximal phalanx PP_1 and the central portion of the first metatarsus ME_1. The curving shot area CK extends farther rearward than the instep shot area IK.

[0097] The reason why soft polyurethane of relatively low hardness is used as upper material for the minimal spin shot area NR and hard polyurethane of relatively high hardness is used as upper material for the curving shot area CK and the instep shot area IK is that the ball spin rate after kick is different according to the difference of the hardness.

[0098] First, inventors of the present invention had a top-ranking soccer player actually kick minimal spin shots to see in what conditions the minimal spin shots are achieved.

[0099] A first observer stays at a kick point and a second observer stays at a target point located 50 meters away from the kick point. After the player kicked the ball toward the target point, the first and second observers watch the ball during flight. When both of the first and second observers consider it a minimal spin shot the shot is finally regarded as the minimal spin shot. In this test, whether the shot is a minimal spin shot or not is judged by the ball trajectory. That is, when the kicked ball describes a swaying trajectory without curving in one direction, in other words, when the kicked ball describes an unpredictable trajectory during flight, it is regarded as a minimal spin shot.

[0100] As above-mentioned, FIG. 10A shows the results of judgments whether or not the minimal spin shots were achieved at the tests in which the player tried minimal spin shots eleven times.

[0101] Judging from the judgments of FIG. 10A, the maximum ball spin rate immediately after impact to obtain the minima1 spin shots is 111 (rpm) but considering measurement errors or dispersions of the observers the inventors decided to employ the superior two digits of the significant figures. Therefore, the ball spin rate to obtain the minimal spin shot is found to be less than or equal to 110 rpm.

[0102] Explanation of various data in FIG. 10A and related FIGS. 10(a) and 10(b) were already given and therefore detailed explanation of these drawings is not repeated here.

[0103] Then the inventors of the present invention reviewed the relationship of the ball spin rate after impact at the "diagonal impact test" and the upper limit value of the ball spin rate of 110 rpm at the actual minimal spin shots. The diagonal impact test is thought to correlate very closely with the phenomenon that the player kicks a ball.

[0104] The diagonal impact test, as shown in FIG. 11, is conducted in such a way that a soccer ball B launched by a soccer ball launch device (not shown) impacts a material sheet M as an upper material with the material sheet M attached on the human body hardness plate HB that is fixedly attached to an iron plate IB. Here, the human body hardness plate HB is a plate formed of vinyl chloride of 10 mm in thickness and of hardness of 60 degrees at Asker A scale corresponding to the hardness of the human body. That is, its harness is 60A. The reason why the human body hardness plate HB is interposed between the material sheet M and the iron plate IB is that at an actual kick the human body receives an impact load acted upon the upper of the shoe.

[0105] In FIG. 11, the angle α is an impact angle of the direction of the soccer ball B launched by the soccer ball launch device relative to the surface of the material sheet M when the soccer ball B impacts the material sheet M; the angle β is a rebound angle of the direction of the soccer ball B rebounded from the material sheet M after impact relative to the surface of the material sheet M; V_1 is an impact velocity of the ball B; and V_2 is a rebound velocity of the ball B immediately after impact.

[0106] The reason why the soccer ball B impacts the material sheet M diagonally with an acute impact angle α is that the smaller the impact angle is the larger the number of rotation of the ball after impact is and thus the difference between the materials becomes remarkable. However, when the impact angle α is too small the vertical component of the force at ball impact becomes small and each of the materials cannot display resilient properties. Therefore, considering these two matters the impact angle α is determined at the following value and other conditions of the diagonal impact test are also shown as follow:

$$V_1=23.0\text{-}25.0\text{m/s}$$

$$\alpha=29\text{-}33°$$

Ball spin rate before impact; 0-25rpm
Air pressure of the ball; 0.81kg/cm^2

[0107] Also, a soccer ball used in the test is the official football for the 2006 FIFA World Cup in Germany. Its name is the "+Teamgeist" made by Adidas.

[0108] Here, the reason why the value of V_1 is set in the above range is that such a value corresponds to the average speed of the foot of the professional players and the top amateur players before impact.

[0109] In the diagonal impact test, the ball B is launched toward the stationary material sheet M, but as long as the impact speed V_1 of the ball B coincides with the relative speed of the ball and the foot at an actual kick the diagonal impact test can reproduce the impact phenomenon at the actual kick.

[0110] As the material sheet M, PU40A, or a soft polyurethane with a hardness of 38A at Asker A scale, and natural leather were prepared and the diagonal impact test was conducted. At V_1=24.1m/s, the velocity component parallel to the material sheet M was 20.7m/s and the velocity component perpendicular to the material sheet M was 12.4m/s. At this juncture, the ball spin rate after impact was 911.5rpm, 1045. 5rpm, respectively. On the other hand, when the ordinary player actually kicked the soccer ball with the shoe having the same material at the minimal spin shot area of the upper of the shoe the ball spin rate after kick was 103.1rpm, 128. 6rpm, respectively.

[0111] When the materials are the same, the ball spin rate after impact in the diagonal impact test should coincide with the ball spin rate after an actual kick. As shown in FIG. 12, the horizontal axis is taken as the ball spin rate after an actual kick, and the vertical axis is taken as the ball spin rate after impact in the diagonal impact test. Points (103.1, 911.5) and (128.6, 1045.5) were plotted in FIG. 12. Then, these two points were joined by a straight line L'. The straight line L' is a graph showing the relation between the ball spin rate after an actual kick by the ordinary player and the ball spin rate after impact in the diagonal impact test.

[0112] With regard to the graph L', the ordinate corresponding to the upper limit value (the abscissa) of the ball spin rate of 110 rpm at the minimal spin shot is 947. 8rpm. By employing the upper two digits of the significant figure, the conversion value of the ball spin rate in the diagonal impact test corresponding to 110rpm of the abscissa is 950rpm.

Accordingly, it is found that the upper limit value of the ball spin rate in the diagonal impact test which causes a minimal spin shot after an actual ball kick is 950rpm.

[0113] Consequently, as upper material that covers the medial upper side region 40 of the upper 4, especially the region (or minimal spin shot area) NR extending from the navicular bone NB to the medial cuneiform bone MC and the cuneiform bone IC of the foot, it is necessary that when the diagonal impact test was conducted in such a way that a soccer ball impacts the upper material diagonally the ball spin rate immediately after ball rebound is 950rpm or less.

[0114] When the ordinary player kicks a ball wearing a shoe with such upper material at the minimal spin shot area NR, even the ordinary player can control the spin properties of the ball after kick and can kick a minimal spin shot with ease.

[0115] It is also found from FIG. 12 that when the player kicks a ball at upper material such that the ball spin rate after impact in the diagonal impact test using the upper material exceeds 950rpm a spin shot such as a curving shot, instep shot or the like is achieved. Therefore, as upper material that covers the front side region 45 located in front of the medial upper side region 40 of the upper 4, especially a region (spin shot area) that extends from the base portion of the first distal phalanx DP_1 to the first proximal phalanx PP_1 and the first metatarsus ME_1, it is necessary that when the diagonal impact test in which a soccer ball impacts the upper material diagonally was conducted the ball spin rate after rebound exceeds 950rpm.

[0116] In FIG. 12, a straight line L is a graph showing the relation between the ball spin rate (rpm) after the top players actually kicked a ball and the ball spin rate (rpm) after impact in the diagonal impact test. Point (100, 1044) in the graph indicates a ball spin rate after the top player kicked a minimal spin shot with a shoe having natural leather as a material sheet at the minimal spin shot area of the upper and a ball spin rate after impact in the diagonal impact test using the natural leather.

[0117] Here, the reason why the gradient of the straight line L is greater than the gradient of the straight line L' is that even in the case of the upper material with the same ball spin rate after impact in the diagonal impact test if the ordinary player kicks a ball the ball spin rate becomes high whereas the top player kicks a ball the ball spin rate becomes low and such tendency is remarkable as the ball spin rate in the diagonal impact test increases after impact.

[0118] Also, as can be seen from FIG. 12, in the event that the ordinary player kicked a ball with a shoe having upper material such that the ball spin rate after impact in the diagonal impact test using the upper material is 1045. 5rpm, the ball spin rate after kick is 128.6rpm (>110rpm) and the kicked ball is not a minimal spin shot. To the contrary, in the event that the ordinary player kicked a ball with a shoe having upper material such that the ball spin rate after impact in the diagonal impact test using the upper material is 950rpm, the ball spin rate after kick is 110rpm and the kicked ball is a minimal spin shot.

[0119] As mentioned above, Table 1 showed the relation between the hardness A of the material sheet M at Asker A scale and the ball spin rate after impact in the diagonal impact test using the material sheet M. Then, the hardness A is taken in the horizontal axis and the ball spin rate is taken in the vertical axis and data in Table 1 were plotted.

[0120] Fig. 13 shows a graph of linear function representing a correlation between the data in Table 1. The equation of the graph in FIG. 13 is, if X is taken for abscissa and y is take for ordinate, represented as follows:

$$Y=5.359x+697.2$$

if y=950 then,
X=47.17≈47

[0121] Consequently, it is found that the hardness A corresponding to the ball spin rate of 950 rpm after impact in the diagonal impact test is 47 degrees. However, considering dispersions of measured values the upper limit value of the hardness A is determined at 50 degrees. Also, considering wear resistance as upper material the lower limit value of the hardness A is preferably 30 degrees. Therefore, for hardness of the upper material used for the minimal spin shot area NR of the upper 4, is preferably 30-50A at Asker A scale.

[0122] Also as can be seen from FIG. 13, the hardness A is in direct proportion to the ball spin rate after impact in the diagonal impact test. That is, as the hardness lowers the ball spin rate in the diagonal impact test decreases and conversely as the hardness rises the ball spin rate in the diagonal impact test increases.

[0123] This is because lower hardness allows for longer contact time with the ball during the diagonal impact and thus force is exerted for a longer time to reduce the spin of the ball.

[0124] Therefore, soft polyurethane of lower hardness, preferably PU40A (38A in hardness), is employed at the minimal spin shot area NR where a lower ball spin rate after kick is required, and hard polyurethane 46 of higher hardness, preferably PU80A (80A in hardness), is employed at the instep shot area IK and the curving shot area CK where a certain extent of ball spin rate after kick is required.

[0125] Also, for the minimal spin shot area NR, material of lower modulus of storage elasticity may be disposed, and for the instep shot area IK and the curving shot area CK, material of relatively higher modulus of storage elasticity may be disposed.

[0126] FIG. 14 shows differences of the modulus of storage elasticity E' due to differences of materials. In FIG. 14, PU80A indicates polyurethane with a hardness of 80A at Asker A scale; prior art polyurethane with a hardness of 64A; PU40A polyurethane with a hardness of 38A. The horizontal axis depicts frequency of oscillation implied to the material and the vertical axis depicts the modulus of storage elasticity E'. Measurement of the modulus of storage elasticity is conducted based on the tensile oscillation according to the non-resonance forced vibration prescribed in JIS K 7244-4.

[0127] As can be seen in FIG. 14, as the hardness lowers the modulus of storage elasticity decreases. In view of this, material of a lower modulus of storage elasticity is provided at the minimal spin shot area NR that is located at the medial upper side region 40 and where material of a lower hardness should be disposed. Also, material of a higher modulus of storage elasticity is provided at the front side region 45 that is located in front of the medial upper side region 40 and where material of a higher hardness is required than the medial upper side region.

[0128] Here, the relation between the modulus of storage elasticity and the ball spin rate will be verified hereinafter.

[0129] Now, three kinds of polyurethane with different hardness are prepared. These are PU64A (64A in hardness A; prior art), PU40A (38A in hardness A), and PU80A (80A in hardness A). The above-mentioned diagonal impact test was conducted using the three polyurethane and the ball spin rate after impact was measured. Also, the tensile oscillation test based on JIS K 7244-4 was conducted and the modulus of storage elasticity E' (Pa) at the frequency of 35 Hz was measured. The measurement results were already shown in Table 2. The frequency of 35Hz was calculated based on the natural frequency of the ball.

[0130] Next, E' (Pa) is taken in the horizontal axis and ball spin rate (rpm) in the vertical axis and the measurement values of Table 2 were plotted. The relation between these measurement values was shown as a graph of a linear function in FIG. 15.

[0131] The equation of the graph in FIG. 15 is as follows:

$$Y=2.211E\text{-}05x+727.9 \ (x\text{: abscissa; } y\text{: ordinate})$$

If y=950 then
$x \approx 1.0E+07$

[0132] It is found that the modulus of storage elasticity E' corresponding to the ball spin rate of 950 rpm after impact in the diagonal impact test is 1.0E+07 (Pa), i.e. 1.0×10^7 (Pa). Therefore, the modulus of storage elasticity E' corresponding to the ball spin rate of 950 rpm or less after impact in the diagonal impact test is 1.0×10^7 (Pa) or less. One of the materials that satisfy this condition is PU40A judging from FIG. 15. This also conforms to the graph of FIG. 14 in that the material whose modulus of storage elasticity E' at the frequency of 35 Hz is 1.0×10^7 (i.e. 1.0E+07) (Pa) or less is PU40A.

[0133] In addition, a lowmodulus of storage elasticity means being dynamically soft. Therefore, when the diagonal impact test is conducted with the material of a low modulus of storage elasticity, ball contact time at the diagonal impact onto the material becomes longer and thus the material imparts a shearing force to the ball at the diagonal impact of the ball in such a way to restrain the ball spin in the latter half of the ball rebound. To the contrary, as for the material of a higher modulus of storage elasticity, ball contact time at the diagonal impact onto the material becomes shorter and thus the material imparts a less shearing force to the ball at the diagonal impact of the ball in the latter half of the ball rebound. As a result, the ball spin rate after impact is not reduced.

[0134] In view of this, in this embodiment, the medial upper side region 40 of the upper 4 is formed of the material such that the modulus of storage elasticity is less than or equal to 1.0×10^7Pa when oscillation of 35 Hz is implied to the material and the front side region 4 5 of the upper 4 disposed in front of the medial upper side region 40 is formed of the material such that the modulus of storage elasticity is more than 1.0×10^7Pa when oscillation of 35 Hz is implied to the material.

[0135] Then, the relation between the modulus of storage elasticity and the ball contact time will be verified hereinafter.

[0136] When conducting the diagonal impact test with the above-mentioned three kinds of polyurethane (i.e. prior art; PU40A; and PU80A), the contact time of the ball with the material sheet, or time starting from immediately after ball contact with the material to immediately before the ball separation, was measured. The test was conducted eight times per each of the materials. The average value of the measured contact time is shown in Table 3.

TABLE 3

	PU40A	Prior Art	PU80A
Relative Contact Time	102.65	100.00	96.69

(continued)

	PU40A	Prior Art	PU80A
E'(Pa)	6818400	12868572	18872403

[0137] In Table 3, the relative contact time of PU40A and PU80A is shown when the contact time for prior art is 100.

[0138] Then, relative contact time was taken in the horizontal axis and the modulus of storage elasticity was taken in the vertical axis and the values of Table 3 were plotted in FIG. 16. A graph in FIG. 16 shows a correlation between these values as a linear function. As is clear from FIG. 16, as the modulus of storage elasticity lowers the ball contact time also decreases.

[0139] Next, the reason why the width of the top surface 40A of the soft polyurethane of the medial upper side region 40 in FIG. 4, or the length of the top surface 40A between the slit 41 and the through hole 42, is determined at 2mm or more is explained below:

[0140] As shown in FIG. 17, a panel model P made of polyurethane PU40A and having a plurality of protrusions with a width of t (mm) at an interval of 1.0 (mm) and a ball model B having a diameter of 220 (mm) were prepared and the simulation test was conducted on the same condition that the ball B actually impacts the panel model P. Then, the ball spin rate after impact was calculated by FEM (finite element method) analysis.

[0141] In this simulation test, the width t is changed from 1.0 to 5.0 (mm) at an interval of 1 (mm) and at each of the width t the ball spin rate after impact was calculated. The results of the calculations were shown in Table 4. In Table 4, the relative values (%) at the other widths were also shown with the value of the ball spin rate set at 100 at the width of 1.0 (mm).

TABLE 4

Width t (mm)	Ball Spin Rate (rpm)	%
1.0	674	100
2.0	580	86
3.0	566	84
4.0	576	85
5.0	583	86

[0142] The width t(mm) was taken in the horizontal axis and the ball spin rate(%) was taken in the vertical axis and the data in Table 4 were plotted in FIG. 18. As can be seen from FIG. 18, between the width of 1 (mm) and the widths of 2.0-5.0(mm) the value of ball spin rate is remarkably different. When the width is 2 (mm) or more, the ball spin rate is drastically decreased. Accordingly, the width of the top surface 40A of the soft polyurethane of the medial upper side region 40 is determined at 2 (mm) or more.

[0143] In the above-mentioned simulation test, total thickness D of the panel model P is 1-2mm, but as for the thickness of the base Pb of the panel model P it is verified that even if the thickness of the base Pb is changed the correlation of the ball spin rates is not changed.

[0144] Next, FIGS. 19 to 23 show a soccer shoe according to a second embodiment of the present invention. In these drawings, like reference numbers indicate identical or functionally similar elements.

[0145] As shown in FIGS. 19 to 21, an upper 4 of a soccer shoe 1' includes a medial upper side region 40' disposed at the upper position on the medial side region of the upper 4 and a front side region 45 disposed in front of the medial upper side region 40'. The medial upper side region 40' is a region for kicking a. minimal spin shot as with the medial upper side region 40 of the above-mentioned first embodiment. The medial upper side region.40' extends essentially in the longitudinal direction of the shoe 1' but in this embodiment it is fan-shaped. The medial upper side region 40', similar to the medial upper side region 40 of the above-mentioned first embodiment, extends from a position of a navicular bone NB to positions of a medial cuneiform bone MC and a middle cuneiform bone IC of the foot (see FIGS. 5 and 6).

[0146] The medial upper side region 40' is composed of the material such that when the above-mentioned diagonal impact test with the material is conducted the ball spin rate after impact is 950rpm or less. Alternatively, the medial upper side region 40' is composed of the material such that the modulus of storage elasticity is 1.0×10^7 (Pa) or less when the frequency of 35Hz is imparted to the material. As such material, for example, soft polyurethane with a hardness of 50 degrees of less, preferably 30 to 50 degrees, at Asker A scale is used.

[0147] As shown in FIG. 22, an enlarged view of the panel parts, and in FIG. 23, a sectional view of FIG. 22 taken along line XXIII-XXIII, the soft polyurethane at the medial upper side region 40' is provided on an interior member 4C disposed on the inner member 4B of the upper 4 at the cut-out portion 4a formed in the outer member 4A of the upper 4. The soft polyurethane of the medial upper side region 40' includes a plurality of elongated through holes 42' that extend inside of and along the periphery of the fan-shaped medial upper side region 40' and a plurality of grooves 41' that extend radially outwardly in a cross-shape from the center of the medial upper side region 40'.

[0148] The top surface 40A' of the soft polyurethane at the medial upper side region 40' projects upwardly from the surrounding outer member 4A. In other words, the top surface 40A' of the soft polyurethane at the medial upper side region 40' has a plurality of protrusions that extend essentially in the longitudinal direction of the shoe 1' and that project upwardly from the surrounding regions of the upper 4.

[0149] The width of the top surface 40A' of the soft polyurethane at the medial upper side region 40', that is, the length of the top surface 40A' disposed between the adjacent through holes 42' in FIG. 23 or the length of the top surface 40A' disposed between the adjacent through hole 42' and groove 41' is determined preferably at 2mm or more as with the above-mentioned first embodiment of the present invention. Also, by forming a plurality of grooves 41' and through holes 42' in the soft polyurethane, the medial upper side region 40' can be made lighter in weight and at the same time the medial upper side region 40' can follow the contour of the medial upper side region of the foot of the wearer.

[0150] On the other hand, the front side region 45 in front of the medial upper side region 40' is a region for kicking a spin shot such as a, curving shot, instep shot or the like and extending from the first metatarsus ME_1 to the first proximal phalanx PP_1 as with the above-mentioned first embodiment.

[0151] The front side region 45 of the upper 4 is formed of the material such that when the diagonal impact test with the material is conducted the ball spin rate after rebound is 950rpm or more. Alternatively, the front side region 45 is formed of the material such that the modulus of storage elasticity is greater than 1.0×10^7 (Pa) when the frequency of 35Hz is imparted to the material. As such material, for example, hard polyurethane with a hardness of more than 50A at Asker A scale is used.

[0152] The front side region 45 is, as shown in FIGS. 19 to 21, formed of a plurality of pieces of hard polyurethane 46 that are disposed separately on the upper 4. Each of the hard polyurethane 46 is provided at each of a plurality of cut-out portions 4a' and the upper surface of each of the hard polyurethane 46 projects upwardly from the surrounding outer member of the upper.

[0153] In this case as well, similar to the first embodiment, the spin properties of the ball after kick can be controlled and even the ordinary player can not only kick a minimal spin shot but also kick a spin shot such as a curving shot, instep shot or the like.

[0154] In the above-mentioned first and second embodiment, a soccer shoe was taken as an example for a preferred embodiment of the present invention, but the present invention is also applicable to other football shoes.

Claims

1. An upper structure for a football shoe (1, 1') composed of an upper (4) for receiving a foot of a shoe wearer, said upper (4) covering a medial side region, a lateral side region, an instep region, and a heel region of the foot, wherein upper material for covering a medial upper side region (40, 40') of said upper (4) disposed at an upper position of said medial side region of said upper (4) is formed of material (M) such that a ball speed (V_2) is less than or equal to 950 rpm immediately after rebound of a ball (B) when a diagonal impact test is conducted in which said ball (B) impacts said material (M) diagonally.

2. The upper structure according to claim 1, wherein said medial upper side region (40, 40') covers a navicular bone (NB), a medial cuneiform bone (MC) and a middle cuneiform bone (IC) of the foot.

3. The upper structure according to claim 2, wherein said medial upper side region (40, 40') extends substantially in a longitudinal direction of the shoe (1, 1').

4. The upper structure according to claim 1, wherein said upper material at said medial upper side region (40, 40') includes a plurality of protrusions extending substantially in a longitudinal direction of the shoe (1, 1'), said protrusions protrude upwardly from the surrounding upper regions.

5. The upper structure according to claim 1, wherein said diagonal impact test is conducted in such a way such that said ball (B) impacts said material (M) at a speed (V_1) of 23.0 to 25.0m/s, at a revolution of 0 to 25rpm and at an angle (α) of 29 to 33 degrees relative to a surface of said material (M) with said material (M) attached to a flat plate (HB).

6. The upper structure according to claim 1, wherein said upper material at said medial upper side region (40, 40') is formed of material of a low hardness of less than or equal to 50 degrees at Asker A scale.

7. The upper structure according to claim 6, wherein said low hardness of said upper material is 30 to 50 degrees at Asker A scale.

8. The upper structure according to claim 6 or 7, wherein said upper material of said low hardness is formed of soft polyurethane.

9. The upper structure according to claim 1, wherein upper material for covering a front side region (45) of the upper (4) disposed in front of said medial upper side region (40, 40’) is formed of material (M) such that a ball speed (V_2) is more than 950rpm immediately after rebound of a ball (B) when said diagonal impact test is conducted in which said ball (B) impacts said material (M) diagonally.

10. The upper structure according to claim 9, wherein said front side region (45) of said upper (4) covers a first metatarsus (ME_1) and a first proximal phalanx (PP_1) of the foot.

11. The upper structure according to claim 9, wherein said upper material for covering said front side region (45) of said upper (4) disposed in front of said medial upper side region (40, 40’) is formed of material of a hardness higher than a hardness of said upper material for covering said medial upper side region (40, 40’).

12. The upper structure according to claim 11, wherein said upper material of a higher hardness is formed of hard polyurethane.

13. The upper structure according to claim 1, wherein said upper material at said medial upper side region (40, 40’) is formed of material of a low modulus of storage elasticity.

14. The upper structure according to claim 13, wherein upper material for covering a front side region (45) of said upper (4) disposed in front of said medial upper side region (40, 40’) is formed of material of a higher modulus of storage elasticity than said upper material at said medial upper side region (40; 40’).

15. The upper structure according to claim 1, wherein said upper (4) is composed of an outside member (4A) disposed outside the shoe (1, 1’) and an inside member (4B) disposed inside the shoe (1, 1’), said outside member (4A) being cut-out along a periphery of said medial upper side region (40, 40’) and said upper material for covering said medial upper side region (40, 40’) being provided over said inside member (4B) at a cutout region of said outside member (4A).

16. The upper structure according to claim 15, wherein said upper material for covering said medial upper side region (40, 40’) protrudes upwardly from said outside member (4A) disposed around said medial upper side region (40, 40’).

17. An upper structure for a football shoe (1, 1’) composed of an upper (4) for receiving a foot of a shoe wearer, said upper (4) covering a medial side region, a lateral side region, an instep region, and a heel region of the foot, wherein upper materials for covering a medial upper side region (40, 40’) disposed at an upper position of said medial side region of said upper (4) is formed of material such that a modulus of storage elasticity is less than or equal to 1.0×10^7Pa when oscillation of 35 Hz is implied to said material.

18. The upper structure according to claim 17, wherein upper material for covering a front side region (45) disposed in front of said medial upper side region (40, 40’) is formed of material such that a modulus of storage elasticity is more than 1.0×10^7Pa when oscillation of 35 Hz is implied to said material.

19. The upper structure according to claim 17, wherein said upper material at said medial upper side region (40, 40’) is formed of material of a low hardness of 30 to 50 degrees at Asker A scale.

FIG. 1

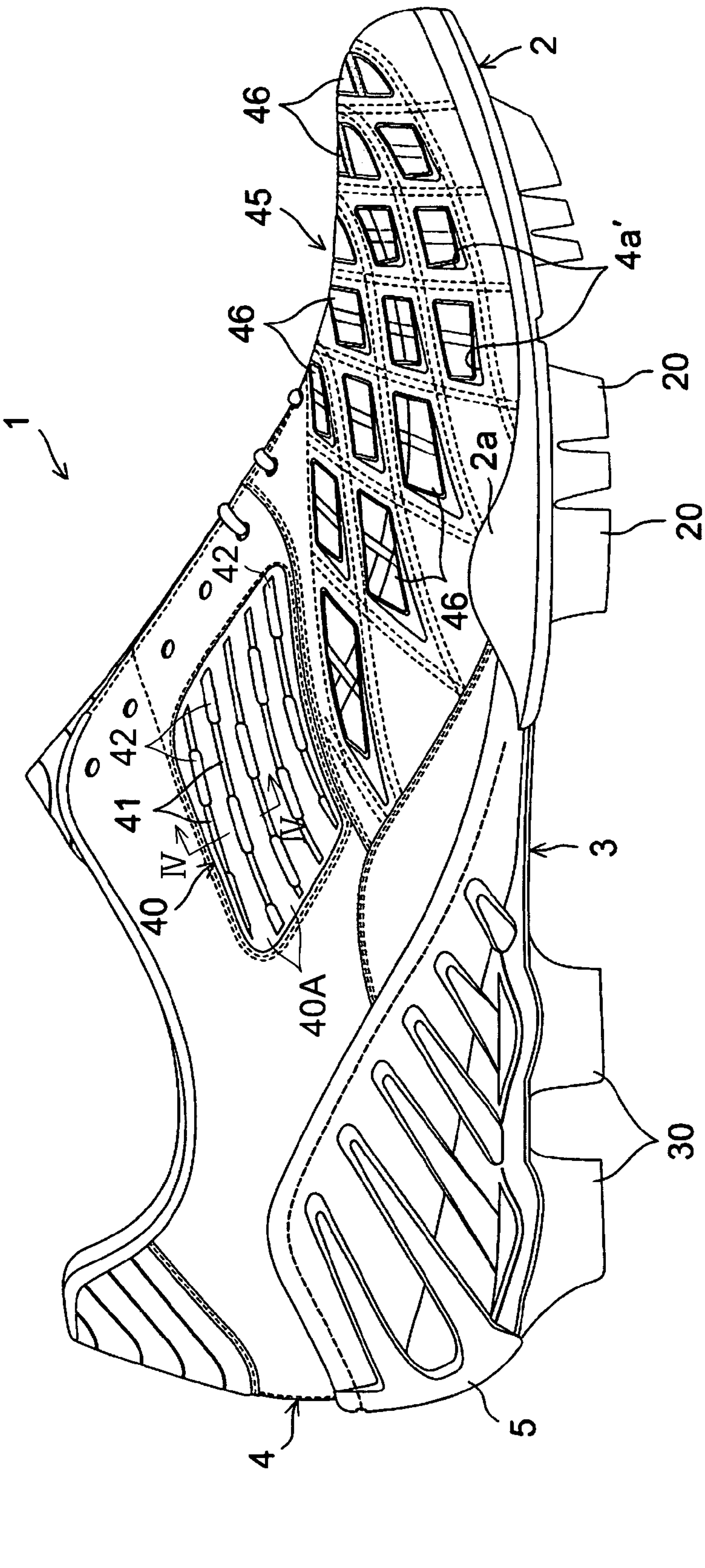


FIG. 2

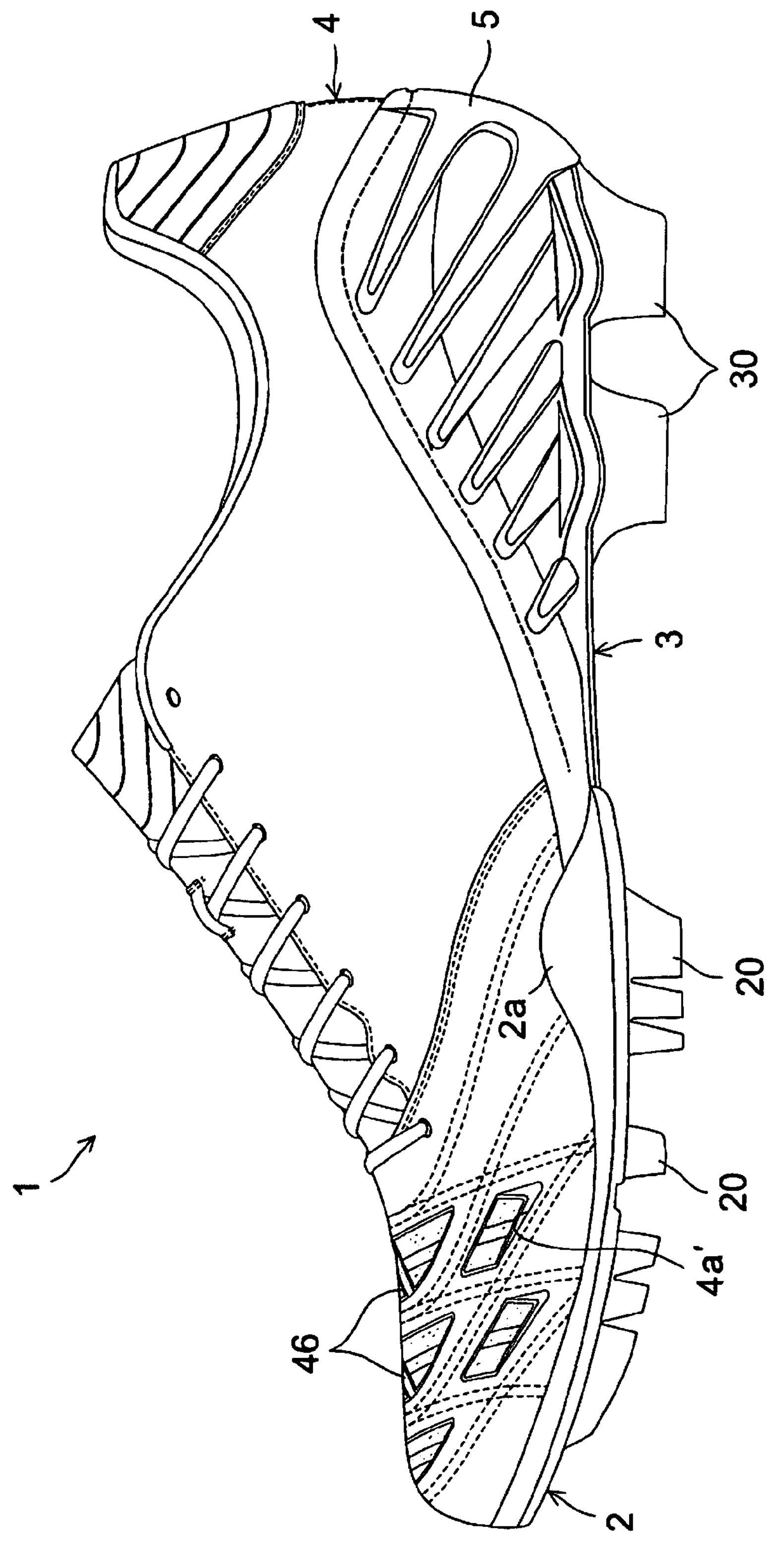


FIG. 3

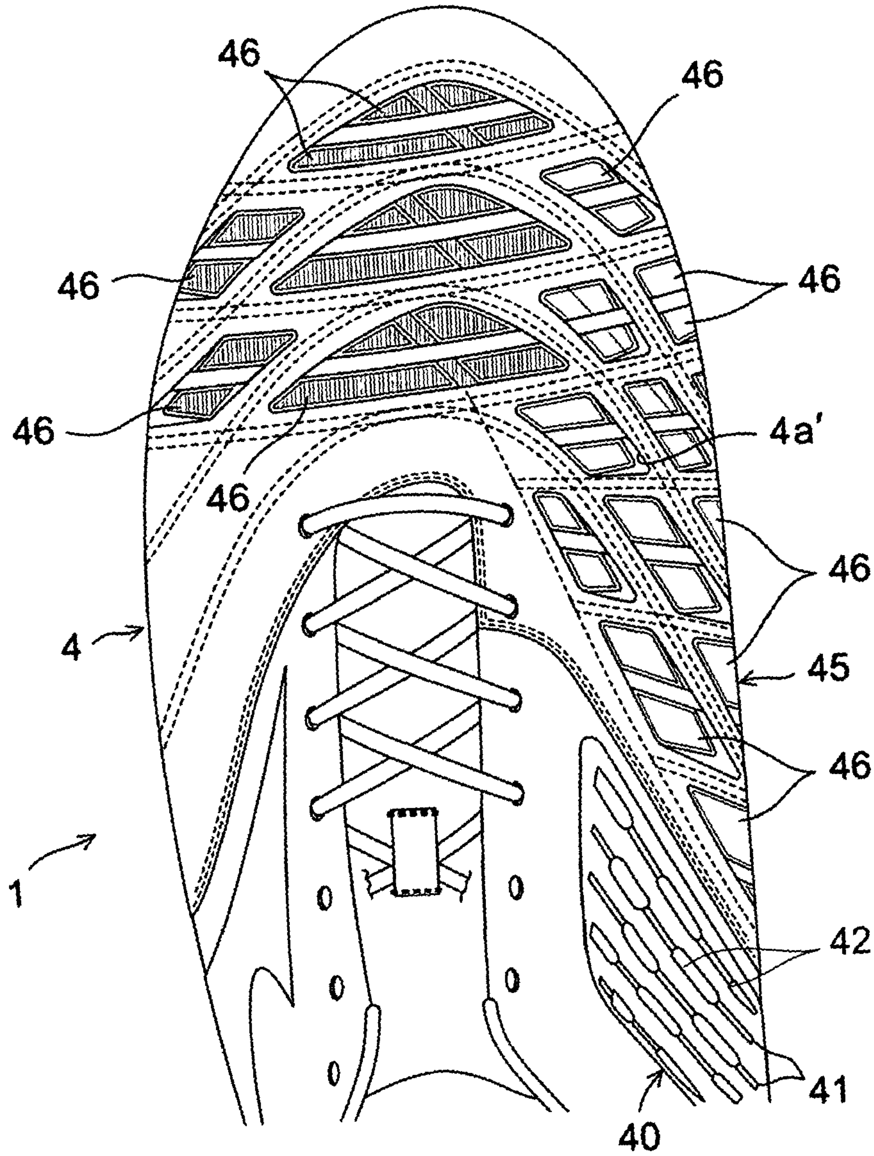


FIG. 4

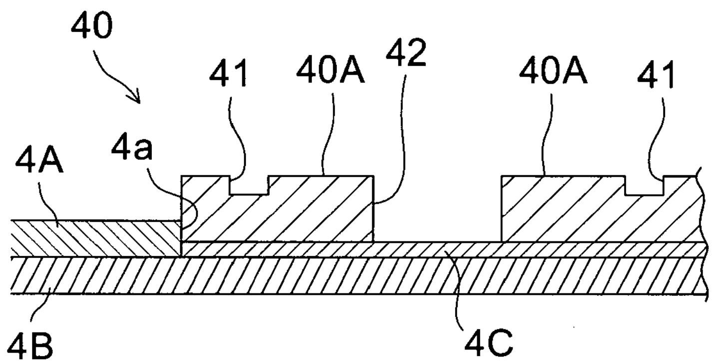


FIG. 5

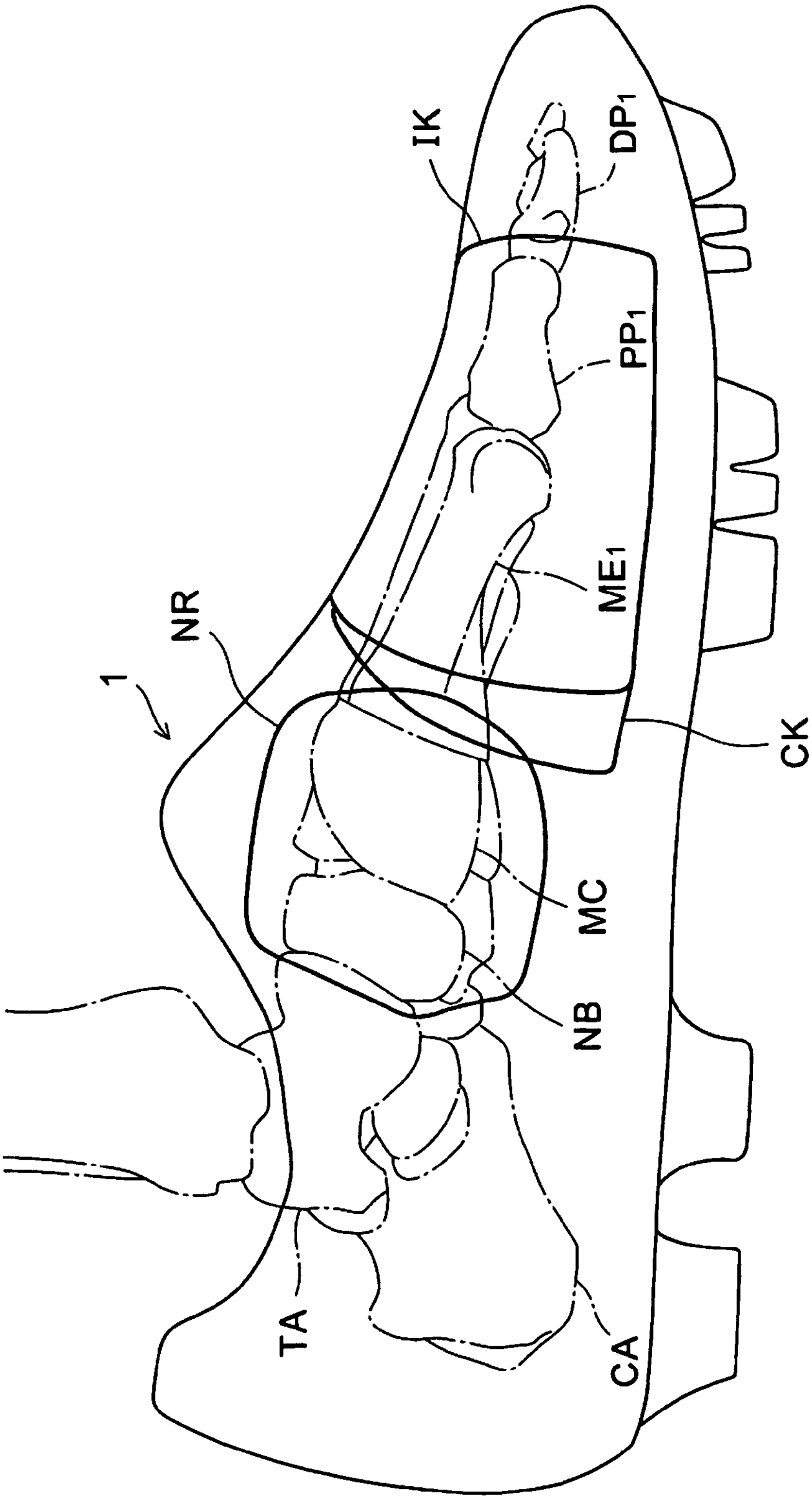


FIG. 6

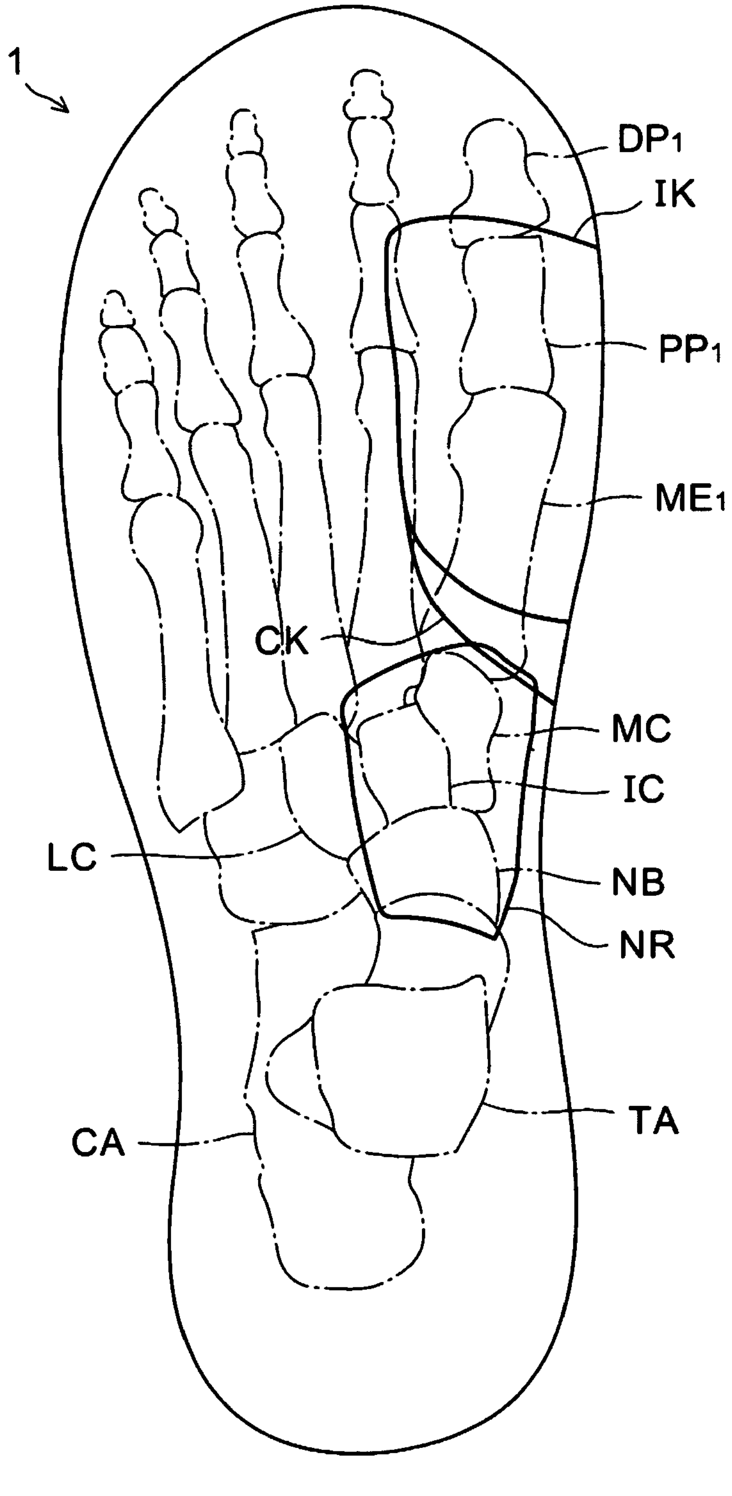


FIG. 7

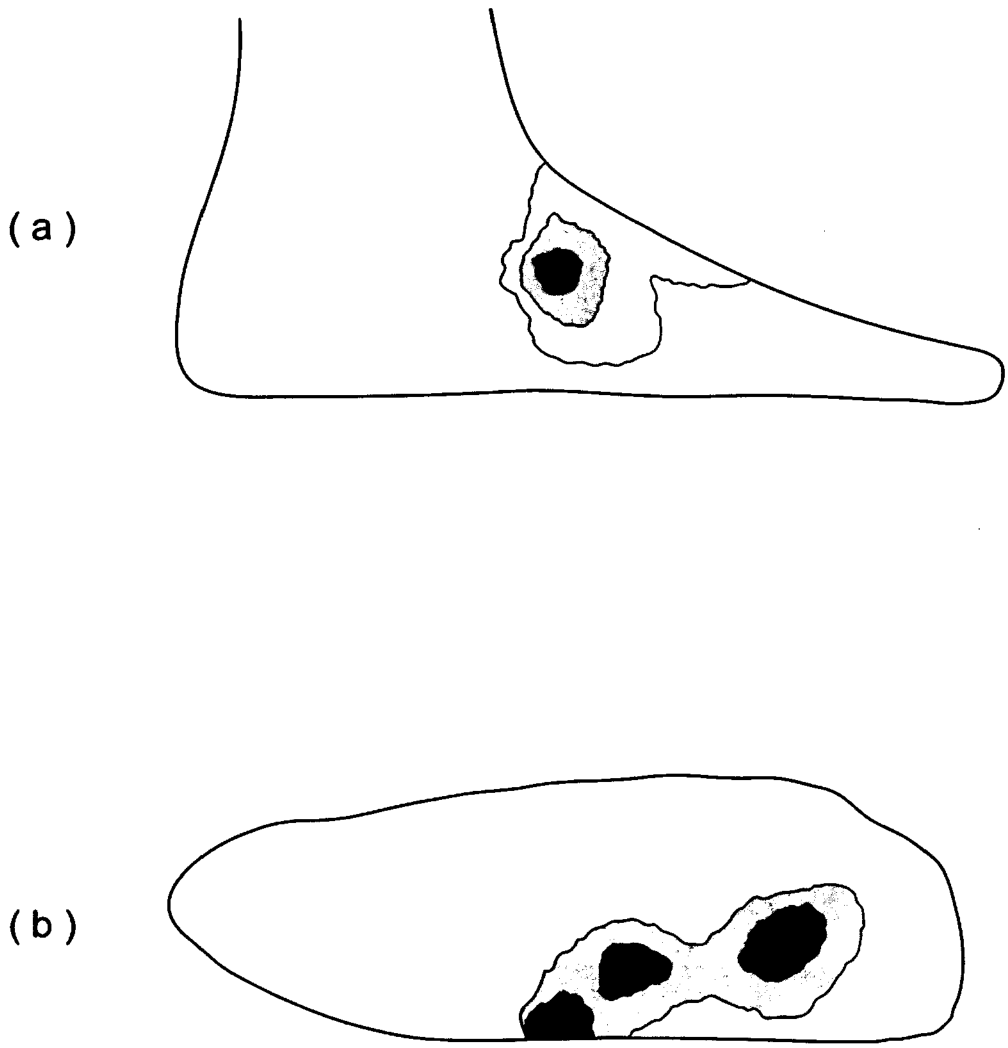


FIG. 8

(a)

(b)

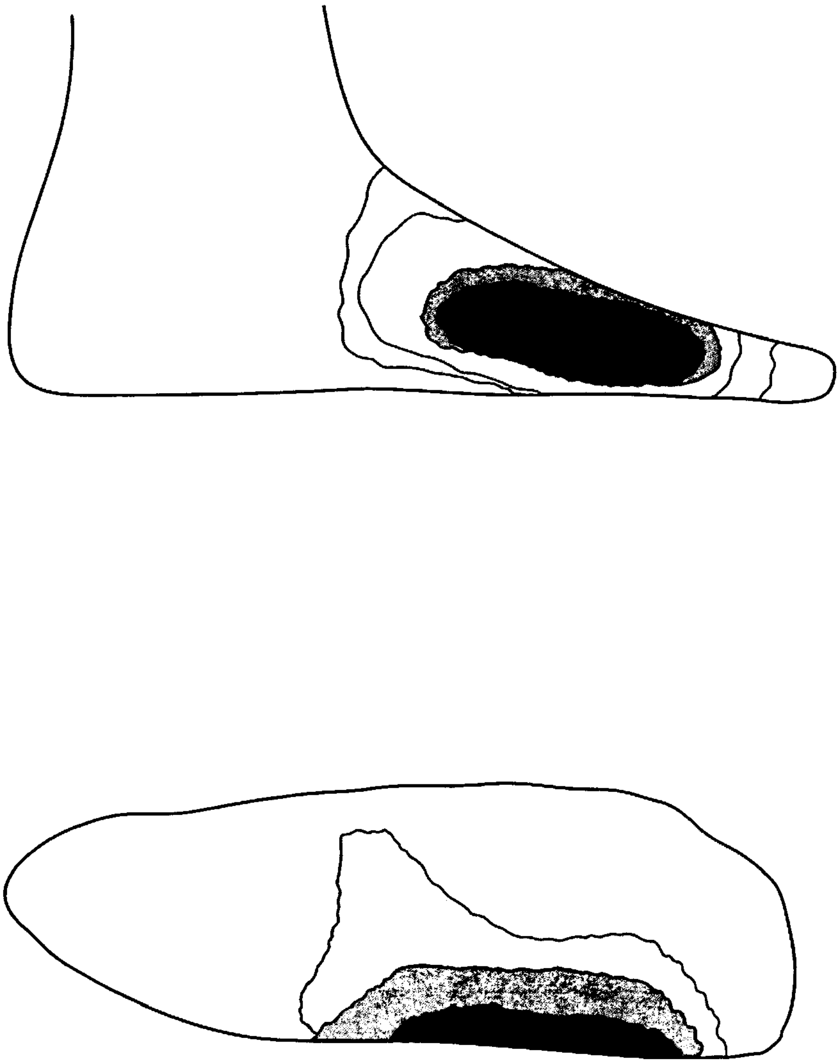
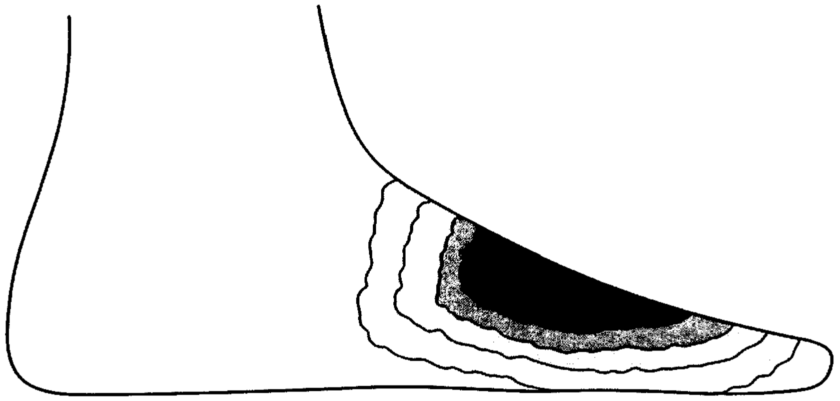


FIG. 9

(a)



(b)

FIG. 10

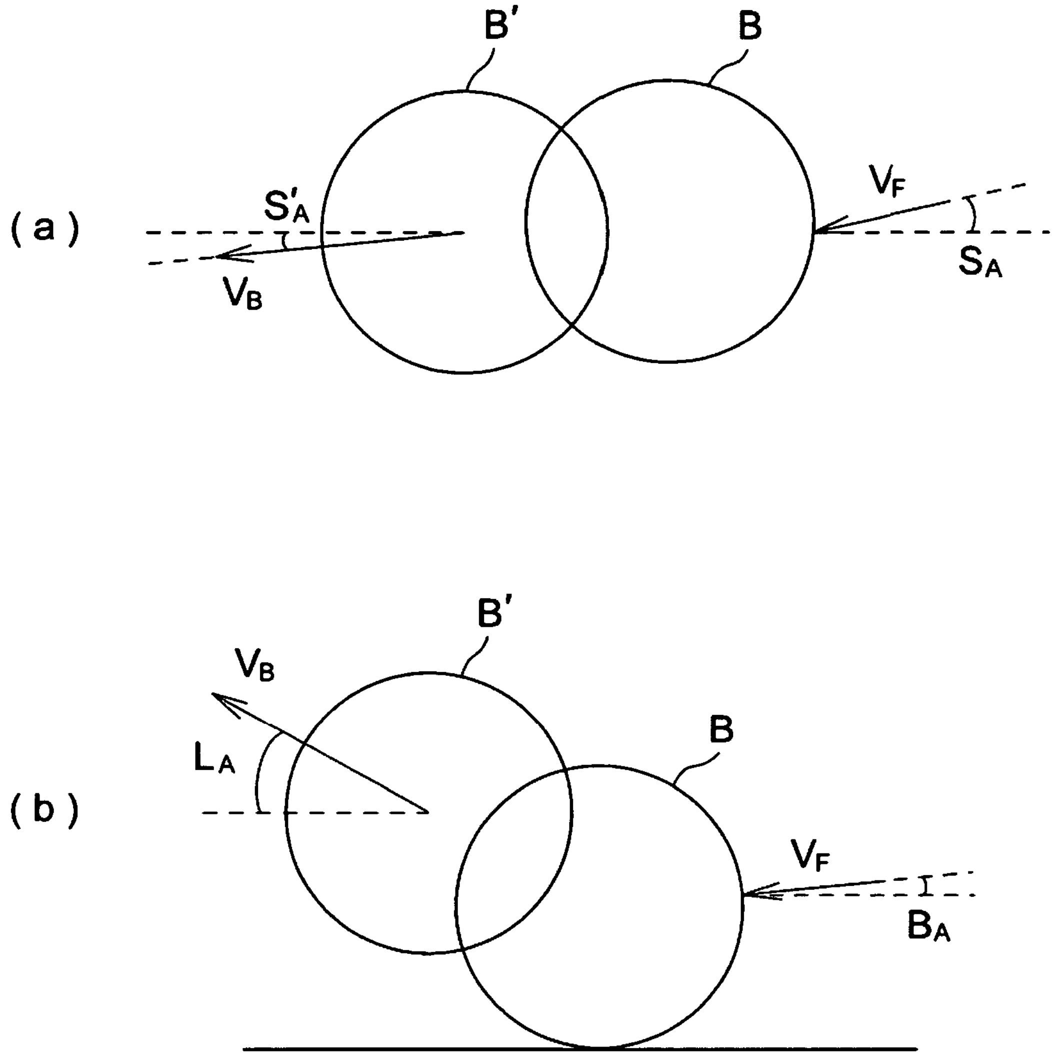


FIG. 10A

	Foot			Ball				minimal spin shot?
Trial	Velocity V_F (m/s)	Blow Angle B_A (deg)	Side Angle S_A (deg)	Velocity V_B (m/s)	Launch Angle L_A (deg)	Side Angle S_A' (deg)	Spin Rate R (rpm)	
1	22.6	-9.2	13.5	27.1	11.3	5.3	99.9	Yes
2	22.0	-10.9	14.4	29.1	13.1	3.0	47.8	Yes
3	21.6	-11.1	13.7	29.4	12.6	2.2	77.1	Yes
4	18.5	-8.2	11.0	23.0	15.5	-5.2	131.8	No
5	19.1	-8.3	14.1	21.3	20.0	2.7	152.0	No
6				24.0			103.1	Yes
7				24.6			111.0	Yes
8				22.1			128.6	No
9				22.3			133.2	No
10				23.9			134.2	No
11				23.7			154.5	No

FIG. 11

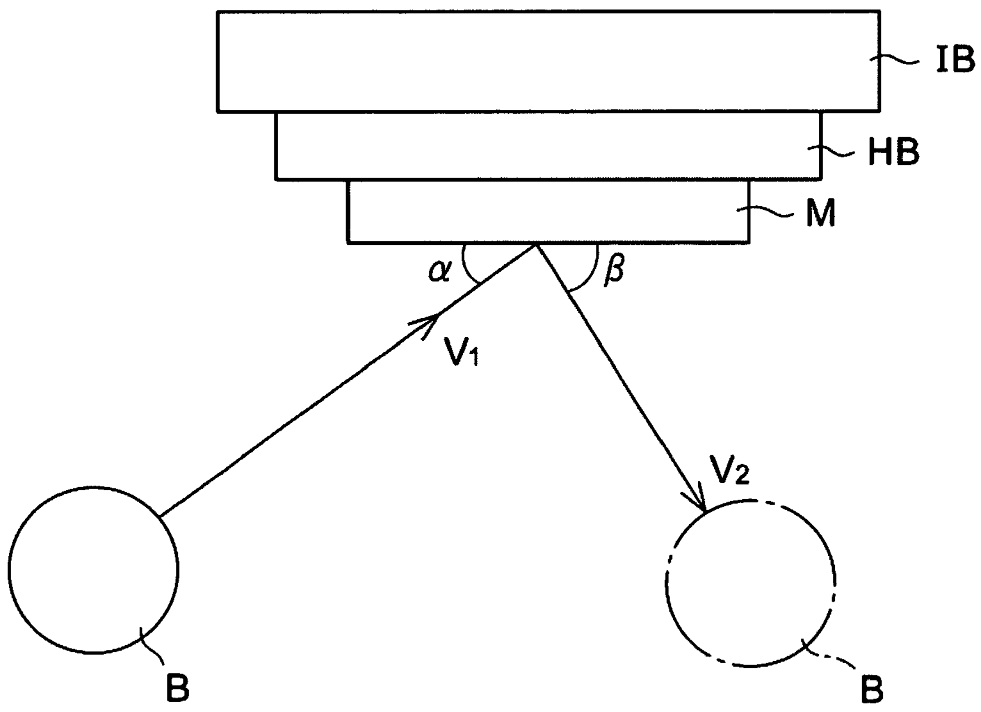


FIG. 12

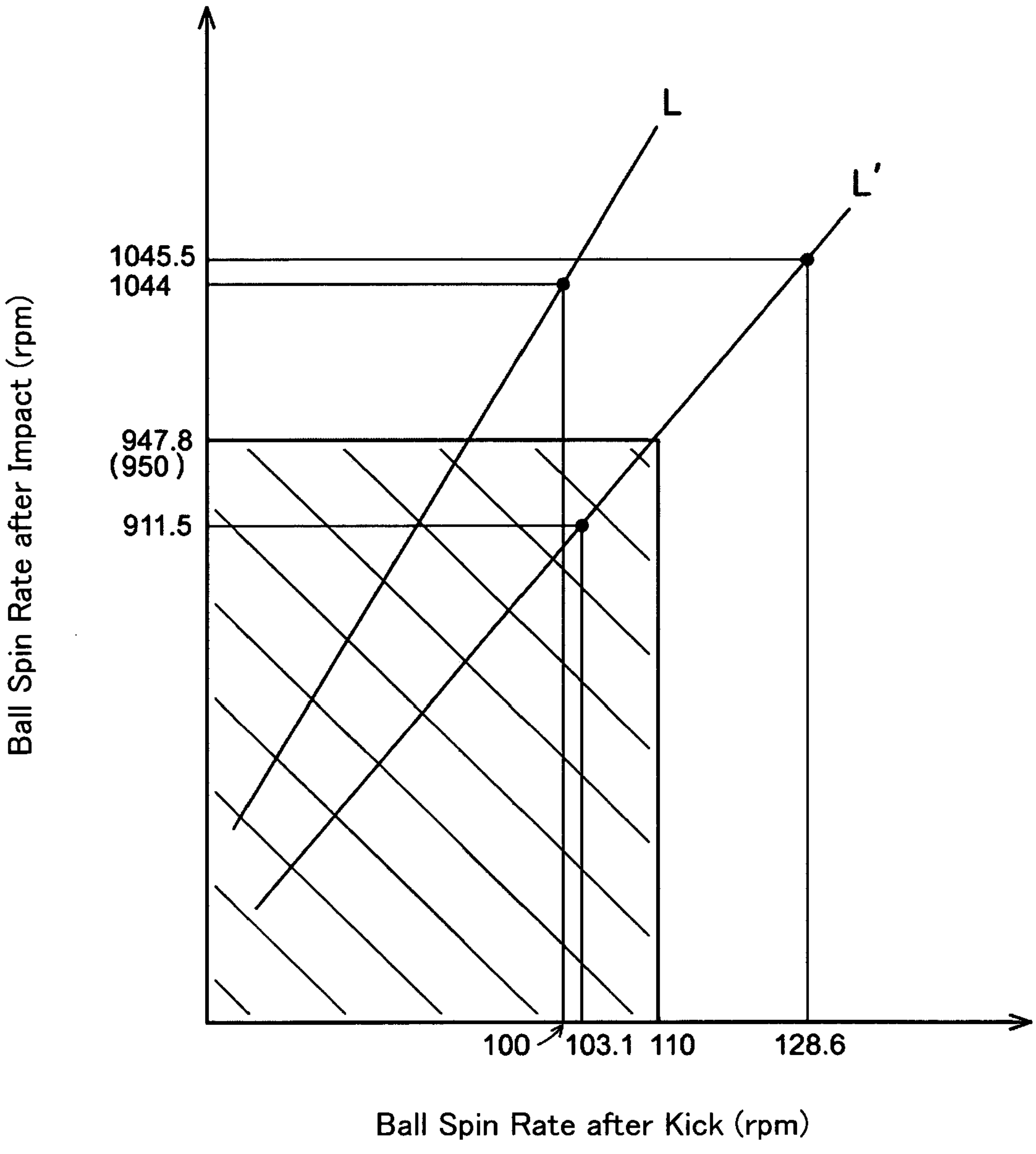

L
L'
1045.5
1044
947.8
(950)
911.5
Ball Spin Rate after Impact (rpm)
100
103.1
110
128.6
Ball Spin Rate after Kick (rpm)

FIG. 13

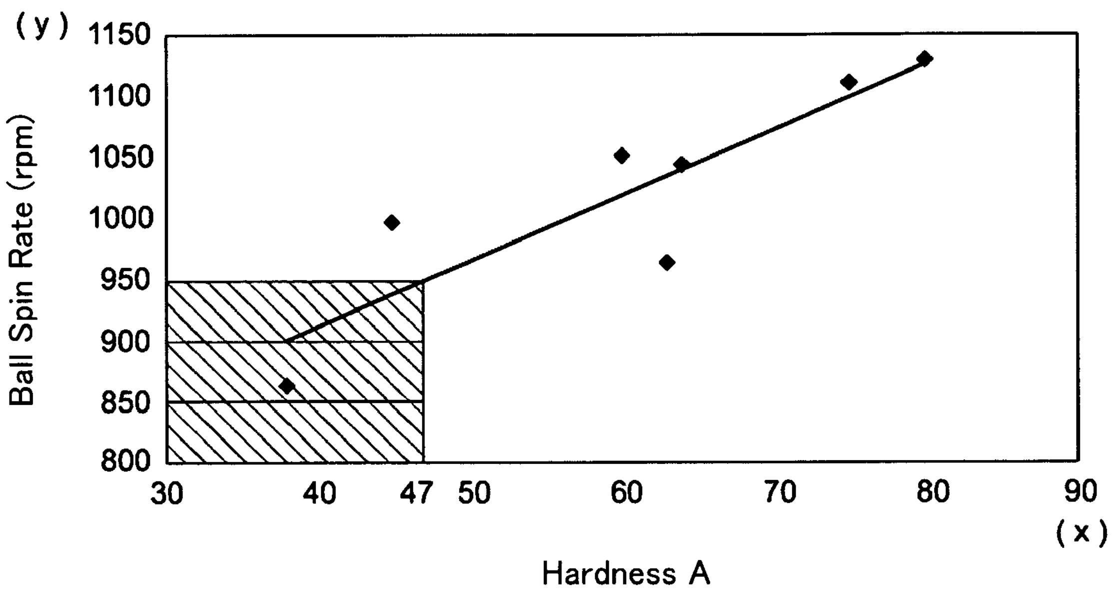

(y)
1150
1100
1050
1000
950
900
850
800
Ball Spin Rate (rpm)
30
40
47
50
60
70
80
90
(x)
Hardness A

FIG. 14

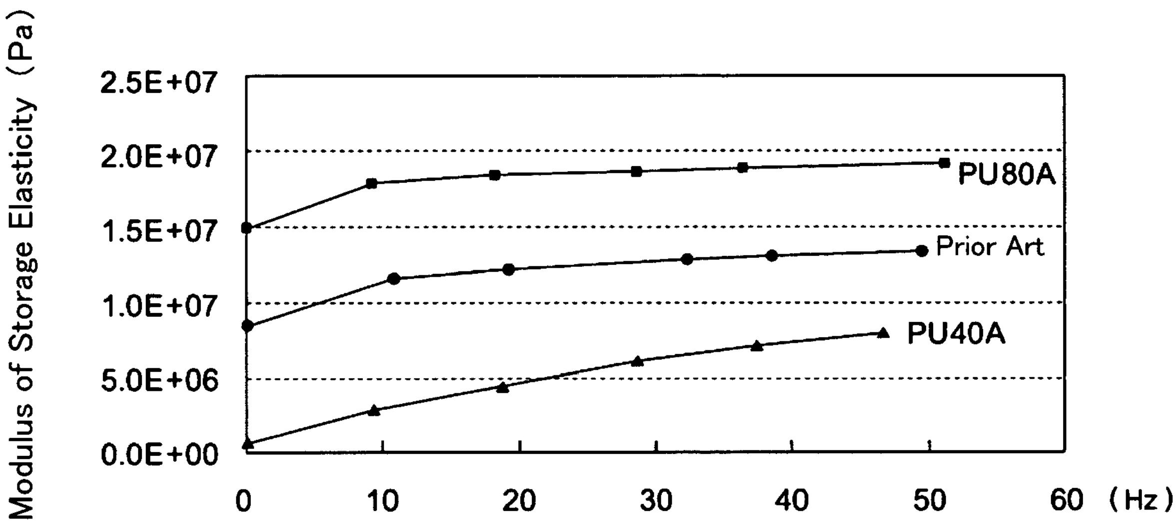

Modulus of Storage Elasticity (Pa)
2.5E+07
2.0E+07
1.5E+07
1.0E+07
5.0E+06
0.0E+00
0
10
20
30
40
50
60 (Hz)
PU80A
Prior Art
PU40A

FIG. 15

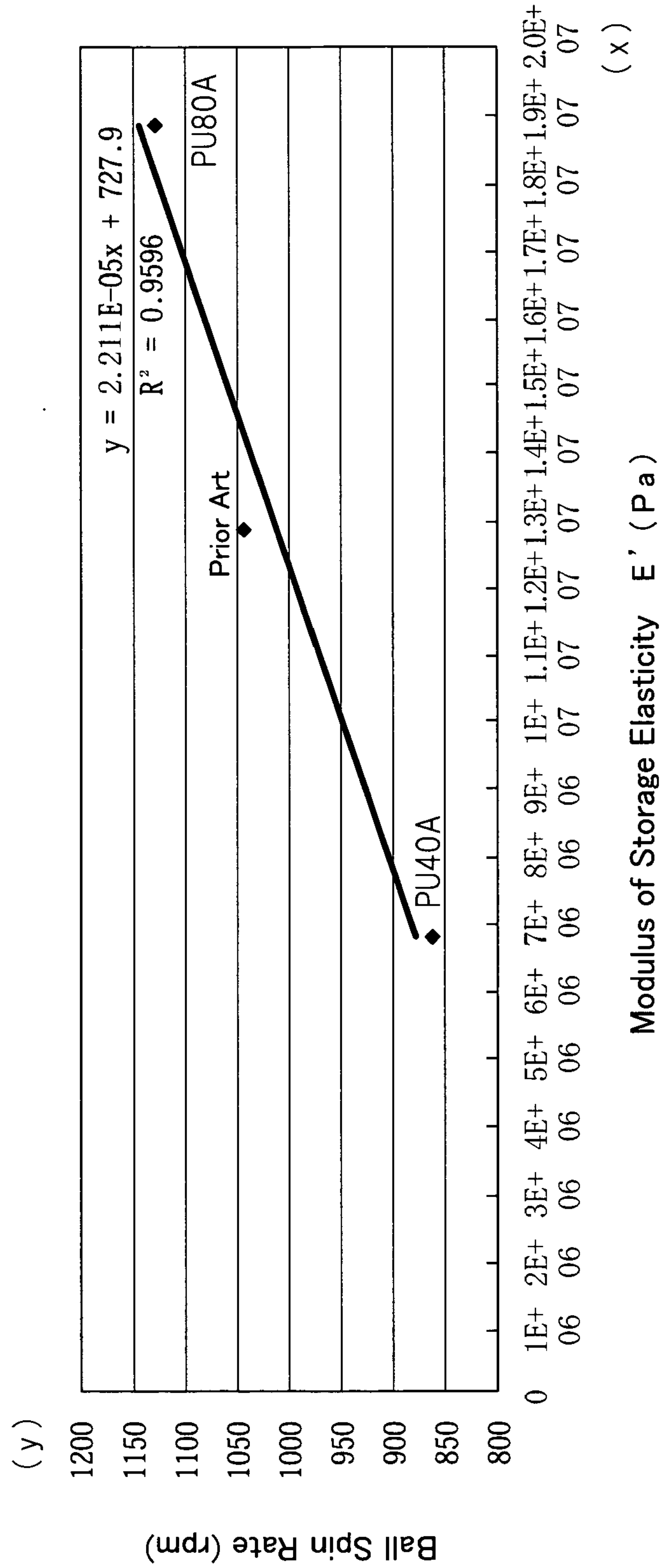
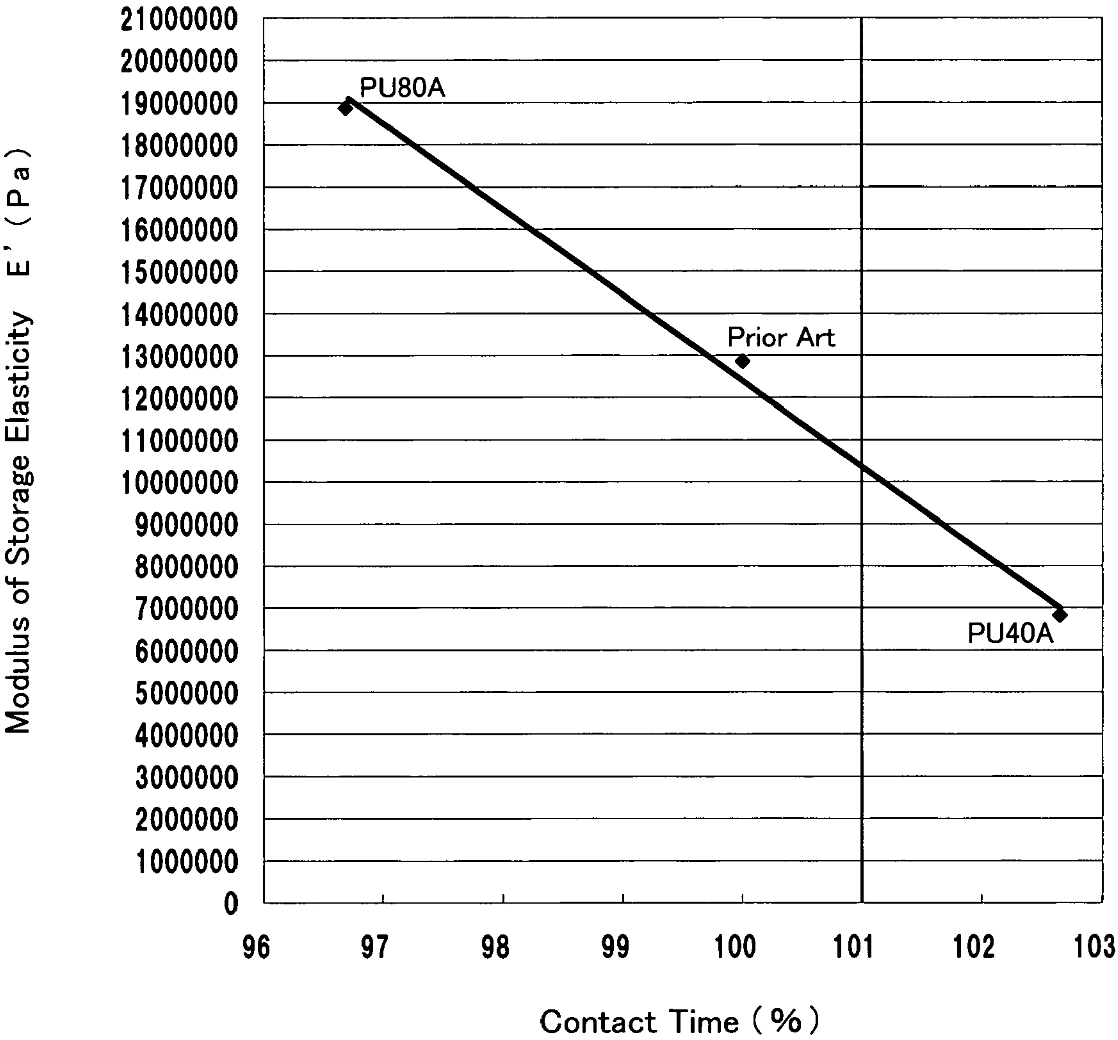

y = 2.211E-05x + 727.9
R² = 0.9596
PU80A
Prior Art
PU40A
Ball Spin Rate (rpm)
(y)
1200
1150
1100
1050
1000
950
900
850
800
0
1E+06
2E+06
3E+06
4E+06
5E+06
6E+06
7E+06
8E+06
9E+06
1E+07
1.1E+07
1.2E+07
1.3E+07
1.4E+07
1.5E+07
1.6E+07
1.7E+07
1.8E+07
1.9E+07
2.0E+07
(x)
Modulus of Storage Elasticity E' (Pa)

FIG. 16



Modulus of Storage Elasticity E'（Pa）
21000000
20000000
19000000
18000000
17000000
16000000
15000000
14000000
13000000
12000000
11000000
10000000
9000000
8000000
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
PU80A
Prior Art
PU40A
96
97
98
99
100
101
102
103
Contact Time（%）

FIG. 17

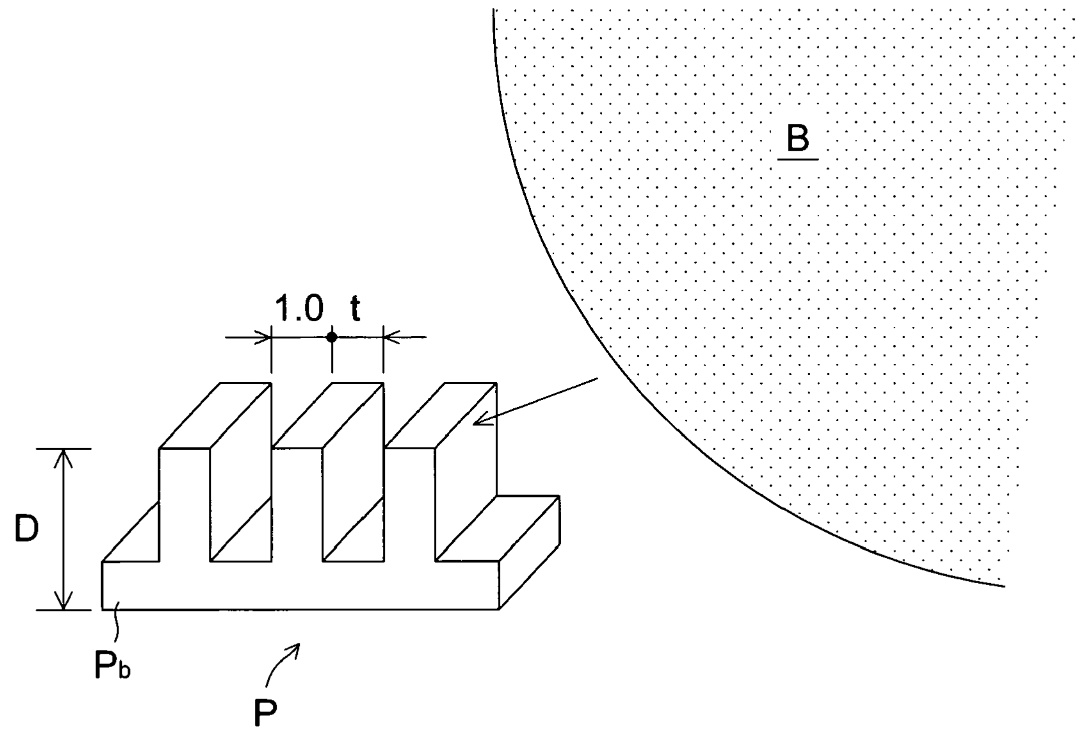


FIG. 18

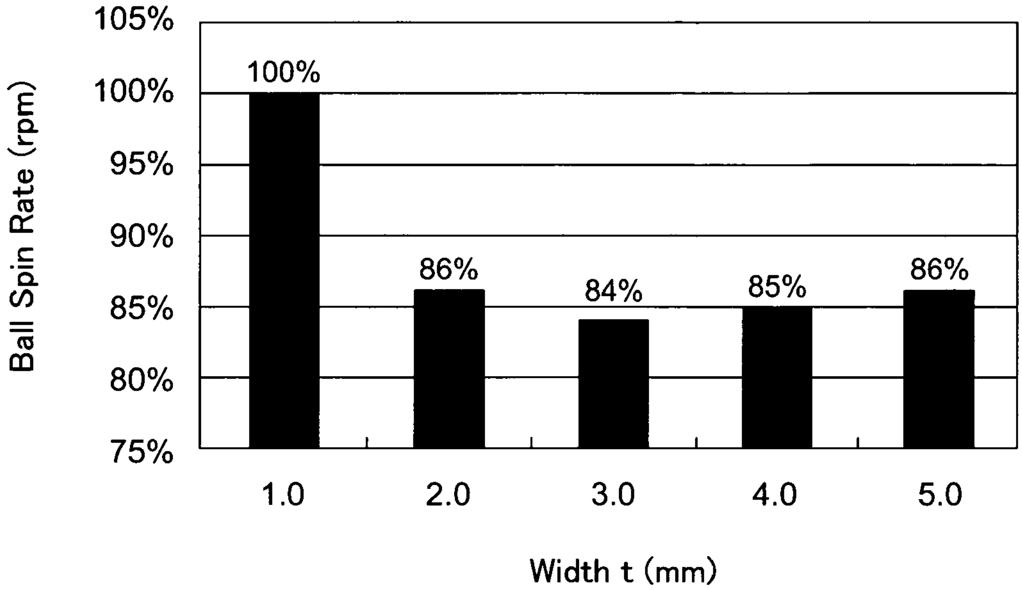

105%
100%
95%
90%
85%
80%
75%
Ball Spin Rate (rpm)
100%
86%
84%
85%
86%
1.0
2.0
3.0
4.0
5.0
Width t (mm)

FIG. 19

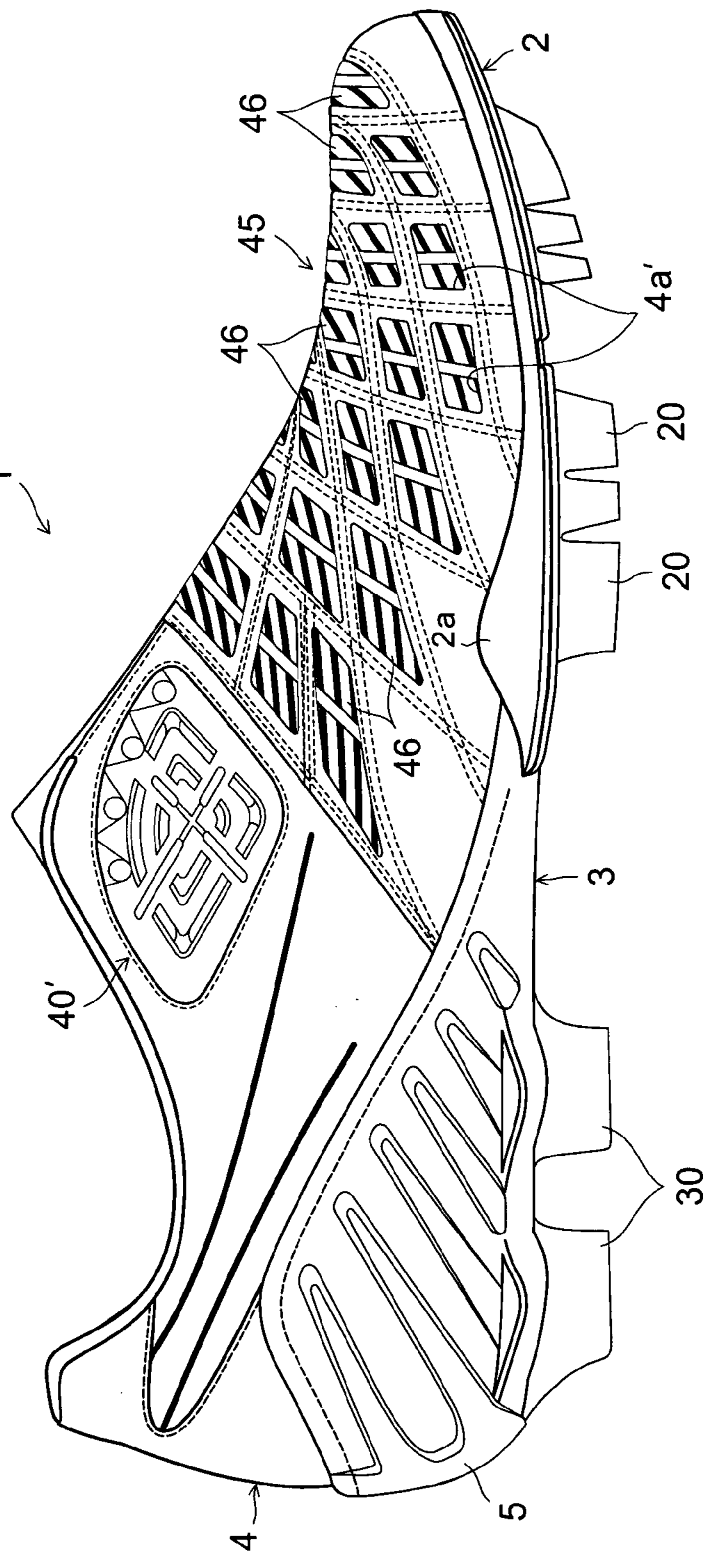


FIG. 20

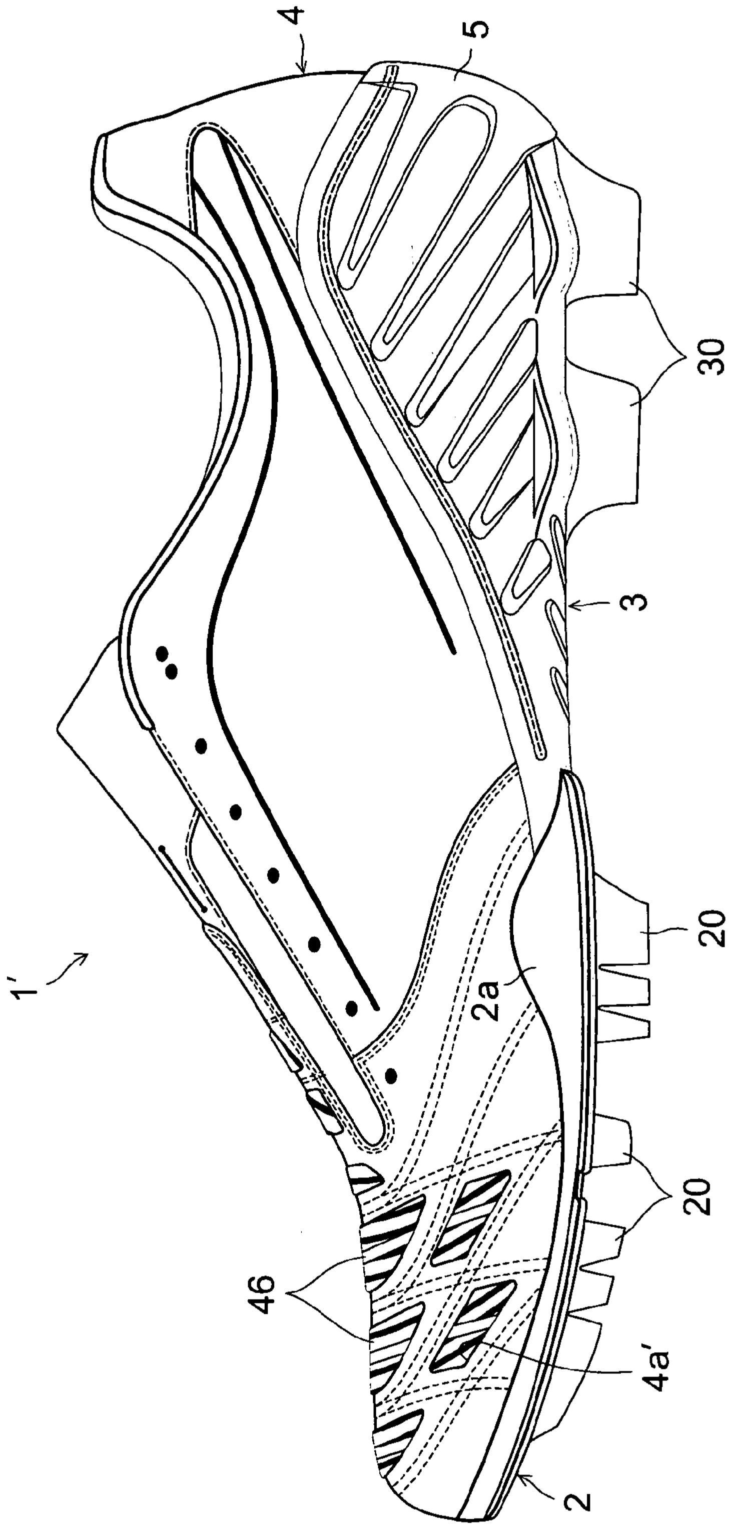


FIG. 21

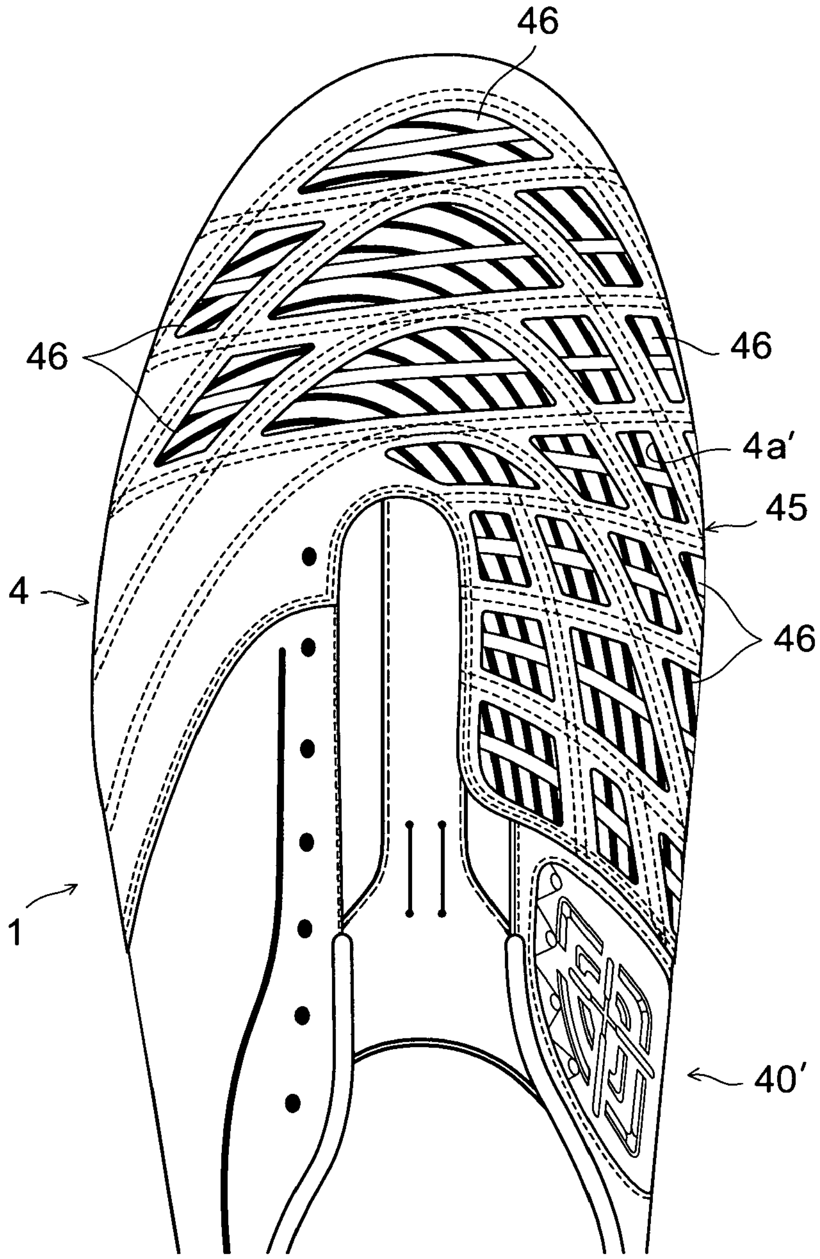


FIG. 22

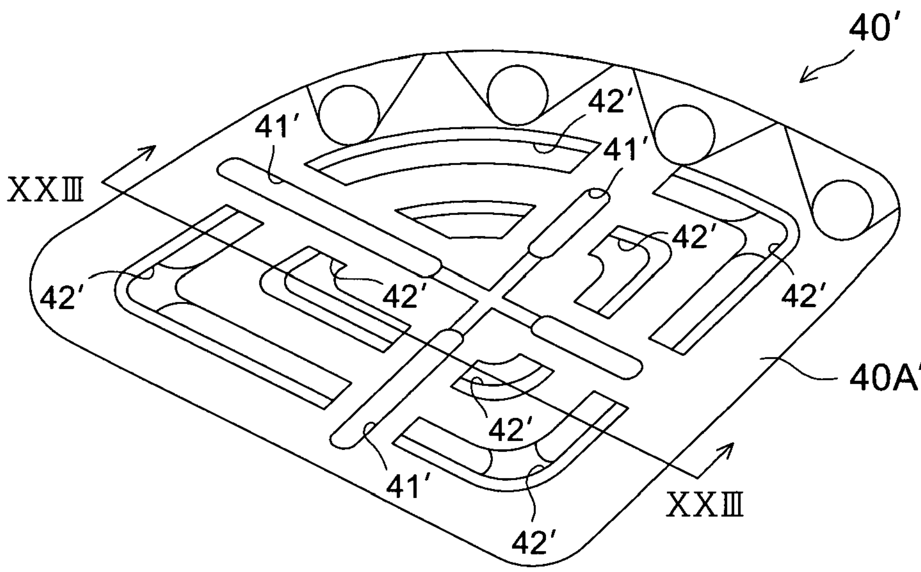
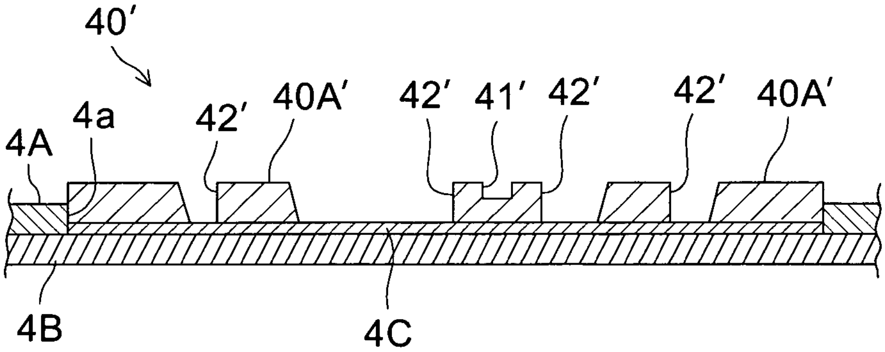

40′
42′
41′
41′
XXIII
42′
42′
42′
42′
40A′
42′
41′
XXIII
42′

FIG. 23


40′
4a
42′
40A′
42′
41′
42′
42′
40A′
4A
4B
4C

Europäisches Patentamt
European Patent Office
Office européen des brevets

PARTIAL EUROPEAN SEARCH REPORT

under Rule 62a and/or 63 of the European Patent Convention.
This report shall be considered, for the purposes of subsequent proceedings, as the European search report

Application Number
EP 10 25 1638

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 6 523 282 B1 (JOHNSTON CRAIG [GB]) 25 February 2003 (2003-02-25) * paragraphs [0033] - [0037]; figures *	2-4,6-8, 10-14, 17,19	INV. A43B23/00 A43B5/02
X	US 2006/174520 A1 (WU CHI-KUNG [TW]) 10 August 2006 (2006-08-10) * paragraphs [0013] - [0015]; figures *	2-4,6-8, 10,13, 17,19	
X	GB 2 259 639 A (QUASERSPORT LIMITED [GB]) 24 March 1993 (1993-03-24) * the whole document *	2-4,6-8, 10-14, 17,19	
A	WO 02/054898 A1 (LEE DAEHEE [KR]; KANG SAEYOUNG [KR]) 18 July 2002 (2002-07-18) * the whole document *	17	
A	WO 01/78540 A1 (DAVIS IAIN [GB]) 25 October 2001 (2001-10-25) * the whole document *	17	

TECHNICAL FIELDS SEARCHED (IPC)

A43B

INCOMPLETE SEARCH

The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC so that only a partial search (R.62a, 63) has been carried out.

Claims searched completely :

Claims searched incompletely :

Claims not searched :

Reason for the limitation of the search:

see sheet C

1

Place of search	Date of completion of the search	Examiner
The Hague	13 May 2011	Cianci, Sabino

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04E07)

Europäisches Patentamt
European Patent Office
Office européen des brevets

INCOMPLETE SEARCH SHEET C

Application Number
EP 10 25 1638

Claim(s) completely searchable:
2-4, 6-8, 10-19

Claim(s) not searched:
1, 5, 9

Reason for the limitation of the search:

Claims 1, 5, 9 do not contain any technical feature of the invention, as they merely disclose the results of experimental tests.
As a consequence the subject-matter of claims 1, 5, 9 has not been searched.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 25 1638

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

13-05-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6523282 B1	25-02-2003	US 2004088888 A1	13-05-2004
US 2006174520 A1	10-08-2006	NONE	
GB 2259639 A	24-03-1993	AU 2572792 A	27-04-1993
		WO 9305673 A1	01-04-1993
WO 02054898 A1	18-07-2002	AT 443458 T	15-10-2009
		BR 0109168 A	10-12-2002
		CN 1416325 A	07-05-2003
		EP 1359819 A1	12-11-2003
		JP 2004520113 T	08-07-2004
		KR 20010025630 A	06-04-2001
		KR 20020061101 A	22-07-2002
		US 2004055183 A1	25-03-2004
WO 0178540 A1	25-10-2001	AT 260579 T	15-03-2004
		AU 4856601 A	30-10-2001
		DE 60102225 D1	08-04-2004
		DE 60102225 T2	17-03-2005
		EP 1276398 A1	22-01-2003
		ES 2217135 T3	01-11-2004
		GB 2361406 A	24-10-2001
		PT 1276398 E	31-08-2004
		US 2003167658 A1	11-09-2003

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 8332101 A **[0003] [0007]**
- JP 9028412 A **[0003] [0007]**
- JP 2004520113 A **[0003] [0007]**
- JP 10501725 A **[0004] [0007]**
- JP 2007509655 A **[0005] [0007]**
- JP 2001523499 A **[0006] [0007]**