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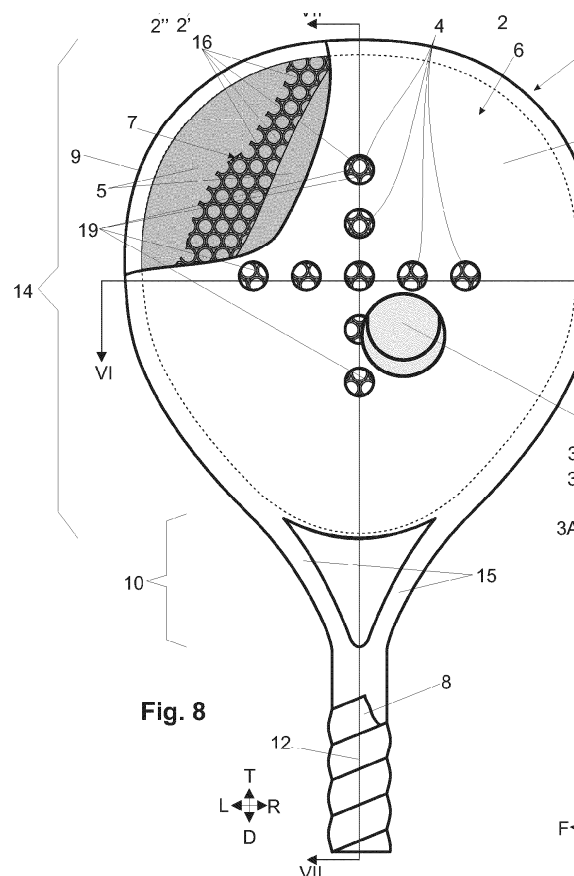
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(54) PADDLE RACKET

(57) Paddle racket (1) comprising two hitting surfaces (2) for hitting the ball (20), a handle (8) and an inner core (3) arranged between the two hitting surfaces (2); wherein at least one hitting surface (2) comprises at least one through hole (4); wherein the inner core (3) comprises a honeycomb layer (7) comprising a plurality of open cells (16) having longitudinal axes (L)

perpendicular to the hitting surfaces (2); wherein the inner core (3) extends transversely through said at least one hole (4) so that, when observing the racket (1) from the front, the hole (4) is partially obstructed by the walls (17) of the cells (16) of the honeycomb layer (7).

**Fig. 8**

Description

TECHNICAL FIELD

[0001] The present invention relates to the field of rackets for ball sports. In particular, the present invention relates to the field of rackets without strings. Even more particularly, the present invention relates to the field of paddle or padel rackets.

BACKGROUND ART

[0002] Padel rackets are known in the state of the art. These are composed of a continuous shell made of composite material, generally comprising glass or carbon fibre, inside which, in the area where the ball impacts the racket, there is a cushion made of expanded polymeric material. The racket also comprises a handle integral with the shell in a continuous manner. The production process of the paddle racket involves placing a layer of composite material comprising glass or carbon fibre on the internal surface of the two halves of a mould, together with a polymeric foam disc surrounded by an inflatable air chamber. Once the mould is closed, the air chamber is inflated to maintain the centre of the disc and to compress, from the inside, the layer of composite material against the mould. The mould is then overheated for a curing or polymerisation phase of the materials. The racket including the handle is then extracted from the mould for the final finishing and painting. Finally, the racket is drilled with several through holes that run through the racket from side to side and lie in the ball impact zone.

[0003] The holes that run through the racket should serve to make the racket more aerodynamic during the game and therefore offer less resistance to the air. In reality, the holes in current paddle rackets offer practically no advantage in terms of less friction with the air.

[0004] Furthermore, the holes made in traditional paddle rackets pass through both the hitting surfaces and the polymer foam disc. In traditional rackets, the hitting surfaces are made by overlapping glass and/or carbon fiber fabrics together with thermosetting resins. Only after the surface is formed, the through holes are performed. Therefore, the holes cut the fibers of the composite material, thus constituting points of fragility of the material from which cracks often propagate that compromise the functionality of the paddle racket. The holes are therefore an element of fragility of the racket that is absolutely not counterbalanced by the aerodynamic advantage generated by the through holes of the racket.

[0005] The solution in document DE202024100253U1 has already reached this conclusion. In this solution, however, the hole in the hitting surface is not used to make the material inside the racket visible and inspectable, but rather it passes through the racket from one side to the other, as in

traditional rackets. In one embodiment, document DE202024100253U1 describes the possibility that the hitting surface has a recess so as to form a blind hole. This solution does not describe or suggest the possibility of drilling the hitting surface but not the material inside the racket. In fact, this document describes a version in which both the inner material and the hitting surfaces are holed with a through hole or a version in which the hitting surface does not have through holes. Furthermore, this solution does not provide for any particular specification for the inner core.

[0006] It is also known in the state of the art to use honeycomb layers in paddle rackets. An example of this is provided by documents TWM647738U and CN204671839U. In both of these solutions, the rackets are perforated with through holes from one side to the other, and therefore the honeycomb layers are perforated as well. Although the regulation seems to require through holes from one side to the other of the racket, making many through holes in the racket significantly weakens it. In particular, it makes no sense to perforate the honeycomb layer because, even in the absence of through holes, the air transits anyway through the honeycomb layer. These two known solutions, in order to comply with the regulation, make the racket weaker.

[0007] In other types of rackets, it is also known to use a honeycomb as an inner core and to drill holes through them. For example, in document CA3038087A1 the hitting surfaces are in contact with the honeycomb layer and a plurality of through holes pass directly through the first surface layer, the inner honeycomb layer and the second surface layer to make the racket more permeable to air. This document describes a pickleball racket that includes a perimeter band that clamps and holds together the hitting surfaces and the honeycomb, creating a protruding edge that extends outward from the hitting surfaces and can interfere with the ball during play. This perimeter band is typical of pickleball rackets and is absent in paddle rackets. The outer surface of paddle rackets is continuous and without rims to allow impact with the ball at any point. Furthermore, the thickness of the pickleball racket is less than half the thickness of the paddle racket. Therefore, if a paddle racket would be made following the teachings of this document, the perimeter band would be incompatible with the paddle game. Furthermore, in this racket, as in other known pickleball rackets, the honeycomb structure extends from the head portion of the racket to the handle. Since the honeycomb structure can connect to the impact surfaces only at the front and rear rims of the open cells of the honeycomb structure, the contact points between the two elements are limited. This means that, at the handle and the connection area of the handle with the head portion, only a few rims of the cells are connected to the impact surfaces and the numerous flexions due to the impact of the racket with a ball, would quickly lead to the breakage of the racket if there were no perimeter

band to clamp the various layers of the racket together. For this reason, the perimeter band cannot be avoided in the racket of document CA3038087A1. This racket is therefore not suitable for playing paddle.

[0008] Document WO2023227819A1 describes a solution where two half-shells are filled with expanded polymer foam. Inside the half-shells it is possible to have foam cushions and a reinforcing element consisting of a honeycomb structure with cells oriented according to the width or according to the height of the racket. All layers of the racket are provided with through holes from side to side of the racket to make the racket permeable to air. The honeycomb is arranged with cells having longitudinal axes parallel to the hitting surfaces to reduce the propensity of the racket to bend or twist relative to the handle. Again, the honeycomb layer is perforated with through holes.

[0009] Another known solution with half-shells joined together is described in the document EP3197569B1, which describes various ways of interconnecting two half-shells that, when joined, form the outer shell of the racket. However, this racket is filled in a traditional manner with an expanded polymer foam and includes a plurality of holes passing through the racket, to make it permeable to air.

[0010] In all known rackets, honeycomb structures are made up of structures in which neighbouring cells share walls. Therefore, the walls are particularly unstable and tend to easily collapse sideways when compressed. For this reason, the walls of the cells are thickened, increasing the weight of the honeycomb structure. However, a honeycomb layer that is too heavy is incompatible with a paddle racket that generally weighs less than 380-400g.

[0011] None of the known solutions allows to realize a paddle racket that is more structurally resistant, that optimizes the ball rebound performance on the racket and that is less noisy when it hits the ball. Furthermore, none of the known solutions describes a racket that is easier to make and assemble and therefore cheaper.

SUMMARY

[0012] These and other drawbacks of the state of the art are now solved by a racket comprising two hitting surfaces for hitting the ball, a handle and an inner core arranged between the two hitting surfaces. The at least one hitting surface comprises at least one through hole. The inner core comprises a honeycomb layer comprising a plurality of open cells having longitudinal axes perpendicular to the hitting surfaces, when these are at rest. The inner core extends transversely through said at least one hole so that, when observing the racket from the front, the hole is partially obstructed by the walls of the cells of the honeycomb layer. The walls of the cells of the honeycomb pass through the hole, partially obstructing it. The thicker the walls of the cells, the more obstructed the hole is. When observing the hole

along its axis, the front or rear edges of the open cells are visible. In this way, the honeycomb layer remains intact and better resists bending when the ball hits the racket. The honeycomb layer helps to structurally compensate the discontinuity of material that is created in the hitting surface due to the hole. Furthermore, the possibility of seeing the honeycomb through the hole or holes in the racket increases the appeal of the racket itself.

[0013] Preferably, the hitting surface is continuous, flat and closed and has only one hole. The hole is used to see and inspect the inner core. If desired, it can be touched the inner core with the finger through the hole in the hitting surface.

[0014] There can be only one hole per hitting surface.

[0015] The hole or holes can also be made only on one hitting surface and the other is closed.

[0016] Through the at least one hole in the hitting surface is possible to see one or more cells, even partially, of the honeycomb layer.

[0017] The honeycomb layer has no through holes but only open cells.

[0018] The honeycomb layer is not perforated.

[0019] Preferably, each hole in one hitting surface can be coaxial with a corresponding hole in the other hitting surface to allow air to pass through said holes and through the cells of the honeycomb layer. Air can pass through the racket if both hitting surfaces are perforated. In this way, air passes first through one hitting surface, then through the honeycomb layer and then through the other hitting surface.

[0020] Advantageously, the inner core can be a multilayer core comprising an upper layer, a lower layer, and an intermediate layer stacked between the upper and lower layers. In this manner, the stiffness and flexural properties of the inner core are the sum of the properties of various layers that form the multilayer core.

[0021] In particular, the honeycomb layer can be the intermediate layer and the upper and lower layers can be foam layers. In this way, behind each hitting surface there is a foam layer that elastically absorbs the bending of the hitting surface. When the ball hits the hitting surface, the foam layer partially returns the energy accumulated during the impact for the rebound phase of the ball. The honeycomb layer, in addition to being permeable to air, is axially rigid in compression and therefore supports the foam layer during the impact of the ball with the racket. This effect is obtained on both sides of the racket, since the inner core is symmetrical from the point of view of properties.

[0022] Alternatively, the upper and lower layers can be honeycomb layers and the intermediate layer can be a foam layer. In this way, each hitting surface is supported by a respective honeycomb layer. This allows to make hitting surfaces thinner. In this case, the hitting surface is glued or bonded to the honeycomb layer.

[0023] Preferably, the foam layer can be perforated with at least one through hole, and each hole in the

foam layer is coaxial with respective holes in the hitting surfaces so that air passes through the holes in the hitting surfaces and in each foam layer and through the cells of the honeycomb layer. The multilayer inner core is therefore permeable to air.

[0024] In particular, the honeycomb layer can have a higher density than the density of the foam layer. The honeycomb layer is stiffer and has a much higher compressive strength than the foam layer. Preferably, the density of the honeycomb layer can be more than double the density of the foam layer. The honeycomb layer affects the balance, shifting the center of gravity of the racket toward the head portion of the racket. The higher density of the honeycomb layer helps to make the head portion of the racket stiffer.

[0025] Advantageously, the honeycomb layer can be thinner than the foam layer. If the density of the honeycomb layer is higher than that of the foam layer, it is better that the thickness of the honeycomb layer is smaller than the thickness of the foam layer, so as not to make the racket too heavy.

[0026] The hitting surfaces can be joined to the upper layer and lower layer respectively, and the intermediate layer can be joined to the upper and lower layers. Preferably, this joining is realized through an adhesive or fusion. By joining the upper, intermediate and lower layers together, the inner core becomes compact. By joining the inner core to the hitting surfaces, the racket becomes more robust and durable. In addition, by joining the layers together, the honeycomb layer dampens the vibration of the foam layer and consequently reduces the noise emitted by the racket.

[0027] Advantageously, the upper layer can be equal as the lower layer. In this way, the inner core is symmetrical and both sides of the paddle racket are balanced.

[0028] Preferably, the handle can be rigidly connected to the hitting surfaces. The hitting surfaces can be directly and monolithically connected to the handle. Each hitting surface may be rigidly connected to a half-handle. This solid connection between the hitting surfaces and the handle makes the racket elastic to bending when the ball hits a hitting surface.

[0029] In particular, the hitting surfaces may be connected to each other by a sidewall which, in turn, is also connected to the handle. The hitting surfaces and the sidewall form the head portion of the racket. When these elements are connected to each other, the head portion assumes a desired torsional and bending stiffness with respect to the handle.

[0030] The hitting surfaces and the sidewall may be connected to the handle by a connecting portion which joins these elements of the racket together in a stable manner. The side portion also keeps the hitting surfaces spaced apart and substantially parallel to each other when they are at rest.

[0031] Preferably, the hitting surfaces and the sidewall form a head portion of the racket that has a rounded shape and does not have sharp edges. The

silhouette of the head portion is therefore tapered and allows for better air flow over the outer surface of the racket, improving its aerodynamics. Furthermore, a rounded head portion is more pleasing to the eye and less dangerous during play. Any sharp edges could be dangerous in the event of a collision with another player.

[0032] In particular, the hitting surfaces, the handle, the sidewall and the connecting portion are part of a shell. This shell can be a single piece, in order to improve the torsional and flexural resistance of the racket, or it can be divided into two half-shells, to make the production of the racket simpler and more economical. In this last case, the two half-shells can be joined together directly or through a coupling element that further facilitates their union.

[0033] These and other advantages will be explained in more detail in the description below of an example of implementation given for indicative and non-limiting purposes with reference to the attached drawings.

DESCRIPTION OF DRAWINGS

[0034] In the drawings:

Fig. 1 shows a front view of a paddle racket according to a first embodiment of the present invention;

Fig. 2 shows a top view, sectioned along section plane I-I, of the racket in Fig. 1;

Fig. 3 shows a side view, sectioned along the section plane III-III, of the racket in Fig. 1;

Fig. 4 shows a top view, sectioned along the section plane II-II, of the racket in Fig. 1;

Fig. 5 shows a front view of a paddle racket according to a second embodiment of the present invention;

Fig. 6 shows a top view, sectioned along the section plane IV-IV, of the racket in Fig. 5;

Fig. 7 shows a side view, sectioned along the section plane V-V, of the racket in Fig. 5;

Fig. 8 shows a front view of a paddle racket according to a third embodiment of the present invention;

Fig. 9 shows a top view, sectioned along the section plane VI-VI, of the racket in Fig. 8;

Fig. 10 shows a side view, sectioned along the section plane VII-VII, of the racket in Fig. 8;

Fig. 11 shows an axonometric view of the honeycomb layer according to the present invention;

Fig. 12 shows a detail view of Fig. 11.

DETAILED DESCRIPTION

[0035] The following description of one or more embodiments of the invention refers to the attached drawings. The same numerical references in the drawings identify equal or similar elements. The object of the invention is defined by the attached claims. The technical details, structures or characteristics of the solutions described below can be combined with each other in any manner.

[0036] The figures show the axes to indicate the top-down (T-D), right-left (R-L) and front-back (F-B) directions.

[0037] The racket 1 illustrated in the various figures and here described is configured and shaped for the game of paddle, or padel. The game is a ball sport derived from tennis. It is played in pairs on a rectangular court enclosed by walls on four sides. The game is played with a racket 1 with which a ball 20 is exchanged, the same as a tennis ball but with less internal pressure, which allows for greater control of the shots and rebounds on the sides.

[0038] The figures show various embodiments. In all embodiments, a paddle racket 1 comprises two hitting surfaces 2, i.e. two flat and parallel surfaces against which the ball 20 hits during play.

[0039] The hitting surfaces 2 are spaced apart from each other by a distance that normally is such as to create an overall thickness of the racket 1 of 38 mm. Preferably, the thickness of the paddle racket 1 is at least 20 mm, therefore the distance between the hitting surfaces 2 is at least 18 or 19 mm, depending on the thickness of the hitting surfaces 2.

[0040] The racket 1 of the present invention has two synergic peculiarities. The hitting surface 2 has one or more holes 4 that pass through the thickness of the hitting surface 2. However, each hole is partially obstructed by the cells 16 of a honeycomb 7 which, like a net, reinforce the discontinuity created with each hole 4.

[0041] The hitting surface 2 is a flat, continuous, rigid and closed surface except for the at least one hole 4 that passes through it.

[0042] Hole 4 runs from the outer face 2' of hitting surface 2 to the inner face 2" of the same.

[0043] There may be one hole 4, as shown in Fig. 1-3, or there may be multiple 4 holes, as shown in Fig. 8-10.

[0044] Furthermore, the hole 4 can be present on both hitting surfaces 2, as illustrated in Fig. 1-3, or on only one hitting surface 2, as illustrated in Fig. 5-7.

[0045] The figures show various embodiments of the racket 1. In all embodiments, a paddle racket 1 comprises a rigid shell 6 which includes the two hitting surfaces 2.

prises a rigid shell 6 which includes the two hitting surfaces 2.

[0046] The shell 6 also includes a handle 8 to allow the racket 1 to be held during play.

[0047] The handle 8 is preferably monolithically connected to the hitting surfaces 2 either directly or through a connecting portion 10, which is also part of the shell 6, as illustrated in Fig. 1-3 and 5-10.

[0048] The shell 6 also comprises a sidewall 9 which keeps the hitting surfaces 2 spaced apart and parallel, or substantially parallel, to each other, as better illustrated in Fig. 2, 3, 6, 7, 9 and 10.

[0049] The sidewall 9 is connected to the handle 8 via the connecting portion 10.

[0050] The connecting portion 10 is preferably hollow in the center, as illustrated in Fig. 1, 4, 8 and 10, so as to form two connections 15 that connect the sidewall 9 and the hitting surfaces 2 to the handle 8. As illustrated in Fig. 1 and 8, these elements of the connecting portion 10 diverge from the handle 8 outwards, by connecting in a substantially tangential manner to the sidewall 9.

[0051] The central cavity of the connecting portion 10 shown in Fig. 1 and 8 has a substantially triangular shape but can assume any other shape. The cavity of the connecting portion 10 can also be absent or blind as illustrated in Fig. 5.

[0052] The shell 6 therefore comprises a head portion 14 which includes the hitting surfaces 2 and the sidewall 9, a connecting portion 10 and a handle 8. These portions of the racket 1 are preferably connected monolithically to each other to form a single piece.

[0053] In the embodiment illustrated in Fig. 5-7, the shell 6 is realized with a plurality of pieces. In this case, the hitting surfaces 2 are independent elements and each hitting surface 2 is connected to a part of the sidewall 9 and together they are monolithically connected to a part of the handle 8, through a part of the connecting portion 10. The shell 6 comprises two half-shells 6A, 6B connected to each other. These half-shells 6A, 6B can be divided along a vertical plane parallel to the hitting surfaces 2, as illustrated in Fig. 5-7 or orthogonal to them (version not illustrated). Each half-shell 6A, 6B may comprise a part or a hitting surface 2, a part of a connecting portion 10, a part of a sidewall 9 and a part of a handle 8. These half-shells 6A, 6B are joined by a coupling element 21 which serves to keep the two half-shells 6A, 6B joined together. In the example illustrated in Fig. 5-7, the coupling element 21 runs around the profile of the racket 1 astride the boundary line that separates the two half-shells 6A, 6B. Each coupling element 21 connects/joins both half-shells 6A, 6B, preventing them from separating or coming closer together.

[0054] The coupling element 21 is preferably an element that connects to the outer surface of the half-shells 6A, 6B, preferably by gluing or melting.

[0055] The coupling element 21 is preferably made of

one or more pieces. Furthermore, the coupling element 21 is preferably made of the same material as the half-shells 6A, 6B. In particular, the material from which the half-shells 6A, 6B and the coupling element 21 are made can be a thermoplastic, for example polyamide or polypropylene, reinforced with glass or carbon fibre, in pieces or spun. Alternatively, the shell 6 can be made of wood.

[0056] The coupling element 21 extends from the handle 8 to the head portion 14 astride the two half-shells 6A, 6B, as illustrated in Fig. 5-7. Preferably, the coupling element 21 covers the large part of the sidewall 9 as illustrated in Fig. 6, for protecting the sidewall 9 from accidental impacts.

[0057] The head portion 14 is preferably rounded and has no sharp corners or edges, as illustrated in Fig. 1-3, 5-10. The shape of the racket 1 is tapered and the hitting surfaces 2 do not include raised edges as occurs in pickleball rackets.

[0058] The shell 6, at the head portion 14, is hollow inside and allows for the housing of an inner core 3. The inner core 3 is arranged between the hitting surfaces 2 and the sidewall 9.

[0059] As illustrated in Fig. 4, the handle 8 of the racket 1, in all embodiments, has a polygonal profile, preferably it has the shape of an irregular octagon as in the traditional paddle rackets. The handle 8 may be covered by a grip 12, as illustrated in Fig. 1, 5 and 8.

[0060] The outer surface of the racket 1 is smooth and continuous. The hitting surfaces 2 may have a pronounced surface roughness on their outer face 2' to increase the grip on the ball 20.

[0061] Through the at least one hole 4 of the hitting surface 2 it is possible to see what is inside the cavity of the shell 6, in correspondence with the head portion 14, thus the inner core 3.

[0062] The inner core 3 contributes to the elasticity of the hitting surfaces 2 and helps to dampen their vibrations.

[0063] Unlike traditional paddle rackets, which have through holes, the present racket 1 has an inner core 5 that extends through the window 4, therefore it crosses it from one side to the other.

[0064] In the embodiments of Fig. 1-3 and 5-7, the honeycomb layer 7 can even be touched through a hole 4.

[0065] The hole 4 preferably has a circular section. In particular, the hole can have a diameter greater than or equal to 9 mm and preferably less than or equal to 13 mm.

[0066] The thickness of the hitting surface 2 depends on the material used. In the case of hitting surfaces 2 made at least in part of carbon or glass fiber or other composite material, the thickness is preferably between 0,4 mm and 1 mm.

[0067] The inner core 3 can be entirely made of a honeycomb layer 7 as illustrated in Fig. 1-3, or be a multilayer core, as illustrated in Fig. 5-10. The multi-

layer core is composed of an upper layer 3A, a lower layer 3C and an intermediate layer 3B placed between the other two.

[0068] The honeycomb layer 7 comprises a plurality of cells 16 interconnected with each other, as better illustrated in Fig. 11 and 12.

[0069] Specifically, the honeycomb layer 7 of the present invention provides a special honeycomb structure, where each cell 16 has at least a portion of the wall 17 not shared with the adjacent cell 16. In this manner, the cells 16 are at least partly independent of each other. This aspect is maximized when the cells 16 do not share any wall 17 with each other. Sharing a wall means that the wall of one cell is also the wall of another cell. The wall 17 of a cell 16 is not shared with another cell when the cells 16 have their own walls 17 and the cells 16 are independent of each other before being joined.

[0070] As illustrated in Fig. 5-12, the cells 16 have a tubular shape, preferably with a circular section, and, when joined together, form the honeycomb layer 7, as better illustrated in Fig. 11.

[0071] In the honeycomb layer 7 of Fig. 11, the cells 16 are independent cylindrical tubular elements connected to each other. The walls 17 of adjacent cells 16 are connected to form the honeycomb layer 7. The honeycomb layer 7 is then appropriately cut to obtain the desired shape. In the honeycomb layer 7 of Fig. 11 no walls 17 are shared and for this reason the resistance to deformation is maximized because the cells 16 support each other.

[0072] The honeycomb layer 7 can comprise cells 16 having different shapes from the circular one shown in Fig. 11 and 12. For example, the shape of the cell 16 may be squared, rectangular, recessed hexagonal, or have any other shape. Even in these cases, the walls 17 of the cells 16 may be completely or partially independent of each other.

[0073] The fact that the walls 17 of the cells 16 are at least partly independent of each other improves their reaction to compression along the longitudinal axis L of the cell 16.

[0074] In any case, the side walls of the cells can also be shared, as illustrated in Fig. 1-3 for the honeycomb layer 7. In particular, the honeycomb layer 7 of Fig. 1-3 has hexagonal shaped cells.

[0075] The wall 17 of the cell 16 may also have at least one geometric perturbation that develops on a plane orthogonal to the longitudinal axis L, so as to make the cell 16 slightly flexible to compression along the longitudinal axis L.

[0076] When the cells 16 are independent of each other, as illustrated in Fig. 11 and 12, i.e. when they have connected but not shared side walls 17, each cell 16 behaves like a spring compressed along its longitudinal axis L.

[0077] In the racket 1 according to the present invention, when the ball 20 hits the hitting surface 2, the

impact force of the ball 20 is distributed by the hitting surface 2 over a large number of cells 16 of the honeycomb layer 7. The impact force of the ball 20 causes the hitting surface 2 to flex, which consequently compresses several cells 16 axially. The walls 17 of the cells 16 flex slightly in an elastic manner, reacting to the compression with an elastic force that tends to return the cells 16 to their original shape. Consequently, the hitting surface 2 that is impacted by the ball 20 is pushed by the elastic force of the cells 16 and the ball 20 rebounds more energetically.

[0078] Furthermore, when the open cell 16 has a cylindrical shape, as illustrated in Fig. 11 and 12, the reaction of each single cell to the compression along the longitudinal axis L is optimized and any possible lateral bending of the cell 16, which would tend to make it collapse rapidly, is supported and avoided by the adjacent cells 16. The cells 16 are in fact interconnected to each other through their side walls 17, as illustrated in Fig. 11 and 12. Specifically, each cell 16, except those at the edges of the honeycomb layer 7, is surrounded and connected to six other neighbouring cells 16, as in Fig. 11 and 12. The walls 17 of the cells 16 can be joined to each other through an adhesive material. Alternatively, each cylindrical cell 16 can comprise an internal polycarbonate cylinder externally wrapped by a thin layer of polyester. Since the melting point of polyester is lower than that of polycarbonate, tubular cells previously joined together so as to minimize the intercellular gaps can be joined together by raising the temperature above said melting temperature of the polyester, so as to melt the polyester coatings together and weld the adjacent cells together. Other materials and methods of joining the cells 16 are possible without departing from the scope of the present invention.

[0079] The honeycomb layer 7 may alternatively have cells 16 with completely shared walls 17.

[0080] The cells 16 of the honeycomb layer 7 of Fig. 11 and 12 have an initial elastic behaviour when compressed along the axis L. If the honeycomb layer 7 is further compressed until it reaches and exceeds the yield strength of the material, the cells 16 deform plastically, progressively crumpling along the longitudinal axis L in an irreversible manner. By appropriately selecting the material of the cells 16, the thickness of the walls 17 of the cells 16 and the size of the cells 16, it is possible to adjust the behaviour of the honeycomb layer 7 upon impacts with the ball 20, increasing its out-of-plane stiffness and avoiding plastic deformation of the cells 16. The honeycomb layer 7 of the present invention is in fact designed to operate in the elastic behaviour range. For example, very thin walls tend to deform plastically more easily than thicker walls. Conversely, thicker walls make the honeycomb layer 7 heavier and therefore unsuitable for use inside a paddle racket 1. The threshold beyond which the cells 16 collapse and deform plastically, in the face of a longitudinal compression along the axes L, is proportional to the

modulus of elasticity of the material used to make the walls 17 and to the square of the ratio between the thickness of the walls 17 and the size of the cell 16. Small cells and/or thick walls, together with harder materials, make the honeycomb layer 7 more stable and therefore less likely to deform plastically. For the same size of the cells 16 and thickness of the walls 17, the choice of material affects the elastic response of the honeycomb layer 7. More elastic materials will absorb the impact of the ball 20 more, while stiffer materials will make the racket 1 more rigid and reactive to impacts with the ball 20.

[0081] Preferably, the thickness of the walls 17 of the cells 16 is less than 0,1 mm.

[0082] As illustrated in Fig. 11 and 12, the front and rear edges 19 of the cells 16 are very thin and only minimally limit the passage of air through the holes 4,18 of the racket 1.

[0083] Preferably, the cells 16 have walls 17 made of plastic material. Plastic materials such as PC (polycarbonate) allow for a greater elastic reaction to axial compression and therefore a push of the racket 1 on the upper ball. Other possible plastic materials may be PVC (polyvinyl chloride), PET (polyether heptalate) or ABS (acrylonitrile butadiene styrene).

[0084] Alternatively, the honeycomb layer 7 can be made of an elastic material, such as rubber, in order to combine the elastic properties, which are currently the prerogative of the polymer foam layer of traditional rackets, with the permeability of a honeycomb structure.

[0085] In the example of Fig. 1-3, the honeycomb layer 7 can be made of an elastic material that never deforms plastically in the bending range of the hitting surface 2 and, although deforming, returns to its original shape when the stress ceases.

[0086] The density of the honeycomb layer 7 is preferably greater than 50 kg/m³, even more preferably greater than or equal to 60 kg/m³.

[0087] Foam layer 5 is a polymer foam layer with a density less than 40 kg/m³, preferably less than or equal to 30 kg/m³.

[0088] Since foam layer 5 is less dense than honeycomb layer 7, foam layer 5 is thicker than honeycomb layer 7.

[0089] The foam layer 5 can be an EVA (ethylene vinyl acetate) foam layer, a polyethylene foam layer or a TPE-E (thermoplastic polyester elastomer) foam layer. In particular, these foams can be nitrogen-filled.

[0090] The foam layer 5 has elastic properties, but also serves to dissipate part of the energy of the impact of the ball 20 against the hitting surface 2 which, due to the rigidity of the hitting surface 2, is converted into vibrations which, propagating along the shell 6 can reach the handle 8 and therefore the player's hand.

[0091] The inner core 5 is preferably made of three layers.

[0092] The foam and the honeycomb layers 5,7 may

alternate so that the intermediate layer 3B, thus the one in the center of the thickness of the inner core 3, is the foam layer 5 or the honeycomb layer 7, as illustrated respectively in the second embodiment of Fig. 5-7 and in the third embodiment of Fig. 8-10.

[0093] The layers of the inner core 3 are joined together, preferably with glues. Good results have been obtained using neoprene glues.

[0094] The upper layer 3A and the lower layer 3C of the inner core 3 are then joined to the inner faces 2" of the hitting surfaces 2.

[0095] If the upper and lower layers 3A,3C are honeycomb layers 7, the connection between the internal face 2" of the hitting surface 2 and the honeycomb layer 7 can be achieved by means of viscous glues which, by pressing the honeycomb layer 7 against the internal face 2", tend to rise up the walls 17 of the cells 16 and better adhere the cells 16 to the hitting surface 2. Alternatively, the connection between the honeycomb layer 7 and the hitting surface 2 can be obtained by means of a thermal glue, a thermosetting epoxy resin or a two-component glue.

[0096] If the upper and lower layers 3A,3C are foam layers 5, the connection between the inner face 2" of the hitting surface 2 and the foam layer 5 can be made with a glue similar to that used in the connection between the honeycomb layer 7 and the foam layer 5.

[0097] The honeycomb layer 7 is permeable to air as it is formed by open cells 16 with longitudinal axes L oriented orthogonally to the hitting surfaces 2.

[0098] To make the honeycomb layer 7 permeable to air and/or visible, the foam layer 7 comprises one or more through holes 18 which are coaxial with respective holes 4 of the hitting surface 2.

[0099] Each hole 18 of the foam layer 7 has the same shape and size as the respective holes 4 of the hitting surfaces 2. In essence, the racket 1 is perforated from side to side with one or more holes that would be through holes if it were not for the presence of the honeycomb layer 7, which instead is not perforated.

[0100] Through the hole 4 or holes 4 of the contact surfaces 2 and through the hole or holes 18 of each foam layer 5 it is therefore possible to easily see, and if desired also touch, the honeycomb layer 7, as illustrated in Fig. 1, 5 and 8.

[0101] The honeycomb layer 7 extends transversely, i.e. in the right-left R-L and top-down T-D directions, through each hole 4, 18, so that, when observing the racket from the front or from behind, the front or rear edges 19 of the cells 16 are visible within the perimeter of each hole 4, 18. In particular, through each hole 4, 18 it is possible to distinguish, even if only partially, one or more cells 16 of the honeycomb layer 7.

[0102] By varying the thickness of the honeycomb layer 7 or its characteristics, such as the size of the cells 16, the thickness of its walls 17 and/or the material, it is possible to make the inner core 3 more rigid.

[0103] In the embodiment of Fig. 1, 2 and 3, only the

hitting surfaces 2 are perforated since the racket 1 does not have any foam layer 5. Specifically, the holes 4 are one for each hitting surface 2 and the holes 4 are identical and coaxial.

[0104] In the embodiment of Fig. 5-7, a hitting surface 2 is perforated and the foam layer 5 is also perforated. Specifically, the hole 4 of the front hitting surface 2 and the hole 18 of the foam layer 5 are identical and coaxial.

[0105] In the embodiment of Fig. 8-10, both hitting surfaces 2 are perforated and each of them comprises a plurality of holes 4. The two foam layers 5 are also perforated and the holes 18 of the foam layers 7 are identical and coaxial to the respective holes 4 of the hitting surfaces 2.

[0106] Other combinations of holes and layers different from those illustrated are possible. Specifically, the holes 4 for each hitting surface 2 can be one or more and be present on one or both hitting surfaces 2. The foam layers 5 can be absent or present in an even or odd number and can comprise one or more holes 18 or no holes. In all versions, the cells 16 of the at least one honeycomb layer 7 remain visible, at least in part, from the outside through the holes 4, 18.

[0107] When the holes 4 of the hitting surfaces 2 are coaxial with the respective holes 18 of each foam layer 5, as illustrated in Fig. 8-10, the air can pass from one side of the racket 1 to the other, even if the air flow is partially limited by the edges 19 of the cells 16 of the honeycomb layer 7. In practice, if the inner core 5 comprises at least one foam layer 5, this comprises one or more holes 18 coaxial with the holes 4 of the hitting surfaces 2 to allow the passage of air through the racket 1.

[0108] In the case of an inner core 5 composed only of a honeycomb layer 7, air can pass through the racket 1, and the flow of air passing through it is minimally limited by the cells 16 of the honeycomb layer 7.

[0109] The upper layer 3A is equal to the lower layer 3C to make the racket 1 symmetrical in terms of masses in the front-back direction F-B. In particular, the upper layer 3A has the same thickness as the lower layer 3C, as can also be appreciated in Figs. 6, 7, 9 and 10.

[0110] The alternation of soft and elastic foam layers 5 with more rigid honeycomb layers 7, allows to optimize the rigidity of the inner core 5 and therefore the rigidity, in the front-back direction F-B of the racket 1.

[0111] The density of the material from which the shell of traditional rackets is made is tens or hundreds of times higher than the density of the polymer foam inside the shell. The polymer foam cushions the impact of the ball against the racket and provides an elastic effect that helps to bring the flat portion of the shell back to its original position. Following multiple flexions due to impact with the ball, the hitting surface of traditional rackets tends to fracture at the holes. For this reason, the racket 1 of the present invention combines

a limited number of holes 4 in the hitting surface 2 with an inner core 3 that is more rigid and therefore capable of better supporting the flexions of the hitting surfaces 2. In this way, the racket 1 has a longer useful life.

[0112] The specific technical features of the embodiments described above can be combined with each other in a manner different from that described and illustrated in the figures. For example, the racket of the first embodiment or of the third embodiment can have a shell 9 divided into two half-shells 9A,9B as illustrated and described for the second embodiment. It is also possible that the honeycomb layer illustrated in Fig. 1-3 is used in the rackets of the other embodiments. For the sake of brevity, the other possible combinations of the technical features of the various embodiments described above are not herein described.

[0113] In conclusion, the invention thus conceived is susceptible to numerous modifications and variations all falling within the scope of the inventive concept, furthermore all the characteristics are replaceable with technically equivalent characteristics. In practice the quantities can be varied according to the specific technical needs. Finally, all the characteristics of the previously described embodiments can be combined in any way, so as to obtain other embodiments that are not described here for reasons of practicality and clarity.

Legend of reference signs:

[0114]

- 1 paddle racket
- 2 hitting surface
- 2' outer face
- 2" inner face
- 3 inner core
- 3A upper core layer
- 3B intermediate core layer
- 3C lower core layer
- 4 hole (of the hitting surface)
- 5 foam layer
- 6 shell
- 6A,6B half-shell
- 7 honeycomb layer
- 8 handle
- 9 sidewall
- 10 connecting portion
- 11 handle section
- 12 grip
- 14 head portion
- 15 connection (of the connecting portion)
- 16 cell
- 17 wall (of the cell)
- 18 hole (foam layer)
- 19 edge (of the wall of the cell)
- 20 ball
- 21 coupling element

L longitudinal axis

Claims

1. Paddle racket (1) comprising two hitting surfaces (2) for hitting the ball (20), a handle (8) and an inner core (3) arranged between the two hitting surfaces (2);

wherein at least one hitting surface (2) comprises at least one through hole (4);
 wherein the inner core (3) comprises a honeycomb layer (7) comprising a plurality of open cells (16) having longitudinal axes (L) perpendicular to the hitting surfaces (2);
 wherein the inner core (3) extends transversely through said at least one hole (4) so that, when observing the racket (1) from the front, the hole (4) is partially obstructed by the walls (17) of the cells (16) of the honeycomb layer (7).

2. Paddle racket (1) according to claim 1, wherein the hitting surface (2) is continuous, flat and closed, and has a single hole (4)

3. Paddle racket (1) according to claim 1 or 2, wherein each hole (4) of a hitting surface (2) is coaxial with a corresponding hole (4) of the other hitting surface (2) to allow air to pass through said holes (4) and through the cells (16) of the honeycomb layer (7).

4. Paddle racket (1) according to any of the preceding claims, wherein the inner core (3) is a multilayer core comprising an upper layer (3A), a lower layer (3C) and an intermediate layer (3B) stacked between the upper and lower layers (3A,3B); and wherein the honeycomb layer (7) is the intermediate layer (3B) and the upper and lower layers (3A,3C) are foam layers (5), or the upper and lower layers (3A,3C) are honeycomb layers (7) and the intermediate layer (3B) is a foam layer (5).

5. Paddle racket (1) according to claim 4, wherein the foam layer (5) is perforated with at least one through hole (18), and each hole (18) of the foam layer (5) is coaxial with respective holes (4) of the hitting surfaces (2) so that the air passes through the holes (4,18) of the hitting surfaces (2) and of the foam layer (5) and through the cells (16) of the honeycomb layer (7).

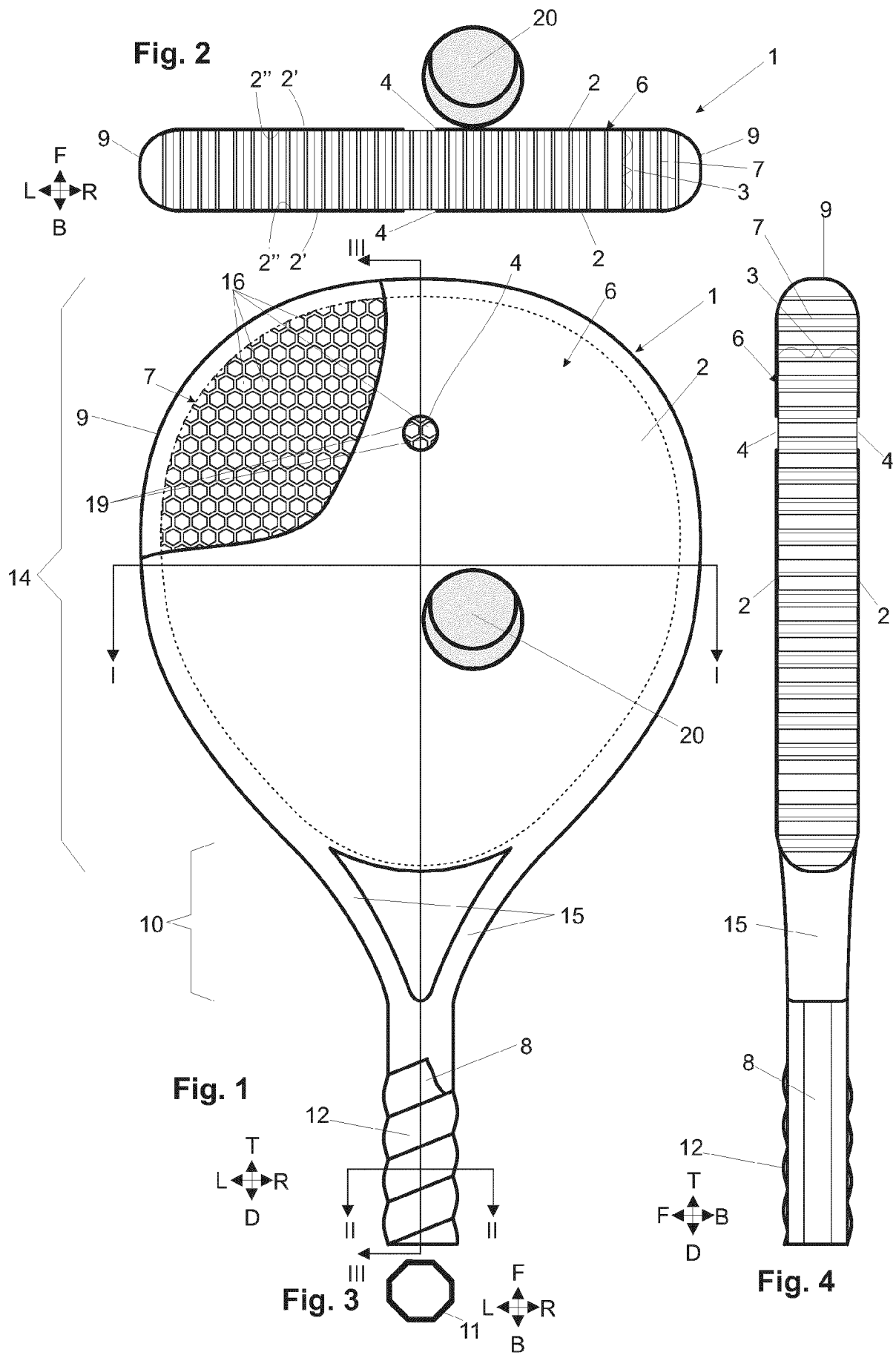
6. Paddle racket (1) according to claim 4 or 5, wherein the honeycomb layer (7) has a density higher than the density of the foam layer (5), preferably the density of the honeycomb layer (7) is more

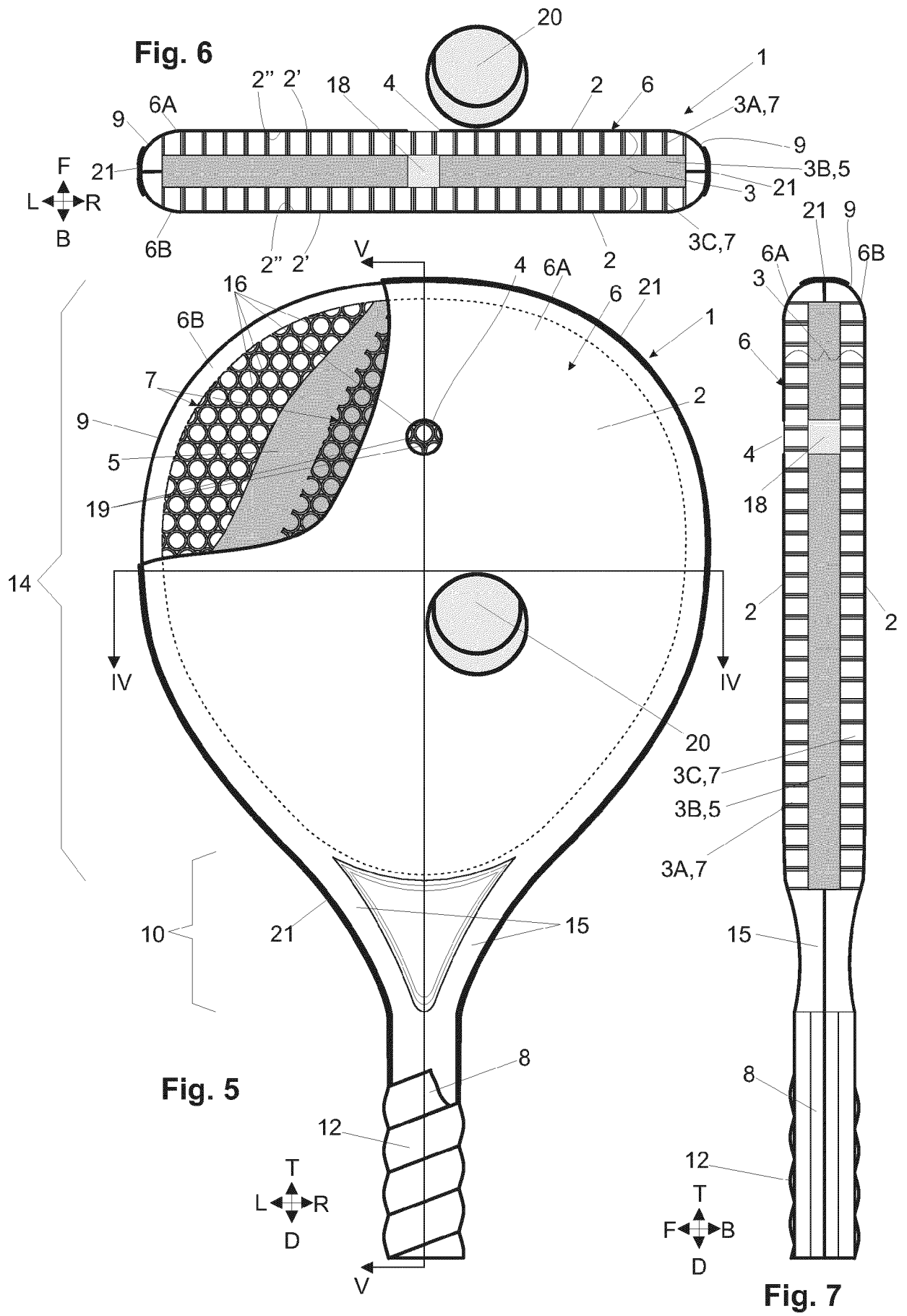
than double the density of the foam layer (5).

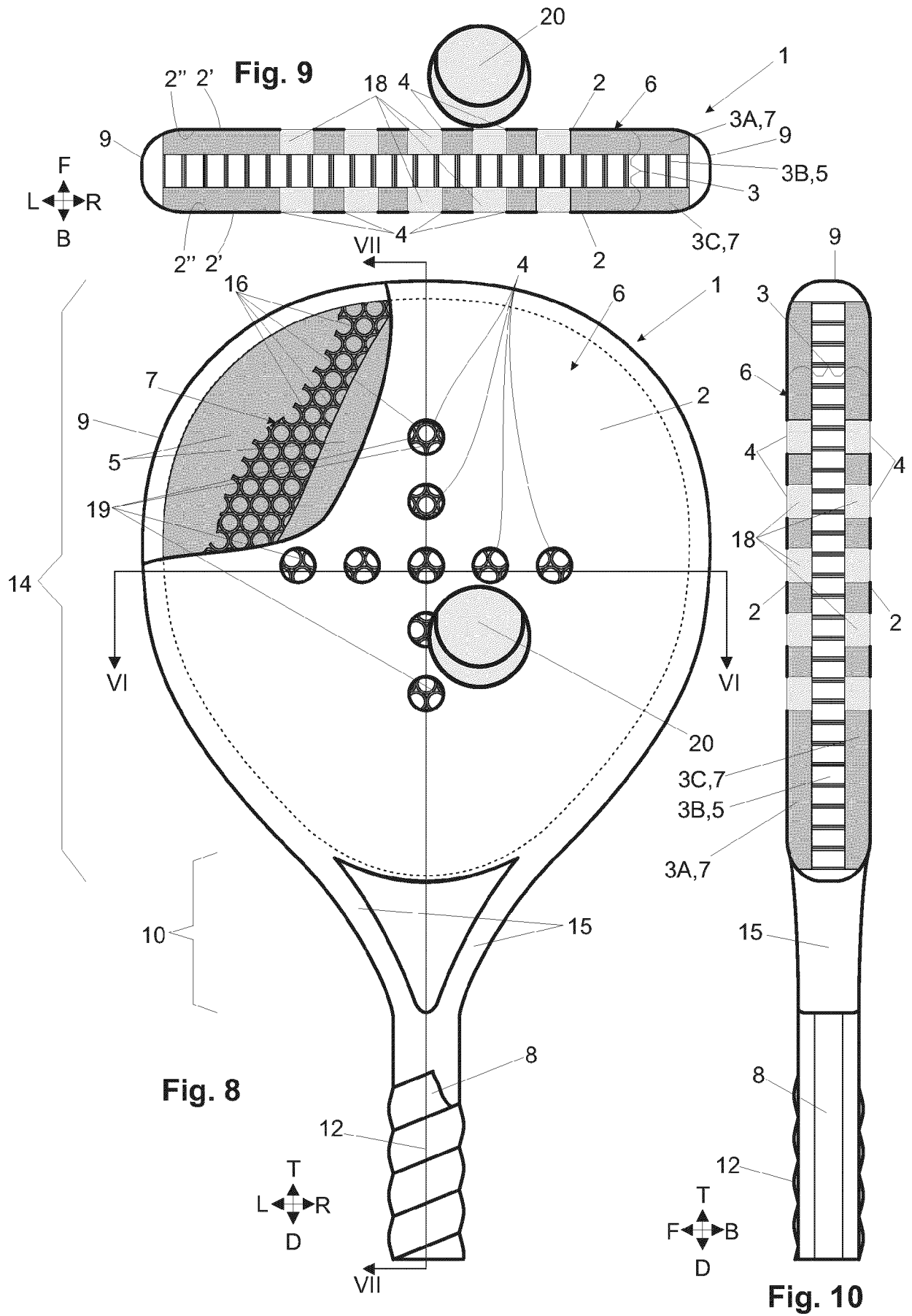
7. Paddle racket (1) according to claim 6, wherein the honeycomb layer (7) is thinner than the foam layer (5). 5
8. Paddle racket (1) according to any of claims 4 to 7, wherein the hitting surfaces (2) are respectively joined to the upper layer (3A) and the lower layer (3C), and the intermediate layer (3B) is joined to the upper and lower layers (3A,3C), preferably said joining is achieved by means of an adhesive or fusion. 10
9. Paddle racket (1) according to claim 8, wherein the upper layer (3A) is equal to the lower layer (3C). 15
10. Paddle racket (1) according to any of the preceding claims, wherein the handle (8) is rigidly connected to the hitting surfaces (2). 20
11. Paddle racket (1) according to claim 10, wherein the hitting surfaces (2) are connected to each other via a sidewall (9) which is also connected to the handle (8), preferably the hitting surfaces (2) and the sidewall (9) are connected to the handle (8) via a connecting portion (10). 25
12. Padel racket (1) according to claim 10 or 11, wherein the hitting surfaces (2) and the sidewall (9) form a head portion (14) of the racket (1) which has a rounded external shape without sharp edges. 30
13. Paddle racket (1) according to claim 11 or 12, wherein the hitting surfaces (2), the handle (8), the sidewall (9) and the connecting portion (10) are part of a shell (6). 35
14. Paddle racket (1) according to claim 13, wherein the shell (6) is a single piece. 40
15. Paddle racket (1) according to claim 13, wherein the shell (6) is divided into two half-shells joined together directly or via a coupling element (21). 45

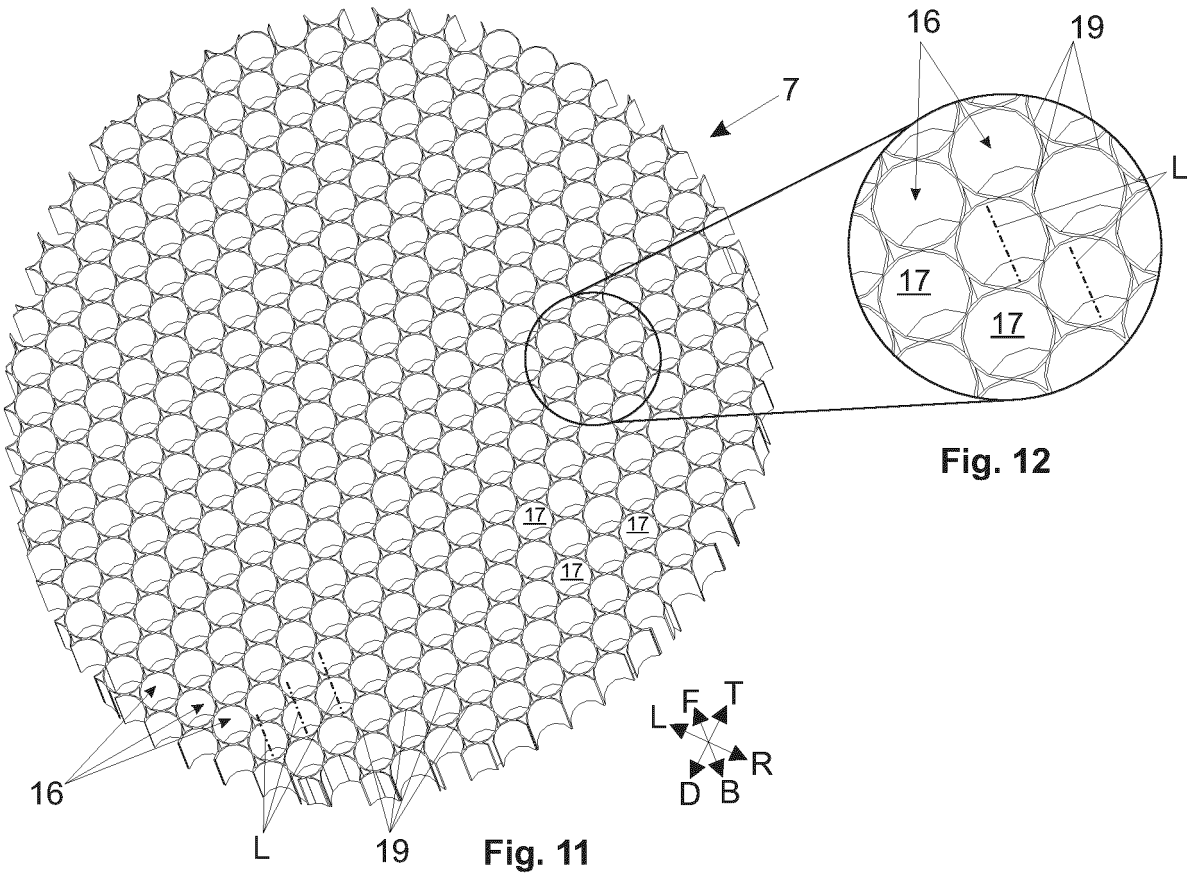
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