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(54) **SPORTS SHOE**

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(57) **ABSTRACT**

A shoe designed to cooperate with an apparatus through a pedaling action, the shoe including a base extending lengthwise from a rear end to a front end, widthwise between a lateral side and a medial side, and depthwise between a surface for cooperating with the apparatus and an inner surface, the base having, from the rear end to the front end, a rear zone, a central zone, a metatarsal zone, and a front zone, the shoe including a lateral wall and a medial wall. The lateral wall and the medial wall are affixed directly to the base, and the base, the lateral wall, and the medial wall are rigid subdivisions of the shoe.

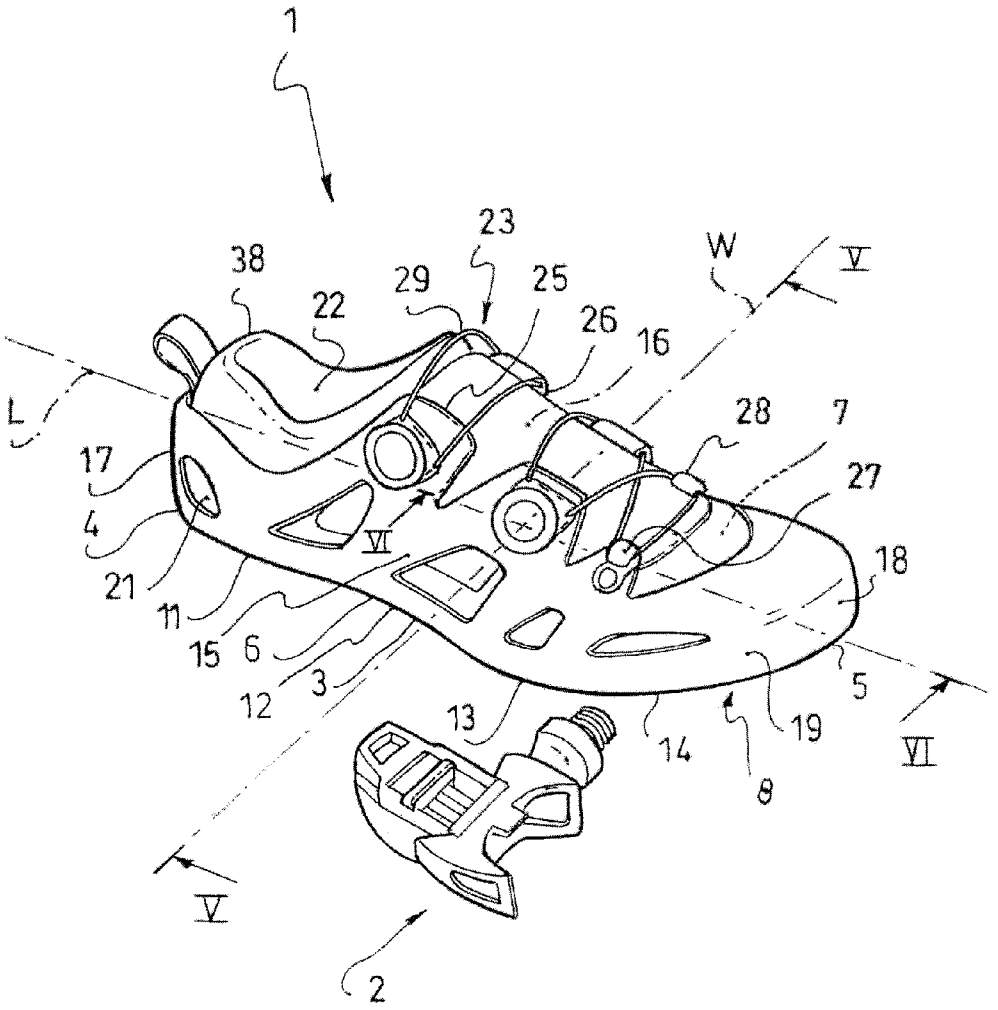
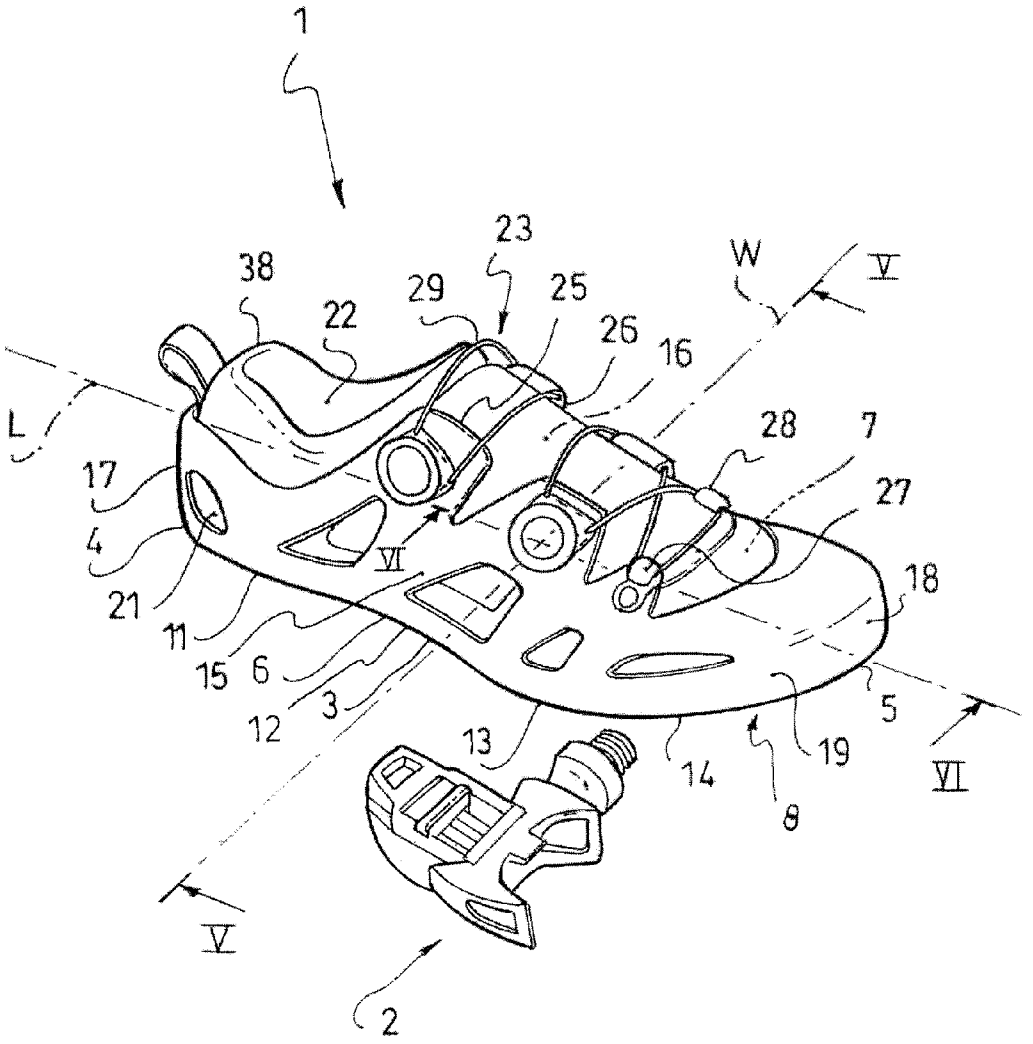


Fig. 1


1
23
38
W
V
29
25
22
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16
L
28
7
17
27
4
VI
18
21
11
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6
3
12
13
14
19
5
VI
8
V
2

Fig. 2

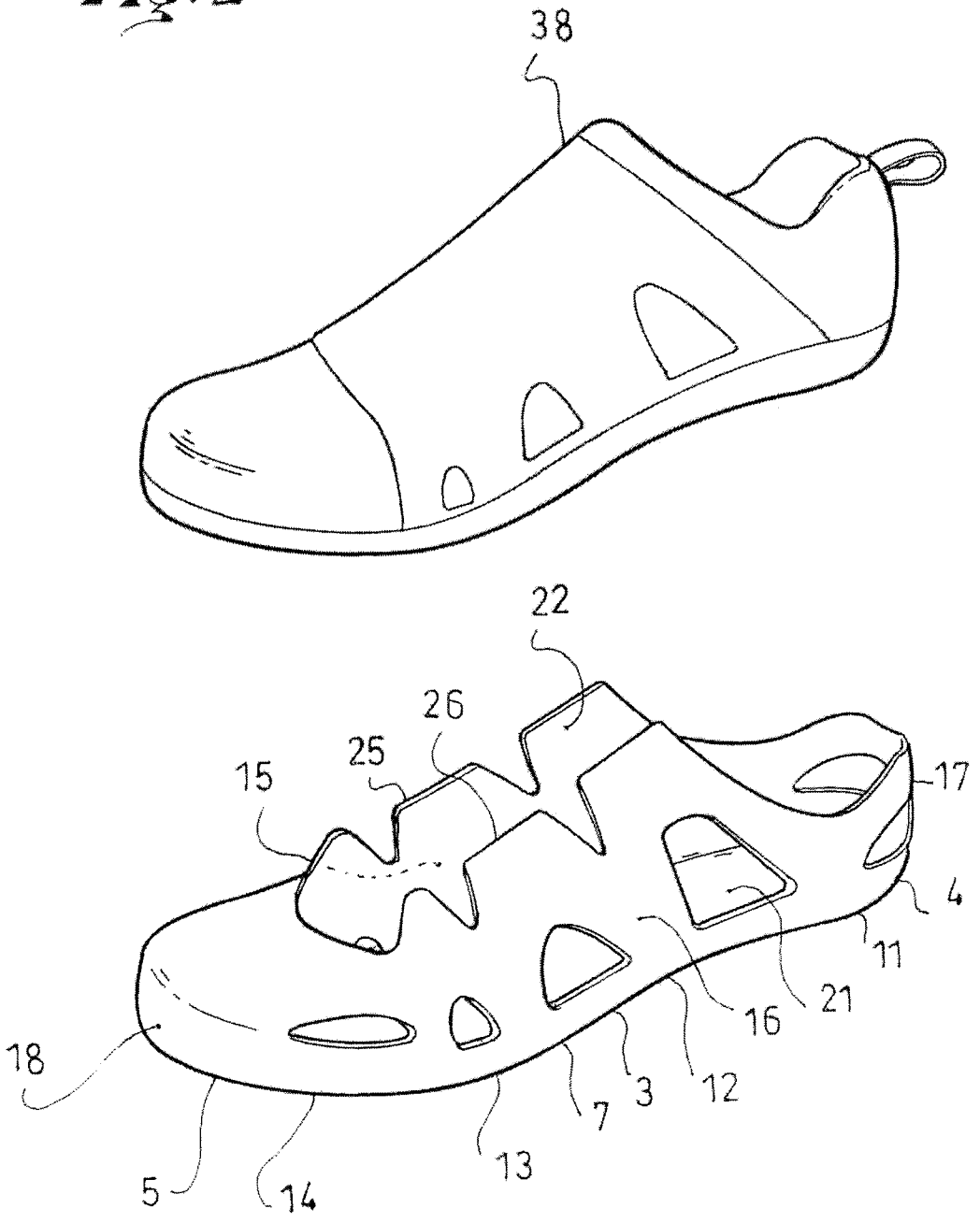


Fig. 3

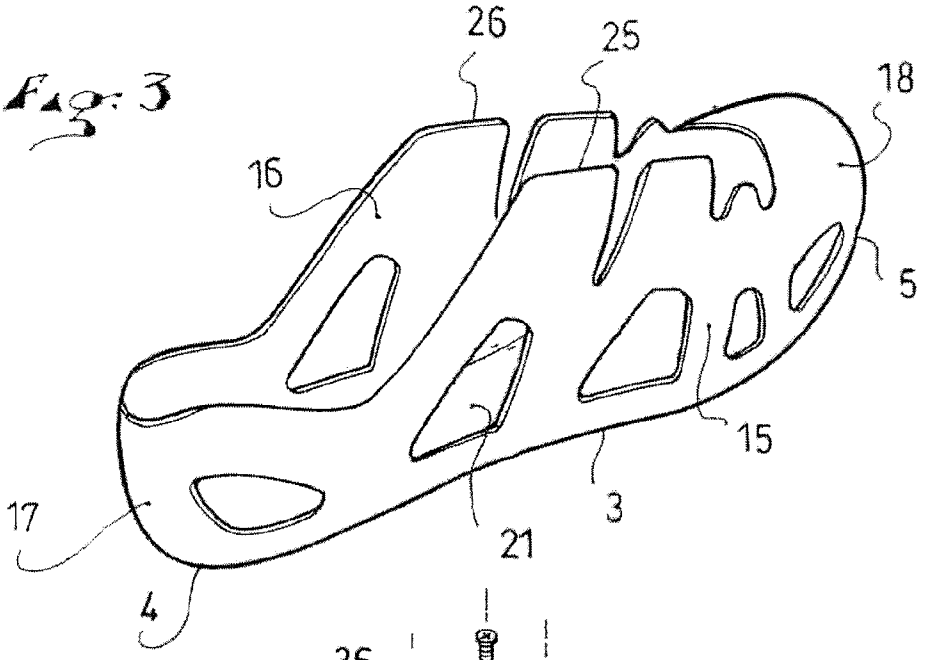
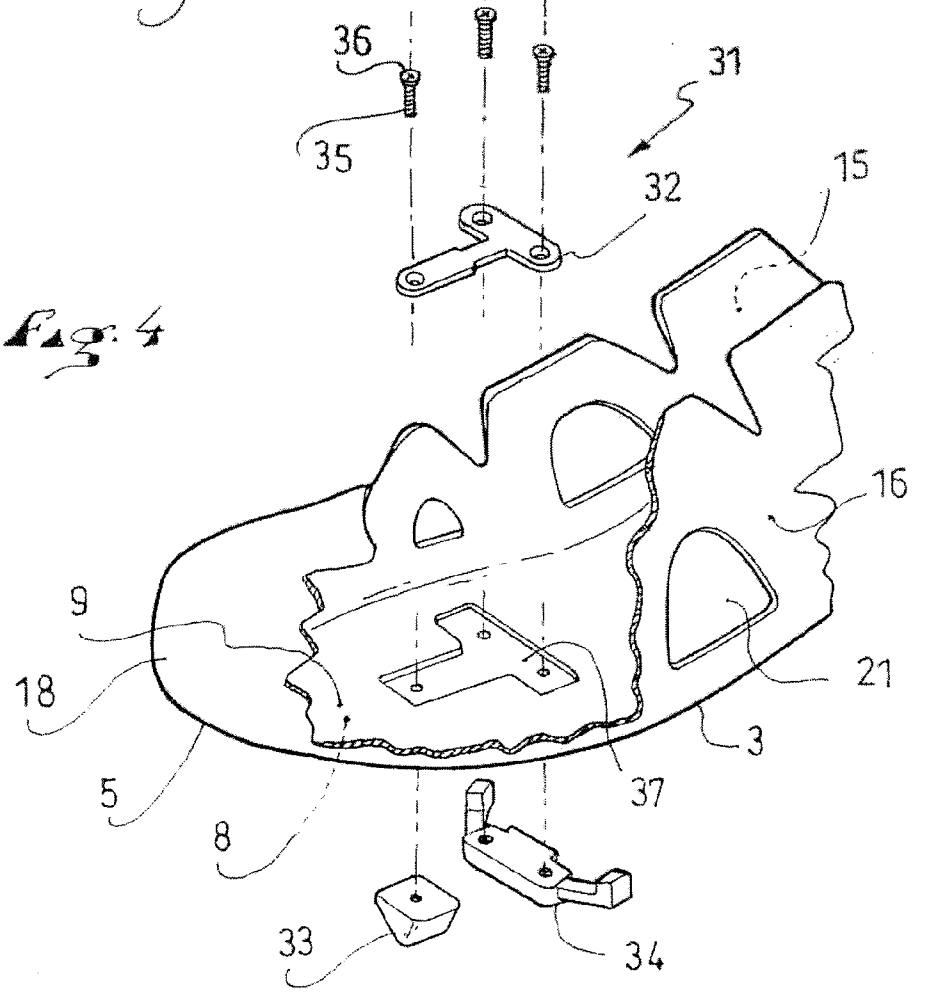
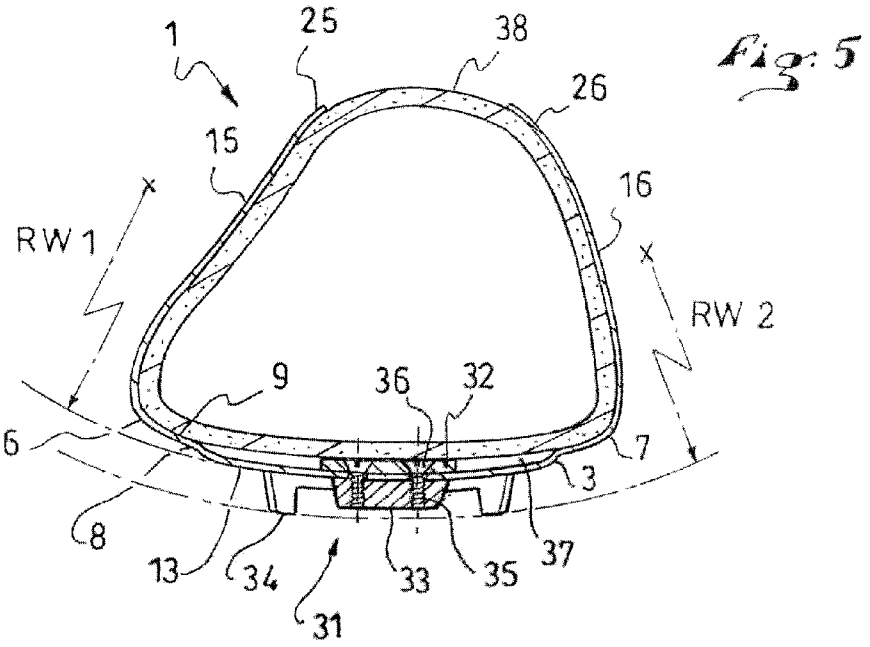


Fig. 4




1
25
38
26
15
16
RW 1
RW 2
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36
32
6
7
3
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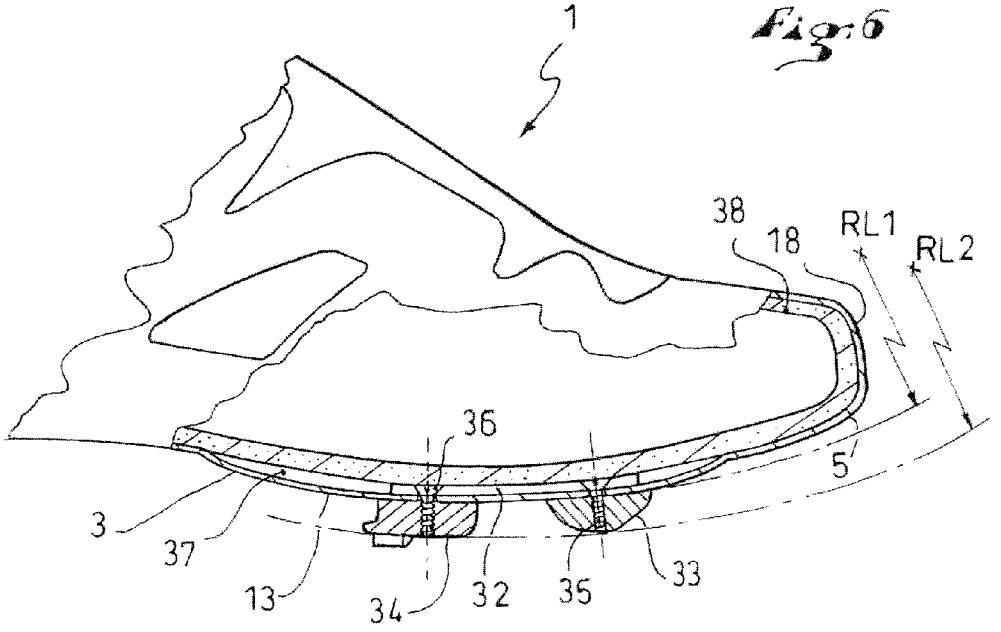
13
34
33
35
37
31

Fig: 5


1
38
18
RL1
RL2
36
5
3
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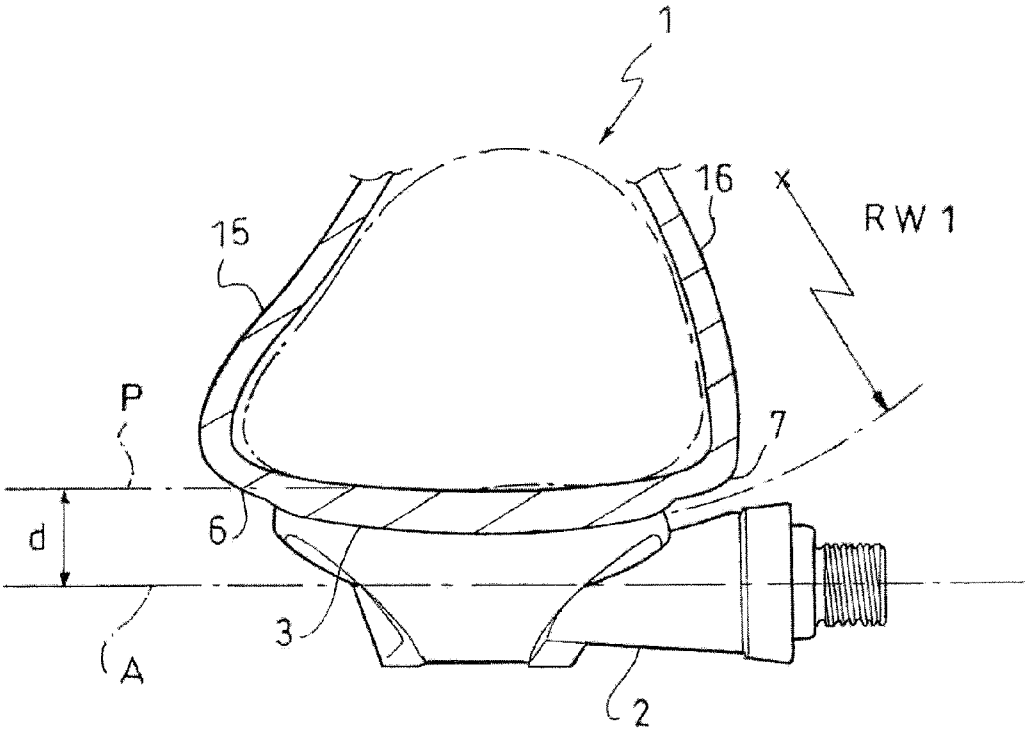
13
34
32
35
33

Fig: 6

Fig: 7



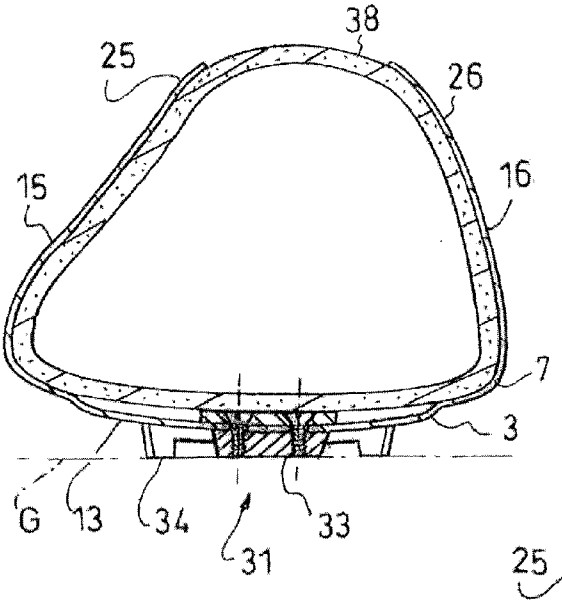


Fig. 8

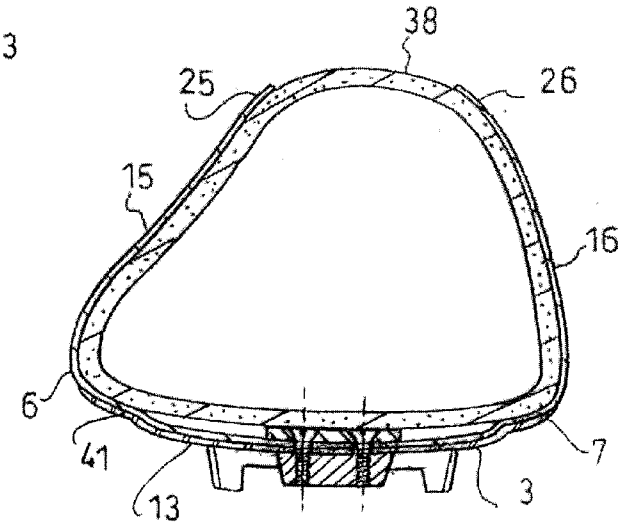


Fig. 9

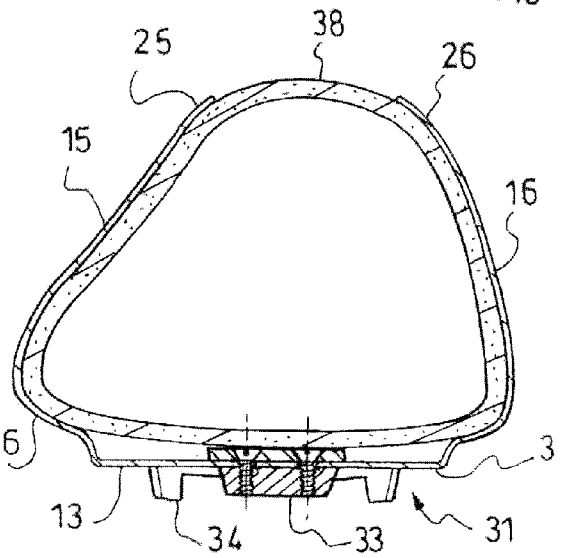


Fig. 10

SPORTS SHOE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based upon French Patent Application No. FR 14/01845, filed Aug. 13, 2014, the disclosure of which is hereby incorporated by reference thereto in its entirety, and the priority of which is claimed under 35 U.S.C. §119.

BACKGROUND

[0002] 1. Field of Invention

[0003] The invention relates to a shoe adapted to cooperate with an apparatus through a pedaling action, and relates more particularly to cases in which the apparatus is a vehicle. A shoe according to the invention can be used with a bike, a delivery tricycle, a go-kart, an indoor training machine, or any other apparatus requiring a pedaling action.

[0004] 2. Background Information

[0005] In the field of cycling, for example, the shoe cooperates with a pedal of the apparatus, namely the bike in this case, particularly to make it move forward. The shoe serves, among other functions, to transmit driving or steering forces or impulses, to transmit sensory information, or to return the reactions of the ground or of the apparatus itself to the cyclist. To fulfill these functions, the prior art has proposed structures for the shoes used in the respective fields involved.

[0006] Traditionally, a cycling shoe comprises at least a sole assembly and an upper, defining a fitting volume, and often also comprises a wedge, or cleat, for connection to the pedal. The first two elements are described below.

[0007] First, the sole assembly includes a subdivision referred to as the outer sole assembly. This is a rigid subdivision of the shoe in the sense that it should not bend, or should bend only very slightly, longitudinally. This means that it should preferably not be deformed in bending along a transverse axis of the shoe, the axis being parallel to the sole assembly, in particular to better transmit forces coming from a user's lower leg to the pedal. To this end, the outer sole assembly typically includes one or more layers of materials from which it inherits its mechanical properties, including bending strength. In EP 0 749 704-B1, for example, a middle sole layer is employed that both rigidifies and thickens the sole and more greatly spaces apart the user's foot and the axis of rotation of the pedal.

[0008] Second, the upper is a subdivision of the shoe adapted to cover the foot. The upper generally comprises a number of elements, such as a lateral quarter, a medial quarter, a vamp, a tongue, a heel, a rear stiffener, a protective toe-cap, a tightening device, an inner liner, and the like. The shoe is manufactured by assembling and three-dimensionally shaping elements that are cut and assembled flat, that is to say, in two dimensions. Conventionally, the upper is associated with a lasting sole to demarcate a footwear element. According to a first method, the upper is glued to the lasting sole using an adhesive layer. The lasting sole, also referred to as the lasting board, is relatively rigid to withstand the assembly process. The gluing operation is carried out by pulling the upper in relation to the shoe form, or last, and pressing it onto the lasting board, with the last is positioned in the upper. This is the traditional shoe lasting assembly. This technique makes it possible to exert sufficient pressure when heating the adhesive in order to obtain the footwear element. A second method, also known, involves obtaining the footwear element by stitching the upper to the lasting board. This is referred to as the Strobel lasting assembly. The lasting board in this case is a more flexible stitchable sole, referred to as the Strobel sole. For each of the first and second methods, the lasting board is integral with the sole assembly in a broad sense. In fact, the sole assembly can be considered to comprise at least the outer sole assembly and the lasting board. Finally, the shoe is mainly formed by the association of the footwear element with the constituent parts of the sole assembly. This means that the shoe comprises a sole assembly and an upper.

[0009] In general, a shoe according to the prior art is satisfactory, in the sense that it enables each user to properly operate his/her apparatus. Indeed, the user is able to transmit steering forces or thrusts, or to perceive sensory information, as well as reactions of the ground or of the apparatus itself. However, it is still apparent that a shoe according to the prior art has disadvantages.

[0010] First, it is a source of fatigue, especially during intense uses, such as in sporting events, for example. In other words, it can be said that the performance of a shoe according to the prior art is insufficient. This means that the user must supply more energy than theoretically required for the use of the apparatus. A reason for this is the overly large gap between the foot and the axis of rotation of the pedal. Indeed, it is known that the closer to the pedal axis the sole of the foot gets, the better the pedaling efficiency will be. Another reason is the relatively substantial weight of the shoe, which has the effect, for example, of increasing its mechanical inertia.

[0011] Secondly, a shoe according to the prior art has a complicated structure, thereby making it time-consuming and expensive to manufacture.

SUMMARY

[0012] In view of the foregoing, the invention generally seeks to improve a shoe and, more particularly, a shoe designed to cooperate with an apparatus through a pedaling action. In particular, the invention increases pedaling efficiency and reduces user fatigue. This means that the invention seeks to improve the performance related to use, for example during sporting events. The invention also seeks to reduce the cost and manufacturing time of a shoe, the underlying idea being to simplify the structure of the shoe.

[0013] To this end, the invention provides a shoe designed to cooperate with an apparatus through a pedaling action, the shoe comprising a base extending lengthwise from a rear end to a front end, widthwise between a lateral side and a medial side, and depthwise between a surface for cooperation with the apparatus and an inner surface, the base having, from the rear end to the front end, a rear zone, a central zone, a metatarsal zone, and a front zone, the shoe comprising a lateral wall and a medial wall.

[0014] The lateral wall and medial wall of the shoe according to the invention are directly affixed to the base, and in that the base, the lateral wall and medial wall are rigid subdivisions of the shoe. For example, the lateral and medial walls are rigid within their respective planes, that is, in the planes of their respective thicknesses and can have the same substantial rigidities and inextensibilities within their respective thicknesses.

[0015] Due to this arrangement, the lateral and medial walls contribute to the longitudinal bending strength of the shoe. In other words, these walls preclude bending of the shoe along a transverse axis thereof, the axis being parallel to the base.

This is a structural and functional difference in relation to a shoe according to the prior art, for which the bending strength is achieved at least in large part, if not entirely, by the outer sole assembly. It can be said that the invention modifies the distribution of forces caused by the longitudinal bending stresses, the invention locating these forces substantially in the area of the lateral wall and the medial wall. By corollary, the invention makes it possible to produce a shoe having a base with reduced thickness in relation to that of a sole assembly of a shoe according to the prior art, in order to obtain a shoe with satisfactory bending strength, since the lateral and medial walls participate in this bending strength.

[0016] The resulting technical effects include the foot being brought closer to the cooperation surface of the base. Given that the latter takes support on the pedal, as will be better understood from the following description, the sole of the foot becomes closer to the axis of rotation of the pedal. Therefore, advantageously, pedaling efficiency increases and user fatigue is reduced.

[0017] Another technical effect resulting from the reduction in thickness of the base is a reduced weight of the lower region of the shoe. In the invention, this region is lighter than the same region in a shoe according to the prior art, thereby resulting in the entire shoe being lighter. It can be said that the invention reduces the mechanical inertia of the shoe. A resulting advantage is, again, a reduction in user fatigue.

[0018] Two technical effects, namely, the reduction in the distance between the foot and the pedal axis, on the one hand, and the reduction in mass of the shoe, on the other hand, are combined to reduce user fatigue and to improve user performance.

[0019] Other advantages result from a shoe according to the invention having a simplified structure in relation to a shoe according to prior art, in the sense that it is manufactured with a reduced number of parts. This results in a reduction in manufacturing costs and manufacturing time.

[0020] Generally speaking, it can be said that the invention improves a shoe designed to cooperate with an apparatus through a pedaling action.

BRIEF DESCRIPTION OF DRAWINGS

[0021] Other characteristics and advantages of the invention will better understood from the following description, in reference to the annexed drawings illustrating, by way of non-limiting embodiments, how the invention may be embodied, and in which:

[0022] FIG. **1** is a front perspective view of a complete shoe and a pedal adapted to receive the shoe, according to a first embodiment of the invention;

[0023] FIG. **2** is an exploded perspective view of constituent portions of the shoe according to FIG. **1**;

[0024] FIG. **3** is a rear perspective view of a constituent portion of the shoe according to FIG. **1**;

[0025] FIG. **4** is an exploded partial, perspective front view of the portion according to FIG. **3**;

[0026] FIG. **5** is a cross-sectional view along the line V-V of FIG. **1**;

[0027] FIG. **6** is a cross-sectional view along the line VI-VI of FIG. **1**;

[0028] FIG. **7** is a schematic transverse cross section of the shoe of FIG. **1**, in a case in which it is supported on the pedal;

[0029] FIG. **8** is a view similar to that according to FIG. **5**, for a second embodiment of the invention;

[0030] FIG. **9** is a view similar to that according to FIG. **5**, for a third embodiment of the invention; and

[0031] FIG. **10** is a view similar to that according to FIG. **5**, for a fourth embodiment of the invention.

DETAILED DESCRIPTION

[0032] Embodiments within the scope of the invention that are described below relate more specifically to a cycling shoe. However, the invention applies to other fields such as those mentioned above.

[0033] A first embodiment is described with reference to FIGS. **1** to **7**. First, FIG. **1** shows a shoe **1** to receive the foot of the user, and a pedal **2** designed to cooperate with the shoe. The pedal is not further described in detail herein, as it is well-known to one of ordinary skill in the art.

[0034] Conventionally, as can be seen in FIGS. **1** to **4**, the shoe **1** comprises a base **3** extending lengthwise along a longitudinal direction L, from a rear end **4** to a front end **5**; widthwise along a transverse direction W, between a lateral side **6** and a medial side **7**; and depthwise between a surface **8** for cooperation with the apparatus and an inner surface **9**. As described below, the cooperation surface **8** can come into contact with the pedal **2** directly or indirectly. Also, the inner surface **9** can come into contact with the foot of the user directly or indirectly, as further described below.

[0035] The base **3** of the shoe, from the rear end **4** to the front end **5**, includes a rear zone **11** provided to be opposite and under the heel of the foot, a central zone **12** provided to be opposite the arch of the foot, a metatarsal zone **13**, positioned forward of the central zone and provided to be opposite the metatarsus, and a front region **14** provided to be opposite the toes.

[0036] The shoe also includes a lateral wall **15** and a medial wall **16**, which are described in more detail below.

[0037] According to the invention, the lateral wall **15** and medial wall **16** are directly affixed to the base **3** and the base **3**, the lateral wall **15**, and the medial wall **16** are respective rigid subdivisions of the shoe. A subdivision is a portion of the shoe. This means that, although they may be flexible, the subdivisions cannot lengthen or shorten under normal conditions of use. In other words, these portions do not have an elastic deformation property enabling them to lengthen or shorten and, thus, cannot form folds or creases. Consequently, the base **3**, the lateral wall **15**, and the medial wall **16** demarcate a rigid housing for receiving the foot of the wearer. Due to this arrangement, the lateral **15** and medial **16** walls participate in the longitudinal bending strength of the shoe, at least in the areas of junction with the base. In other words, these walls prevent the shoe from bending along a transverse axis of the shoe, the axis being parallel to the base. This is a functional difference in relation to a shoe according to the prior art, for which the bending strength is achieved at least in large part, if not entirely, by the outer sole assembly. It can be said that the invention modifies the distribution of the forces caused by the longitudinal bending stresses, the invention localizing these forces substantially in the area of the lateral wall and in the area of the medial wall. The lateral wall **15** is continuous along the entire length of the base **3**, in the sense that it extends along the rear zone **11**, the central zone **12**, the metatarsal zone **13**, and the front zone **14**. Similarly, the medial wall **16** is continuous along the entire length of the base **3**, in the sense that it extends along the rear zone **11**, the central zone **12**, the metatarsal zone **13**, and the front zone **14**. Consequently, the invention provides the base here with a

reduced thickness in relation to that of a sole assembly of a shoe according to the prior art, in order to obtain a shoe with satisfactory bending strength.

[0038] According to the first embodiment, the shoe **1** comprises a rear wall **17** affixed directly to the base **3** and a front wall **18** affixed directly to the base **3**, the rear **17** and front **18** walls being rigid subdivisions of the shoe, the rear **17**, lateral **15**, front **18**, and medial **16** walls forming a peripheral belt. This means that the rear **17**, lateral **15**, front **18**, and medial **16** walls are co-extensive with one another around the base **3**. The rear wall **17** and the front wall **18** do not have an elastic deformation property enabling them to lengthen or shorten and, thus, cannot form folds or creases. For example, these walls are rigid within their respective planes, that is, in the planes of their respective thicknesses. Consequently, it is the base **3**, the rear wall **17**, the lateral wall **15**, the front wall **18**, and the medial wall **16** which demarcate the rigid housing for receiving the foot. Due to this arrangement, the assembly formed by the base **3** and the walls **15**, **16**, **17**, **18** demarcates a fitting volume that is rigid in longitudinal bending, and also rigid in torsion. This increases the ability of the shoe to transmit steering forces, sensory information, reactions of the ground or of the apparatus, and the like.

[0039] Without being limiting, the base **3** and each of the walls **15**, **16**, **17**, **18** form a cradle-shaped element having a continuous unitary structure. This means, for example, that each of the walls **15**, **16**, **17**, **18** is an extension of the base in a direction away from the inner surface **9**. This is the simplest structure, which has the advantage of ease of manufacture and a lower production cost due to its unitary configuration. This does not, however, preclude from alternatively providing embodiments in which at least one or all of the walls are attached and affixed to the base, by any means such as gluing or any equivalent.

[0040] The rear wall **17** is strictly convex outside of the shoe and, therefore, strictly concave inside of the shoe, that is to say, opposite the fitting volume. Consequently, the rear wall has a rounded shape which, on the outside, facilitates the rolling movement of the foot during walking and, on the inside, surrounds and maintains the heel of the foot, in the manner of a bowl. "Rolling movement" refers to the flexibility of the foot during walking and particularly, the flexing of the foot, such as that at the metatarsal-phalangeal joint during walking, which is facilitated by the shoe of the invention.

[0041] The front wall **18** is also strictly convex outside of the shoe and, therefore, it is strictly concave inside of the shoe, opposite the fitting volume. It follows that the front wall has a rounded shape which, outside of the shoe, facilitates the rolling movement of the foot during walking and which, inside of the shoe, covers the toes.

[0042] At least one of the walls **15**, **16**, **17**, **18** has openings **21**. These opening are all designated by the same reference numeral for reasons of convenience. Without being limiting, the lateral wall **15** has a plurality of openings, and the medial wall **16** has a plurality of openings. Some of these openings also extend in the area of the rear wall **17**. It may be optionally provided to arrange openings in the area of the front wall **18**. In any case, the openings lighten the shoe, and also provide aeration of the fitting volume. This arrangement contributes to improving performance because the removal of material reduces the mechanical inertia, on the one hand, and improves comfort by evacuating a portion of the moisture and/or heat generated by the foot. This arrangement still allows a certain transverse flexibility to adapt to the contour of the foot when tightening the lateral and medial walls, as discussed below.

[0043] Still in relation to the arrangement of the walls, the shoe **1** has an upper opening **22** extending opposite the rear zone **11**, opposite the central zone **12**, and at least partially opposite the metatarsal zone **13**. This enables passage of the foot to put the shoe on or to remove it. In addition, the shoe comprises a device **23** for tightening the lateral **15** and medial **16** walls. By its action, the tightening device **23** enables the foot to be held in the fitting volume during use of the shoe. Indeed, the lateral wall **15** has a free end **25** and the medial wall **16** has a free end **26**, these ends being biased towards one another by the tightening device **23** when actuated by the user. This is possible because, although their constituent material is rigid, the lateral **15** and medial **16** walls are deformable in transverse bending in the area of their respective free ends, along the direction W. Conversely, the walls do not deform in transverse bending in the area of the base **3**, because they are affixed thereto. Only the free ends **25**, **26** of the walls can bend like only the end of a diving board can bend, if comparison is to be used to describe this phenomenon. In fact, embodiments can be provided, in which the thickness of the lateral wall and/or the thickness of the medial wall decreases in a direction from the base **3** to the free end **25**, **26**.

[0044] By way of non-limiting example, the tightening device **23** includes lateral keepers **27**, medial keepers **28**, a linkage **29** that runs through the keepers, and possibly a linkage-blocking mechanism. The linkage-blocking mechanism is not illustrated, although it could be embodied by or based upon a mechanism such as disclosed, for example, in U.S. Pat. No. 5,477,593 or U.S. Pat. No. 5,956,823, the disclosures of which are hereby incorporated-by-reference thereto in their entireties. A keeper is an arrangement provided to guide the linkage, such as a hole in the context of an eyelet, a hook, a fork with a pulley, or any equivalent element. The linkage may be a string or cable section, or the like.

[0045] Still with respect to the first embodiment of the invention, and without being limiting, the base **3** and the walls **15**, **16**, **17**, **18** here are comprised of fibers and/or fiber portions affixed to one another by a matrix of synthetic material. This association of materials offers multiple possibilities for the development of the rigid housing that receives the foot. For example, the fibers and/or fiber portions are mainly made of carbon. This material makes the base and the walls, that is to say, the housing for the foot, both rigid and lightweight. Consequently, the shoe is well-suited to sporting and intense use. For example, the matrix of synthetic material, that is to say, the material used as a binder to the fibers, is a thermosetting resin, a thermoforming material such as polyurethane or the like, or any equivalent material. With respect to the fibers, as an alternative to carbon, it is possible to use glass, which is economical, or aramid, for its mechanical properties which, in certain cases, represent an advantageous alternative in relation to the properties of carbon, or the like.

[0046] With respect to dimensions, still in the case of use of fibers, the thicknesses of the base **3** and of the walls **15**, **16**, **17**, **18** are between 0.3 and 2.0 mm, with values between 0.5 and 1.0 mm having yielded good results. In a particular embodiment, the thicknesses of the walls can be substantially the same and even substantially the same as that of the base. In any event, the part formed by the base and the walls is thin, particularly in the area of the base, as compared with the outer sole assembly of a shoe according to the prior art and, further, it is relatively thin from front to rear, including in the middle,

such as in the central zone and in the metatarsal zone. Therefore, the shoe according to the invention enables the foot to be located closer to the axis rotation of the pedal, which in particular results in improved pedaling efficiency. The resulting advantages include reduced fatigue for a given effort, or improved performance during intense sporting events.

[0047] In a non-limiting fashion, still in the case of use of fibers, the thickness of each wall **15**, **16**, **17**, **18** can be constructed to be between 50 and 150% of the thickness of the base **3**. This homogenizes the structure of the part formed by the base and the walls. A resulting advantage is a simple and easy manufacture. Indeed, it suffices to apply one or more layers of fibers evenly on a last, that is to say, an element having a geometry similar to that of a foot, and to make the matrix rigid, in order to obtain the part.

[0048] Alternatively, but still in the context of the first embodiment of the invention, the base **3** and the walls **15**, **16**, **17**, **18** are made of a plastic material. In the case in which the base and the walls form a part having a continuous structure, the plastic material may be implemented using any known technique, such as injection molding, three dimensional printing using a special printer, cutting a block of material by means of a five-axis numerical control machine, for example, or by any other suitable technique. The material injection has the advantage of speed of manufacture. The three-dimensional printing has the advantage of ease of modification, in the sense that a simple programming change makes it possible to modify the technical characteristics of the shoe. For example, it can be very simple to modify the thickness of the base or of a wall. In any case, the part obtained is simple, compared to what is proposed in the prior art, due to its unitary structure.

[0049] With respect to dimensions, for the invention and still in the case of use of a plastic material, the thickness of the base **3** is between 1.0 and 6.0 mm, and the thickness of each wall **15**, **16**, **17** **18** is between 1.0 and 3.0 mm. In certain cases, as mentioned above, the wall thickness decreases towards the free ends. The noted values are conventional in the field of plastic material injection. They can also easily be obtained by implementing the other techniques mentioned above.

[0050] It has been shown that the first embodiment of the invention is directed to a cycling shoe. Thus, as shown particularly in FIG. **4**, the shoe non-essentially comprises a cleat **31**, or wedge, arranged in the metatarsal zone **13**, the cleat being designed to cooperate with a pedal **2** of the apparatus. Well known to one with ordinary skill in the art, the cleat is not described in detail herein, although it can take any of different structures and styles. Nevertheless, the cleat **31** includes a plurality of elements, such as an inner plate **32**, outer fastening elements **33**, **34**, and screws **35** for affixing the inner plate to the fastening elements by extending through the base **3**. The cleat **31** ensures precise retention of the shoe **1** in relation to the pedal **2**. Consequently, the steering performance is more consistent. According to the first embodiment, the cleat **31** comprises at least one screw **35** whose head **36** is located on the side of the inner surface **9** of the base **3**. In fact, for each screw, the head **36** is located on the side of the inner surface **9** and positioned, for example, in the thickness of the inner plate **32**. This reduces the space requirement of the cleat **31** within the fitting volume, thereby enabling the foot to remain as close to the pedal as possible during operation of the bicycle or other apparatus. It already been shown that this proximity helps to achieve greater pedaling efficiency.

[0051] FIGS. **5** and **6** show that, in the metatarsal zone **13**, the base **3** has a cavity **37** open towards the inner surface **9**. This cavity receives the plate **32** of the cleat **31**, as well as the heads **36** of the screws **35**. Thus, the plate and the screw heads are flush with the remainder of the inner surface **9** of the base **3**. In other words, the plate **32** and the screws **35** do not project above the portion of the inner surface **9** that extends around the cavity **37**. This enables the foot to be placed in the shoe without hindrance, for greater comfort of use.

[0052] Without it being mandatory, and still with respect to FIGS. **5** and **6**, the shoe **1** comprises a liner **38**. Again, this element is well-known to one with ordinary skill in the art, and is not described in further detail. The liner, for example, is intended to provide a certain level of comfort to the user. It can be removably mounted in the shoe **1**, thereby facilitating its replacement or its temporary removal to access the screws **35**, for example. Through this access, it is possible to act on the screws, for example to loosen and then tighten them, in order to adjust the position of the cleat **31** in relation to the base **3**. The access is easier as the upper opening **22** of the shoe **1** extends up to the metatarsal zone **13**. Because the plate **32** and the heads **36** of the screws **35** are positioned in the cavity **37**, the positioning and removal of the liner are carried out freely, without hindrance.

[0053] Further, in the metatarsal zone **13**, the cooperation surface **8** has a convex curvature in the longitudinal direction and a convex curvature in the transverse direction. In other words, the cooperation surface **8** has a convex boss in the area of the metatarsal zone. The base **3** is convex in all directions, on the side of the cooperation surface **8**, in the metatarsal zone **13**. This makes it possible to position the shoe **1** on the pedal **2** by movements with three rotational degrees of freedom, in the manner of a ball and socket joint. A resulting advantage is the possibility to adjust the position of the shoe **1**, on the pedal, in a manner that is convenient to most or all users.

[0054] By way of non-limiting example, the cooperation surface **8** has a spherical boss in the area of the metatarsal area. In other words, the boss is circular in all directions, particularly in the longitudinal direction and transverse direction. The boss, in this case, is a spherical portion. The radius of curvature is constant, and it is the same in all directions.

[0055] Alternatively, as another non-limiting example, the radius of curvature varies either in one direction or in multiple directions, or in all directions.

[0056] In terms of values, the radius or radii of curvature RL**1** of the longitudinal convexity of the cooperation surface **8** is between 150 and 250 mm, and the radius or radii of curvature RW**1** of the transverse convexity of the cooperation surface is between 150 and 250 mm. These values are given by way of example. Good results have been obtained with radii between 170 and 200 mm. Further, the fastening elements **33**, **34** of the cleat **31** follow the longitudinal convexity of the cooperation surface **8** along one or more radii of curvature RL**2**, on the one hand, and the transverse convexity of the cooperation surface **8** along one or more radii of curvature RW**2**.

[0057] A schematic synthesis of the result provided by the invention, according to the first embodiment, is shown in FIG. **7**. The latter simply shows the distance d measured between the lower surface P of the foot and the axis A of the pedal **2**. The lower surface of the foot is located in the area of the inner surface **9** of the base **3** in the case in which the shoe is devoid of a liner or of an inner sole. The lower surface of the foot is located in the area of a surface of a liner or of an inner sole for

receiving the foot, in the case in which the shoe is provided therewith. In all configurations, the shoe according to the invention brings the foot closer to the pedal axis by several millimeters, in comparison with a shoe according to prior art. The approximation is equal to or greater than 3.0 mm. For example, distances d between 10 and 13 mm have been measured, whereas the prior art shows distances greater than or equal to 16 mm.

[0058] Other embodiments of the invention are summarily described below with reference to FIGS. **8** to **10**. For reasons of convenience, it is mainly the differences from the first embodiment that are highlighted. In addition, the same reference numerals are used for identical or similar elements seen in the first embodiment.

[0059] Thus, according to FIG. **8**, the second embodiment features a shoe **1**, with its base **3** and the edges **6**, **7**, its lateral **15** and medial **16** walls, the cleat **31**, and the liner **38**.

[0060] What is specific to the second embodiment is the geometry of the cleat **31**. Here, the fastening elements **33**, **34** follow the longitudinal and transverse convexities for their affixation to the cooperation surface **8**, but are within a plane G in the area of contact with the pedal **2**. The latter, not shown, has a flat surface for receiving the shoe. This is simply an alternative embodiment which enables the use of a bicycle equipped with flat pedals.

[0061] The third embodiment, according to FIG. **9**, also features a shoe **1**, with its base **3** and the edges **6**, **7**, its lateral **15** and medial **16** walls, the cleat **31**, and the liner **38**.

[0062] What is specific to the third embodiment is that, in the metatarsal zone **13**, a spacer **41** is arranged so to be opposite the cooperation surface **8**. More specifically, the spacer is interposed between the base **3** and the cleat **31** in the metatarsal zone **13**. This spacer protects the cooperation surface **8** from possible mechanical attacks, such as friction or point supports, which could occur, for example, during a cleat position adjustment, during support on the ground or on the pedal, or the like. The spacer **41** can be comprised of a sheet of synthetic material, for example.

[0063] The fourth embodiment, according to FIG. **10**, also features a shoe **1**, with its base **3** and the edges **6**, **7**, its lateral **15** and medial **16** walls, the cleat **31**, and the liner **38**.

[0064] What is specific to the fourth embodiment is that, in the metatarsal zone **13**, the cooperation surface **8** has a convex curvature in the longitudinal direction and a straight curvature in the transverse direction. The radius or radii of curvature of the longitudinal convexity of the cooperation surface is between 150 and 250 mm, knowing that good results were obtained for radius values between 170 and 200 mm. In certain cases, the longitudinal curvature is along a single radius, there is no curvature in the transverse direction, and the metatarsal zone has a cylindrical portion. This alternative embodiment enables the use of a bicycle equipped with pedals, at least one side of which has a concavity whose curvature is parallel to the pedal axis.

[0065] In any case, the invention is made from materials and according to implementation techniques known to one with ordinary skill in the art.

[0066] The invention is not limited the particular embodiments described above and shown in the drawings, but it includes all of the technical equivalents that fall within the scope of the claims that follow.

[0067] For example, referring to the geometry of the base **3**, a case can be provided, for which the cooperation surface **8** is flat in the metatarsal zone **13**. In this case, if a cleat is used, its surface intended to be affixed to the base **3** must be flat.

[0068] More generally, the geometries of the base **3** in the metatarsal zone **13** can continue into an annex zone, in particular in the front zone **14**, and possibly also in the central zone **12**. This means, for example and without it being limiting, that in the central zone **12**, metatarsal zone **13**, and front zone **14**, the cooperation surface **8** has a convex curvature in the longitudinal direction.

[0069] With respect to the characteristics of the materials, it can indeed be provided to vary the thickness of the base **3** or of one or more walls. For example, the lateral wall **15**, medial wall **16**, or both walls can each have a thickness which decreases from the base **3** to their respective free ends. This further increases the ability of the shoe to tighten the foot, while maintaining rigidity in the area of the base **3**.

[0070] Further, at least because the invention is disclosed herein in a manner that enables one to make and use it, by virtue of the disclosure of particular exemplary embodiments of the invention, the invention can be practiced in the absence of any additional element or additional structure that is not specifically disclosed herein.

1. A sports shoe for cooperating with an apparatus through a pedaling action, the shoe comprising:
- a base extending lengthwise from a rear end to a front end, widthwise between a lateral edge and a medial edge, and depthwise between a surface for cooperation with the apparatus and an inner surface;
- the base having, from the end rear to the front end, a rear zone, a central zone, a metatarsal zone, and a front zone, the shoe comprising a lateral wall and a medial wall; and
- the lateral wall and the medial wall being affixed directly to the base, and the base, the lateral wall, and the medial wall being rigid subdivisions of the shoe.

2. A sports shoe according to claim **1**, further comprising:
- a rear wall affixed directly to the base and a front wall affixed directly to the base, the rear and front walls being rigid subdivisions of the shoe, the rear, lateral, front, and medial walls forming a peripheral belt.

3. A sports shoe according to claim **1**, wherein:
- the base and each of the walls form a part having a continuous unitary structure.

4. A sports shoe according to claim **1**, wherein:
- at least one of the walls has through openings.

5. A sports shoe according to claim **1**, further comprising:
- an upper opening extending so as to be opposite the rear zone, opposite the central zone, and at least partially opposite the metatarsal zone.

6. A sports shoe according to claim **1**, wherein:
- the base and the walls are made of a plastic material.

7. A sports shoe according to claim **6**, wherein:
- the base has a thickness between 1.0 and 6.0 mm; and
- each wall has a thickness between 1.0 and 3.0 mm.

8. A sports shoe according to claim **1**, wherein:
- the base and the walls are made of fibers and/or fiber portions affixed to one another by a matrix of synthetic material.

9. A sports shoe according to claim **8**, wherein:
- the fibers and/or fiber portions are mainly made of carbon.

10. A sports shoe according to claim **8**, wherein:
- the base and each of the walls has a thickness between 0.3 and 2.0 mm.

11. A sports shoe according to claim **8**, wherein:
each wall has a thickness between 50 and 150% of a thickness of the base.
12. A sports shoe according to claim **1**, wherein:
the base has a substantially uniform thickness at least in the central and metatarsal zones.
13. A sports shoe according to claim **1**, wherein:
the base has a substantially uniform thickness in the central zone, the metatarsal zone and within each of the front and rear zones.
14. A sports shoe according to claim **12**, wherein:
each of the walls has a respective rigidity substantially equal to a rigidity of the base within planes of respective thicknesses of the walls and base.
15. A sports shoe according to claim **1**, wherein:
the cooperation surface is flat in the metatarsal zone.
16. A sports shoe according to claim **1**, wherein:
in the metatarsal zone, the cooperation surface has a convex curvature in the longitudinal direction and a straight curvature in the transverse direction.
17. A sports shoe according to claim **16**, wherein:
the longitudinal convexity of the cooperation surface has a radius or radii of curvature of between 150 and 250 mm.
18. A sports shoe according to claim **1**, wherein:
in the metatarsal zone, the cooperation surface has a convex curvature in the longitudinal direction and a convex curvature in the transverse direction.
19. A sports shoe according to claim **18**, wherein:
the longitudinal convexity of the cooperation surface has a radius or radii of curvature of between 150 and 250 mm; and
the transverse convexity of the cooperation surface has a radius or the radii of curvature of between 150 and 250 mm.
20. A sports shoe according to claim **1**, further comprising:
a cleat arranged in the metatarsal zone, the cleat being provided to cooperate with a pedal of the apparatus.
21. A sports shoe according to claim **20**, wherein:
the cleat comprises at least one screw having a head located on a side of the inner surface.
22. A sports shoe according to claim **20**, wherein:
in the metatarsal zone, the base has a cavity open on a side of the inner surface.
23. A sports shoe according to claim **1**, wherein:
in the metatarsal zone, a spacer is arranged so as to be opposite the cooperation surface.
24. A sports shoe according to claim **1**, further comprising:
a device for tightening the lateral and medial walls.
25. A sports shoe according to claim **1**, further comprising:
a liner.

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