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(54) Table tennis bat provided with a frame having a differentiated structure, particularly for sporting games and competitions

(57) Table tennis bat constituted by a frame comprising a handle and a blade having a differentiated structure such as to imparts the table tennis bat pre-fixed characteristics of reaction and bounce following the impact of the ball, particularly suitable for sporting games and competitions.

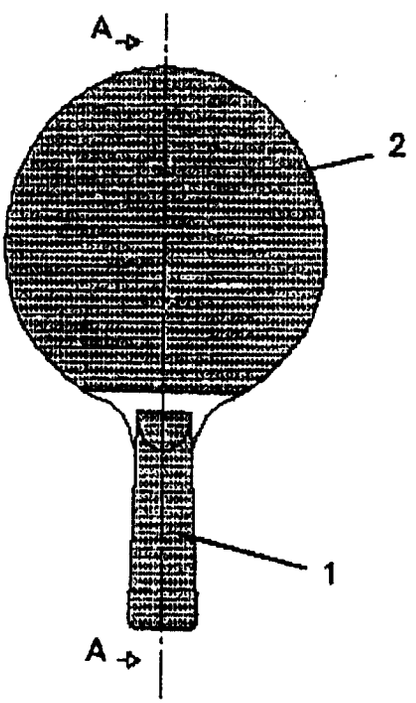

Fig.1

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Description

This invention relates to a table tennis bat having a differentiated structure bat, particularly suitable for sporting games and competitions, such as to impart the equipment particular characteristics of reaction and bounce following the ball impact, so that the user can react promptly and in an appropriate manner to the various types of stresses.

According to the known art, table tennis bats are realized by cutting out from a multilayer plywood made from different woods, a flat and uniform shaped piece which is then fastened by glueing to a handle, which is also realized, in the most precious types, from multilayer wood. Such structure is normally called frame, while the flat shaped portion is called blade. Sometimes one or more layers constituting the slab from which the blade is obtained, are realized from materials other than wood, such as glass, carbon, kevlar fibres or mixed fibres, impregnated with resin. For the practical utilization in the game, a layer of variously constituted rubber is glued on both faces of the blade, which rubber has the function of elastic intermediate layer during the impact between ball and frame.

In all cases, the basic construction and realization characteristics according to the known art are constituted by the fact that said blade is always made from solid and relatively heavy wood layers. Such layers, which are almost always no less than five, are so arranged that the fibres have crossing directions, with the purpose of obtaining a blade with a stiff loadbearing structure almost isotropic in all directions.

Besides, even though such layers are made from different woods, they have moduli of perpendicular elasticity E and tangential elasticity G not too different from one another, with a typical ratio between the values of the stiff layers and the soft layers of about 2-3, and even of about 6-8 if carbon or kevlar fibre layers are interposed. Besides, the ratio between the total thickness of the stiff layers and the soft ones is always about 1, while the succession of stiff and soft layers is alternate, and the position of each layer within the multilayer whole is not critical.

In compliance with the above criteria, different types of natural woods are used in the composition of the layers constituting the blade, with the exclusion of natural cork, as its mechanical characteristics, compared with usual woods, are remakably lower and not such as to impart enough global stiffness to the structure.

While it is known that in the past also applications of cork layers on the blade of table tennis frames have been realized, such applications were only limited to the two outermost layers of the blade, i.e. those that get directly in touch with the ball. These cork elements had therefore only the function of providing a more elastic dampening to the ball impact, and not that of contributing to the overall stiffness of the equipment, which was provided only by the underlying layers of more solid woods, so that this solution was then rapidly given up, and the cork layers were replaced by more effective rubber layers.

It is also known that the performances of a table tennis frame are mainly evaluated on the basis of the "return stroke" or bounce modalities of the ball on the blade. Such basic performances include:

- Bounce uniformity, i.e. the capacity the frame as a whole has to cause the ball that strikes with a given velocity a point whatever of the blade to bounce in a quantitative constant and repetitive manner.

In tha bats according to the known art, only a limited zone of the blade is recognized to have a satisfatory uniforme bounce, and therefore only a small area may be effectively utilized in the play; beyond such area the bounce is not uniform and is casually variable from point to point. If the bounce takes place in such points, the return stroke is very likely to fail.

- Type of bounce, which may be quick, medium, dampened.

The definitions measure quantitatively the scale of the bounce in the return stroke characterized by a given relative ball-blade impact.

With the type of structures adopted for the frame blade of the known art, this characteristic results to be proper of each frame type, which is therefore chosen according to the type of play preferred by the player (attack, allround, defence), and this as the equipment cannot have at the same time and to a high degree dampening and velocity qualities. On the contrary, it would be desirable and highly convenient to have structures capable of supplying dampened returns in case of strokes in which the ball strikes at high velocity the almost immobile blade (defence), and accelerating returns in the opposite case (attack), and this to be in condition of adapting the play to the changing circumstances which may occur during a game.

It is also known that the bats according to the known art show the so-called "edge effect", ascribable to the structural characteristics of the blade, caused by the presence in the blade of an ideal band around the edge, on which the bounce is strongly dampened and in some points even non existent, which causes a completely unpredictable behaviour of the bat.

In the bats made according to the known art, the factors determinating the quality of the return strokes are, in order of importance, and obviously besides the skill of the players, the type of adhesive glue between the rubber and the blade, the nature of the rubber, the structure of the blade and lastly, with an almost negligible effect, the structure of the handle.

According to the known art, the shape and the materials utilized for the handle are chosen with the sole purpose of easing the use of the equipment and of stiffening the frame as a whole, and therefore the bat.

The basic element characteristic of the bat handles according to the known art, besides ergonomics, lies therefore in that they have a high and almost uniform bending stiffness around each main inertia axis (XYZ

axes of Fig. 14).

It is also known that a very frequent and effective return stroke, called sometimes spin or top spin, consists in that the ball is spin-striken with great energy, and accompanied for a short length by an oblique movement of the hand which holds the bat. This movement, causing an effect of tangential stroke on the ball, causes the latter to quickly rotate on itself and the trajectory becomes a wide parabola which ends in the opposed field, where said ball which still retains much of the initial rotatory effect, rebounds in an unforeseeable direction. The effectiveness of this strole is such that it is often conclusive.

In this and other like strokes based on so-called spin effects, which are of the essential in modern competitions, the effectiveness is caused above all by the quality of the glue between the rubber and the blade, and in particular the so-called "fresh" type has proved to be the most effective one, while the so-called "dry" type cannot be used, as it involves a marked disadvantage.

However, the type of so-called "fresh" glue, universally adopted in competitions, has many drawbacks relatively to the so-called "dry" type. It needs being renewed many times during a tournament, it is suspected to be toxic, deteriorates the rubbers which must be frequently replaced, and lastly represents a high running cost.

It is known that, in the table tennis bats of the known art, the player has a very little sensitivity as concerns the exact moment and the impact point of the ball on the bat. In table tennis bats, this fact is due to the very short time in which the impact exhausts - about one millisecond - and the small amount of energy which the ball can transfer to the bat, given the exiguity of the impacting mass (about 2.5 g). The detection of such phenomenon by the player is therefore entrusted to the aleatory evaluation and subjective imagination rather than to the sensory acquisition of a precise and unequivocal characteristic signal. It is also known that, compared with the limitations of the present bats, for the player it is of the essential to acquire in real time the sense of the exact moment, the force and the impact point, for a perfect mastery and control of the stroke. With the bats of the known art, such sensitivity can be acquired only to a very small extent after a very long training devoted to a specific equipment, but this capacity remains always dependent upon the subjective and non quantifiable individual skills.

Object of this invention is to provide a table tennis bat having the capacity of causing the ball to bounce in a quantitative constant manner on a wide surface of the blade and with the utmost bounce uniformity, both in the middle and in the zone near the periphery of said blade, ensuring therefore the return stroke a high reliability and certainty.

Another object of this invention is to provide and put at disposal a table tennis bat having at the same time high control characteristics, namely dampening capacity in the impact relative middle-velocity return strokes, and velocity characteristics, namely ball acceleration capacity in the impact relative high velocity of return strokes.

Still a further object of the invention is to provide a table tennis bat realized according to the type of play and in particular the type of return stroke the user wishes to perform.

A further object of the invention is to provide and put at disposal a table tennis bat substantially free from "edge effect", i.e. from zones on which the ball bounce is dampened and/or nonexistent.

Object of this invention is to provide a table tennis bat constituted by a frame whose shape is determinant for the performances obtained in the return strokes with spin movement of the types called spin or top spin strokes, as it can impart the ball a high rotation.

A further object of the invention is to provide a table tennis bat that can impart the ball wide parabolic trajectories in the strokes made with a spin movement like those called "spin" or "top spin" strokes.

A further object of the invention is to provide a table tennis bat which can be advantageously utilized without having to use "fresh" glues and such as to allow to achieve equivalent performances by using, instead of "fresh" glues, so-called "dry" glues, eliminating in this way also the risk for the user to breath in dangerous and or harmful solvents.

Object of this invention is to provide a handle for sports equipments or articles and the like, suitable to transmit the user of the equipment the stresses - such as impacts or blows against free bodies or the likes received by said equipment - suitably amplified and selected so that the user can promptly and adequaly react to said stress, according to the intensity and type of the latter.

A further object of this invention is to provide a handle for sports equipments and the like, suitable to select the stresses imparted to the equipment, and to transmit suitably amplified to the user only the stresses chosen according to the use for which said equipment is intended.

A further object of this invention is to provide a handle for sports equipments and articles capable of transmitting the user, suitably amplified and selected, the stresses imparted to the equipment, of smooth and easy use and such as not to involve complications and/or heaviness in the equipments with the related discomforts or drawbacks for the user.

These and still other objects and relative advantages which will result from the following description are reached by a table tennis bat constituted substantially by a handle and a shaped portion or blade wherein the multilayer structure of the blade includes at least a layer of natural cork, so arranged and shaped as to constitute a basic element of said structure or which blade comprises a light, elastic and flexible central part or zone, and a peripheral edge heavier and stiffer compared with said central part, or wherein the frame can elastically bend following external stresses in the table plane, while it is stiff in the plane orthogonal to the plane of said blade and is such, besides, as not to undergo torsional elastic

deformations relatively to its longitudinal axis or wherein the handle comprises at least a vibrating elastic element fastened to said structure and/or said handle in one or more points, and resonant with a suitable range of frequences generated by the vibrations ensuing from the stresses imparted to said structure, so as to amplify said vibrations and transmit them to said handle and therefore the user through suitable contact points.

Experimental researches and theoretical studies of the complex phenomenon of the impact between ball and frame show that the structure of the blade most suitable to provide a great bounce uniformity and, besides, a dampening behaviour in case of high speeds of the ball that strikes the frame considered as being still, and a strong acceleration of the ball when it is still while it is stroken by the frame which, on the contrary, moves at high speed, which is different from the frames of the known art.

In fact, the most suitable structure is constituted by a three-layer plywood wherein there are a thick core, elastic, light, homogeneous an yielding, and two external leaves from a much stiffer material having a modulus of elasticity E from 100 to 1000 times greater that that of the core. Besides, the ratio of the overall thickness of the stiff layers and the overall thickness of the soft layer(s) must be comprised between 0.75 and 0.04. Moreover, the specific weight of the core must be as reduced as possible, lower than 200 kg/m^3. The stiff layers may be constituted either from synthetic fibres, such as carbon, kevlar, glass or mixed, impregnated with resin, or from thin one-layer or multilayer wood, provided they have a high modulus of elasticity (greater than or equal to 700-1200 kg/mm^2), or from a combination of layers from synthetic fibres and resin, such as carbon, kevlar, glass and the like, together with wood layers. Alternatively, also four-layer structures are effective, in which, besides the above described layers, also two additional thin layers are comprised made from fibre o wood are located in the external part of the blade. The aforementioned optimum "return" characteristics are achieved in fact by a table structure obtained by coupling materials having markedly different characteristics, and so arranged that each layer satisfies one only specific task: the soft inner layer(s) has the task of imparting elasticity to the impact with the ball, while the outermost stiffer ones have the task of imparting the necessary stiffness to the equipment. The position of the layers within tha blade structure must not be one of simple alternance, but such as to cause a moment of bending transversal inertia as high as possible to said blade. This must be obtained in spite of the presence of the soft layers, and therefore the stiff layers must be arranged in the external zones of the blade, suitable spaced from one another. In the inside, and with a structural function as a spacer of the resistant layers there must be the layer(s) from soft and yielding material. For this reason, the position inside the multilayer of the resistant and soft layers, their alternance as well as their reciprocal thicknesses are no longer indifferent or casual, but are chosen with a specific aim, with the resistant layers preferably located outside and the yielding ones inside.

With this structure, the blades have a large area of uniform return and such as to comprise almost all the useful surface of said blade. Besides, they have a so-called two-velocity behaviour in the return strokes, namely a dampening effect in the strokes with medium-low impact energy (typical of defense strokes) and an accelerating effect in the strokes with high impact energy (typical of attack strokes). The two velocities are due to the different reation to the impact of the two markedly different types of layers constituting the blade. Of the essential for the above described behaviour is the choice of the type of material used to realize the internal yielding layer(s) of the blade structure, and the practical conclusion is that natural cork, in the types with fine structure and low density, has at the same time the characteristics necessary to obtain the effect desired: very low traction elasticity modulus (lower than 200 kg/mm^2), minimum specific weight (lower than 200 kg/m^3), remarkable elastic lenghtenings and almost homogeneous and isotropic internal structures.

By way of non limitative example, the construction ratios and the characteristics of the layers constituting two different blades suitable to supply the performances object of this invention are indicated in the following. First type:

- overall thickness of the blade: 5.5 mm
- number of layers: 5
- arrangement of layers: symmetrical
- outermost layers: 2 of 0.25 mm of thickness each, from tanganika type wood
- intermediate layers: 2 of 0.25 mm of thickness each, from a fabric of carbon-kevlar mixed fibres (warp: 140 g/m^2 of carbon, weft: 85 g/m^2 of kevlar) impregnated with epoxy resin (traction elasticity modulus of the polymerized fabric about 45 GPa)
- central layer; 1 of 4.5 mm of thickness, from natural cork having a fine and homogeneous structure, with a density of about 100 kg/m^3).

Second type:

- overall thickness of the blade: 5.1 mm
- number of layers: 3
- arrangement of layers: symmetrical
- outermost layers: 2 of 0.8 mm of thickness each, from multilayer birch plywood, modulus of elasticity

> 800-1000 kg/mm^2

- central layer: 1 of 3.5 mm of thickness, from natural cork having a fine and homogeneous structure, with a density of about 100 kg/m^3).

More generally, the number of layers, the overall thickness of the blade, the thicknesses of the individual resistant and yielding layers as well as the more suitable elastic characteristics of the layers according to this invention must be chosen from the aforementioned ranges of values on the basis of the results of practical play tests or comparative experimental tests and according to the functions of the desired return stroke characteristics.

More particularly, according to a first embodiment of the invention, the blade is made from a plywood constituted by three layers whose two outermost layers are from homogeneous wood - or from plywood in their turn - or alternatively the external layers are made from a fabric of carbon, kevlar, glass or mixed fibres, while the central layer is from natural cork.

According to another embodiment of the invention, the blade is made from a plywood constituted by five layers, whose two outermost layers are from homogeneous wood - or from plywood in their turn - while the intermediate layers are made from a fabric of carbon, kevlar, glass or mixed fibres impregnated with resin, while the central layer is from natural cork.

According to another embodiment of the invention, the blade is constituted by the same layers of the preceding embodiment, wherein however the external layers are now made from a fabric of impregnated synthetical fibres, while the external ones are from wood.

According to another embodiment of the invention, the blade is made from a plywood constituted by five layers, whose outermost layers are from homogeneous wood - or from plywood in their turn - or from a fabric of impregnated carbon, kevlar, glass or mixed fibres, while the core of the plywood is constituted by two thick layers of natural cork, with a layer from wood or synthetical fibres thinner than the adjoining layers interposed between the cork layers.

According to another embodiment of the invention, the blade is made from a plywood composed by more than five layers, whose outermost layers are from homogeneous wood - or from plywood in their turn - or from a fabric of impregnated carbon, kevlar, glass or mixed fibres, or some of such layers are from wood and other ones from synthetical fibres, while the core of the plywood is constituted by an individual layer from natural cork, or more than one layer is from natural cork with one or more thin layers from wood or synthetical fibres, or some layers from wood and some one from fibre fabric are interposed between the cork layers.

It has been also noticed that radical improvements are obtained by adopting for the blade a structure obtained through the union of two elements having very different elastic and inertia characteristics: a relatively light, elastic and flexible central part to which the ball bounce is assigned, and an even small but relatively heavy and stiff edge. In this way a great bounce uniformity is obtained, and besides, by suitably chosing the thickness and the material constituting the central part, one can measure out the type of return stroke wished.

The useful area of the blade becomes therefore much larger and may comprise the whole surface of the blade, while the edge effect disappears, as the impact near the edge tends to assume a a neutral return characteristic, meaning that the bounce takes place by a ball velocity almost equal to the relative velocity before the impact. The reliability of the equipment results to be better and the failure probabilities of the return stroke due to the uncertainty of the bat behaviour are strongly reduced.

By way of non limitative example, there are indicated some construction ratios between edge and blade which, either individually or jointly, may be considered as typical to impart the bat the properties described in this invention to a remarkable extent.

Having called S the surface of the blade (including the edge but excluding the handle) and Sb the part of surface occupied by the edge only, Sb is indicatively comprised between 2% of S and 55% of S.

Having called EJ the total bending stifness of the straight section of the blade (including the edge but excluding the handle) and EbJb the analogous bending stiffness of the straight section of the edge only, EbJb is indicatively comprised between 15% of EJ and 60% of EJ.

Having called P the total weight of the blade (including the edge but excluding the handle) and Pb the weight of the edge only, Pb is indicatively comprised between 15% of P and 60% of P.

The choice of the ratios within the indicated range that are most suitable in the individual cases, is made as a theoretical experiment according to the global "return" characteristics required of the bat constituted by the edge and blade whole.

More particularly, according to this invention, said blade is made from materials such as wood, plastic materials, such as polyvinyl chloride, polyurethane and the like, metals such as light alloys and the like, plastic materials reinforced with glass or carbon fibres and the like, and/or by the association of two or more of said materials different from one another.

According to an embodiment of the invention, said central part or zone is constituted by a constant thickness flat slab from homogeneous or composite or multilayer material, and said peripheral edge constituted by an edge which surrounds fully or partly said central part is made from a different sfiffer material having a specific weight greater than the material of said central part, and is fastened to said central part by glueing, riveting, pressure, or the like.

According to another embodiment of this invention, said central part and said peripheral edge are shaped as

a constant thickness flat slab, said edge being realized by means of the application of reinforcing elements in the peripheral zone suitable to sfiffen the edge, so that the inertia and elastic characteristics of said central part and said edge are different from one another.

According to another embodiment of the invention, said central part and said peripheral edge are made from the same material and in one only piece, said central part being provided with local lightenings an unevennesses along substantially annular and concentric lines, spaced evenly or unevenly, which concern fully or partly the external surfaces of said central part or which are substantially concentrated in the core area of said central part.

According to another embodiment, said central part and said peripheral edge are made from the same material and in one only piece, said central part being corrugated either on one or on both external surfaces, so that said surface has alternatively a different thickness in the radial section, or, while having a constant thickness, the straight section of said central part has not a rectangular shape.

According to another embodiment, said blade comprising said central part and said peripheral edge is made fron one only piece whose thickness may be evenly variable along its radial section or at times constant and at times variable.

According to other embodiments, said blade is made by suitably combining two or more of the above described embodiments.

The choice of the most suitable embodiment for the blade according to this embodiment may be performed experimentally by attempts, based on the indications provided by expert players, depending on the type of play and return stroke wished. However, such choice may be also made based on the theoretical study of the ball/blade dynamic interaction during the impact as well as through simulations based on the finished elements of the phenomenon stressing the bounce unevenness and particularly the edge effect depending on the blade construction shape.

The study of the dynamic properties of a table tennis bat has shown that the effectiveness of the spin effect and consequently the amplitude of the subsequent parabolic trajectory depends directly on the elasticity of the blade's external surface layer met by the ball during the stage of impact with the equipment. In fact, to impart the ball high rotation velocities in the so-called spin strokes, it is of the essential to protract as much as possible the time when the ball remains in touch with the surface of the equipment, while reducing at the same time the component perpendicular to the impact repulsive force, which on the contrary tends to move the two bodies apart, shortening the impact time.

In the bats according to the known art, this effect is reached either by striking skilfully the ball with a characteristic obliquous movement of the arm, or by adopting suitable materials constituting the external layers of the blade. In particular, the interposition of so-called "fresh" adhesive glues between the surface rubber and the blade impart this type of stroke a remarkable effectiveness.

In fact, the so-called "fresh" glues constitute an elastic and deformable basis that reacts yieldingly to the impact, protracting the contact time and giving then back progressively the previously accumulated energy. On the contrary, the so-called "dry" glues, being stiffer, do not perform well in this use, so that they are almost ignored in competitions.

On the other hand, by indicating by X the longitudinal axis of the frame, by X-Y the blade plane, and by Z-X the plane orthogonal to the blade plane, the analysis of the elastic vibrations proper of a bat of the known art, understood as a body than can freely vibrate in the space, shows that there exists a vibration frequency proper in the X-Y plane, which plane comprises the medium plane of the blade. If this sequence is of sufficient size and is sufficiently stressed, it might supply a remarkable increase in the elasticity of tangential strokes. The blade, performing in this case as a spring which stores at first energy under the stroke, and then gives it back very rapidly, would be capable of causing the ball to rotate rapidly, thanks to this oscillatory movement.

But in the bats of the known art, the great stiffness of the handle towards the bending around the Z axis, perpendicular to the middle plane of the blade, causes this frequency to be about three times the elasticity frequency proper of the ball-rubber layer and consequently, given the difference of the pulsations proper of the two systems, the impact does not excite any useful vibration amplitude in the X-Y blade plane.

The frame of the bat subject matter of this invention is so shaped as to have a bending flexibility many times (>3) lower than the analogous bending stiffness around the Y axis and the torsional stiffness around the X axis, which keep a high value, equal to that found in the bats of the known art.

In this way, the blade results to be elastically yielding in its plane and the relative vibratory frequency lowers proportionally. This allows an active interaction of the small elastic movements of the blade during the impact with the ball, which starts rotating in the so-called spin-strokes.

Besides, the impact time becomes longer as at first the movement follows in synchronism and concordantly the shifting of the ball. This is the stage of elastic accumulation of the impact energy. There follows, in a second stage, a blade movement discordant relatively to the direction of the ball, which movement, giving back energy, causes said ball to strongly rotate.

Besides, the frame of the bat according to this invention is so shaped that the stiffness in the Z-Y plane and around the X axis remains high and greater than the stiffness in the aforementioned X-Y plane. This is necessary as some characteristics of return strokes other than the so-called spin-strokes and which depend on such stiffnesses would be severely prejudiced. Such

characteristics include, for instance, the return uniformity of the blade and the "velocity" of the strokes directed perpendicularly to the blade.

By way of indication, the following values - resulting from experiments - are mentioned:
having called k the ratio between the pulsation frequency in the X-Y plane of the bat whole and the frequency proper of the ball-rubber layer system, one has that for values of k equal to or lower than 2, the elastic effect of the frame in spin-strokes is already marked and increases as this factor decreases.

According to this invention, such characteristic is achieved, by way of non limitative example, by obtaining in the handle a wide through-opening, so that in a section of the latter made according to a plane parallel to Z-X, the resistant section of said handle is reduced to two high and relatively thin leaves having a constant thickness, but such that said handle shows a high deformability if it is stressed by a force parallel to the Y axis, and, on the contrary, a marked stiffness if it is stressed by a force parallel to the X axis. Such handle may be realized from any material either homogeneous or made from layered composite materials from wood and/or plastic materials and/or fibres in different parts, or also from homogeneous material reinforced by metal inserts or other inserts, provided that the end result is constituted by a structure wherein the above stifnesses have a marked difference from one another. The resistant part of the handle which is hold by the player and which represents the structural contrast to the forces which stress the blade, takes up a characteristic form of closed ring variously shaped, while the resulting cavity may be fully or partly filled, for ergonomic reasons, with soft materials that do not show an appraisable resistance to the bending and shear deformation in the X-Y plane, so as not to hinder the functioning of the handle and therefore the frame.

Said vibrating elastic element may be advantageously housed in spaces or cavities suitably obtained within said handle or located fully or partly in the external part of the handle.

Said vibrating elastic element, according to this invention, may be realized from different materials and have a different shape, and be fastened to said structure and/or said handle by mechanical fastening or glueing or may be formed as an integral piece from said structure or said handle.

More particularly, said vibrating elastic element is a device constituted by cantilever-leaves, bridge-leaves, fluids oscillating in special spaces or cavities either provided or not with vibrating walls, electric, electronic or electromagnetic units for the detection, amplification and transmission, or it may be constituted by the combination and/or association of one or more of said devices.

Particularly in the case of a table tannis bat, the impact of the ball on the bat gives rise within the frame of this sports equipment to vibrations that are characteristic of both the elastic properties of the impacting body and those of the impacted body; these weak vibrations propagate, mixing to one another, throughout the structure, handle comprised, and represent - excluding the sensory and optical control because of the very short times - the only source of persistent and proportional information source which user can have. The device according to this invention picks up such vibrations, selects them, amplifies them and transmits them to the user, through the interface unit between the equipment and the human body. In the case of table tennis, such interface is constituted by the handle. In this way, the player gets a strong, persistent and unequivocal sensory information on the moment and the point where the impact of the ball on the bat takes place, and acquires a marked and objective control of the stroke. In particular, through this increased control, the player, even though inexpert, reaches by a very short training the mastery of the equipment.

According to this invention, this is reached by providing the handle with one or more devices which perform the following functions:

Global and/or selective detection of the vibrations generated by the ball-bat impact.

Amplification of one or more characteristic frequencies.

Transmission of said amplified frequencies to the manequipment interface, namely the handle.

In practice, always in the particular case of the table tennis bat, the handle according to the invention detects, amplifies and transmits in real time to the user the signal and/or the vibration caused by the impact of the ball on said bat, which signal is such as to constitute a precise information to the player on the point, time and control of the impact.

The invention will be now described with reference to the attached drawings, enclosed by way of non limitative example of the invention, wherein:

Figs. 1 and 2 show respectively the front view and the A-A section of a table tennis bat with its constituting elements,

Fig. 3 shwos the detail of the cross section of the blade of a bat realized according to this invention, wherein such blade is made from a three-layer plywood,

Fig. 4 shows the detail of the cross section of the blade of another bat realized according to this invention, wherein such blade is made from five-layer wood,

Figs. 5 and 6 show the detail of the cross section of the blade of another bat realized according to this invention, wherein such blade is made from a plywood with five or more than five layers,

Fig. 7 shows schematically the bouncing zones of the ball on the blade of a bat realized according to the known art,

Figs. 8 and 9 show schematically two types of bats realized according to this invention in which the central part of the blade is made from a material other than the material of the edge.

Fig. 10 shows some embodiments of the edge for the blades of Figs. 8 and 9.

Fig. 11 shows a view and a part section of a bat according to the invention, in which the peripheral edge is realized by means of reinforcing elements,

Fig. 12 shows a view and a part section of a bat according to the invention, in which the blade is provided with annular concentric lightenings or is corrugated in the middle, in some different embodiments,

Fig. 13 shows a view and a part section of a bat according to the invention, in which the central part of the blade has a variable thickness, in some different embodiments,

Fig. 14 shows schematically the basic structure of a table tennis bat,

Fig. 15 shows an embodiment of this invention, realized in particular through a special shape of the bat handle,

Figs. 16/17a, 17b and 17c show by way of example different embodiments of the internal structures of the bat handle according to this invention,

Fig. 17 shows another handle of a bat according to the invention, according to a different embodiment,

Figs. 18 through 20 show, in the A-A section, the handle according to the invention, with a vibrating elastic element constituted by different types of projecting leaves, even differently embodied in the two halves of the same handle, fastened within the latter,

Fig. 21 shows the section of the handle according to the invention, wherein the vibrating elastic element is constituted by different types of projecting leaves located externally to the handle,

Fig. 22 shows the section of the handle according to the invention, with the vibrating elastic element made up by several pieces, being constituted in this specific case by a cantilever-leaf associated with a bridge leaf(s) differently embodied in the two halves of the handle,

Fig. 23 shows the section of the handle with the vibrating elastic element constituted by an oscillating fluid, differently embodied in the two halves of the handle,

Fig. 24 shows the section of the handle according to this invention, wherein the vibrating elastic element is constituted by a whole of detection, amplification and transmission units, differently embodied in the two halves of the handle, while

Fig. 25 shows the section of a handle wherein the vibrating elastic element is constituted by leaves fastened within the handle but protruding outside the latter.

With reference to such figures, the table tennis bats (Figs. 1 and 2) are made up by handle 1 and blade 2. On both faces of the blade, the rubber leaves 3 and 3a for the practical utilization of the bat during the game are glued. Fig. 3 shows the detail of the section of a blade constituted by three layers, whose layers 4 and 4a are made from natural wood having a high traction elasticity modulus, or from fabric from carbon, kevlar, glass or mixed fibres, impregnated with resin, while the internal layer 5, thicker than the preceding ones, is from natural cork. Fig. 4 shows the detail of the section of a blade constituted by five layers, whose layers 4 and 4a are made from homogeneous natural wood or plywood or a fabric from carbon, kevlar, glass or mixed fibres impregnated with resin, layers 6 and 6a are made from homogeneous wood or plywood or a fabric from carbon, kevlar, glass of mixed fibres impregnated with resin, while the internal layer 7, thicker than the preceding ones is from natural cork. Fig. 5 shows the detail of the section of a blade constituted by five layers whose layers 4 and 4a are made from homogeneous natural wood or plywood, layers 8 and 8a from natural cork, while the internal layer 9 is from homogeneous wood or plywood or a fabric of carbon, kevlar of mixed fibres impregnated with resin. Fig. 6 shows the detail of the section of a blade constituted by seven layers whose layers 4 and 4a are made from homogeneous natural wood or plywood or a fabric from carbon, kevlar, glass or mixed fibres impregnated with resin, layers 10 and 10a are made from homogeneous wood or plywood or a fabric from carbon, kevlar, glass or mixed fibres impregnated with resin, while the internal layer 11, thicker than the preceding ones, is from natural cork.

In Figs. 7 are schematically indicated, for the bat of Fig. 1 according to the known art, the uniform bounce blade zone 12, which is therefore useful and utilizable for the game, and the zone concerned by the edge effect 13, within which the bounce is uneven and casually variable from one point to another.

Figs. 8 and 9 show two types of bat according to this invention, wherein the central part 14 of the blade is made from a material other than the material of edge 15, which edge may take up different shapes, as shown in Fig. 10; for instance, it may have a rounded shape 15a, or it may have a substantially "H"-shaped section 15b,

or a hollow parallelepiped section 15c, or a hollow rounded section 15d, etc. In these embodiments, the blade is realized by means of the association of two parts from different materials and having different elastic characteristics, namely: a central constant thickness flat part 14 made from a slab of homogeneous or composite or multilayer material, characterized by a relative lightness and flexibility, and a stiffer part from a different material, such as metal or other materials, so shaped as to constitute edge 15 surrounding the central part 14. Such edge 15 may have the same thickness as the blade or a different thickness.

The peripheral edge 15 of the bat of Fig. 8 is "external" relatively to the blade, while in the bat of Fig. 9, it is "internal" to the blade.

In the bat of Fig. 11, the blade is made from one only piece, but so shaped that the inertia and elastic characteristics of the central zone 16 and of the edge 17 are caused to be different by the application of reinforcements 18 opportunely arranged in the peripheral zone and suitable to constitute an edge 17 stiffer than the central part 16.

In the bat of Fig. 12, the diversity of inertia and elastic behaviour of the two parts that constitute the blade is realized by suitably shaping the central part 19, to make it more elastic and/or lighter than edge 20. Such shaping provides for the individual or joint realization of lightenings 21, 22, 23 and/or local differences in the elastic characteristics of the blade along lines having an almost annular and concentric shape 19a, 19b, 19c, evenly or unevenly spaced, which may concern in full or partly the external surfaces of blade 22, or be limited to the core zone of the blade (21 and 23), so that the latter shows only a smooth surface, or the realization of local differences of the elastic characteristics of the blade along the lines obtained as described above, by suitably corrugating (24) one or both external surfaces of the blade, so that the latter has alternatively in the radial section a different thickness or, while having a constant thickness, the straigh section of the blade is no longer rectangular.

In the bat of Fig. 13 the blade is made from one only piece and has inertia and elastic characteristics different between edge 25 and the central part 26, obtained by means of variations of continuous thickness along the radial section as shown in 26a and 26c, i.e. the thickness is at times constant and at times variable, as shown for instance in 26b.

In Fig. 14, X is the longitudinal axis of the frame, X-Y the plane of the blade, and Z-X the plane orthogonal to the plane of said blade.

The bat according to this invention is constituted by blade 2 at one end of which handle 28 is fastened. In the handle there is obtained the wide through-opening or cavity 27, which goes through the X-Y plane, so that the two side parts which circumscribe the opening, substantially parallel to the longitudinal axis X, take up the shape of leaves 28a and 28b, substantially parallel to one another and to the X-Z plane. The stifnesses of the handle may be furtherly differentiated by suitably shaping the outlines of the opening, for instance, as shown by Fig. 17, in an 8-shape; by inserting in the side walls of the opening stiff elements, for instance the strip-shaped elements 29 and 29a, as shown by Fig. 16, or by adopting both solutions.

Besides, the handle of the bat according to the invention may be also realized from any homogeneous material, for instance, as shown by Fig. 17a, or from composite or layered materials or materials provided with various inserts, as shown, always by way of example, by Figs. 17b and 17c.

In Fig. 18 the vibrating elastic element is constituted by leaf 30 located within cavity 31 provided in handle 32 and is cantilever-fastened within the handle by means of screws or rivets 33.

In Fig. 19, the vibrating elastic element is constituted by a couple of cantilever-leaves 34 and 35, fastened in special cavities 36 and 37 respectively, obtained in handle 32.

In Fig. 20 the vibrating elastic element is constituted by vibrating leaves 38, 38a, 38b and 38c, different from one another and resonant with different frequency ranges which provide to detecting, amplifying and transmitting vibrations distinct from one another.

Fig. 21 shows, in a half of the figure, a vibrating elastic element constituted by a leaf 39 fastened to structure 2 of the equipment, while the second half of the figure shows the elastic element 40 fastened, always externally to the handle, in the hollow space 41 of said handle.

In Fig. 22, handle 32 according to the invention is hollow and the vibrating elastic elements 44 are located within cavities 42 and 43, said elements being constituted by leaf 45 associated to the bridge leaf 46, and the vibrating elastic element 47, constituted by the two leaves 48 and 49, associated to the bridge leaves 50 and 51 respectively. In this embodiment, the vibrating units, instead of being realized in one only piece, are made up by several pieces, each of which either individually or jointly with the other ones, performs one or several functions of detection, amplification and transmission of said vibrations to the handle and therefore the user.

In Fig. 23, the vibrating elastic element is constituted by an oscillating fluid 52 which fills the cavity of handle 32 and is in touch, on the one hand with the internal wall of said handle and on the other hand with the surface of structure 2; or, according to another embodiment, the oscillating fluid 53 is kept against the internal wall of handle 32 by a vibrating membrane 54, associated to the bridge-leaf 55 fastened to structure 2 of the bat.

In Fig. 24, the vibrating elastic element is constituted, in an embodiment, by detector 56 applied to structure 2 of the bat and located externally to handle 32; the blow or impact signal is sent by the detector to the amplifier 57 and from here to the vibrating devices 58 in touch with the handle wall. In another embodiment, detector 59 in touch with structure 2 is located within the handle and transmits the impact signal to amplifier 60, also located

within said handle, which transmits the amplified signal to transmitter 61 located externally to handle 32, directly in touch with the hand of the user. The detecting, amplifying and transmitting devices are electric, electronic, electromechanical devices of a known type.

Fig. 25 shows, in a half of the figure, a vibrating elastic element constituted by a leaf 62 fastened to one end of the hollow handle 1 projecting towards the outside, while in the other half its shows the vibrating elastic element constituted by a leaf 63 fastened between the solid handle 64 and structure 2, projecting towards the outside.

The shape, size, arrangement and type of said vibrating elastic element are experimentally chosen according to the equipment or the article for which said handle according to this invention is intended.

The various ambodiments subject matter of this invention may be adopted either individually or variously associated in a same table tennis bat, always within the scope of this invention.

Claims

1. A table tennis bat constituted by a frame comprising a handle and a blade, characterized in that said frame has a differentiated structure, such as to impart said bat prefixed characteristics of reaction and bounce following the ball impact.

2. A table tennis bat, according to claim 1, characterized in that said blade is made from a multilayer material, wherein at least one layer is natural cork.

3. A bat according to claim 2, characterized in that said layer(s) from cork constitutes a basic structural element of the blade.

4. A bat according to claim 2, characterized in that the layers of the multilayer material constituting the blade that are not made from cork are made from homogeneous wood or plywood or impregnated carbon, kevlar, glass or mixed fibres.

5. A bat according to claim 2, characterized in that some layers of the multilayer material constituting the blade that are not made from cork are made from homogeneous wood or plywood, while other layers are made from a fabric from impregnated carbon, kevlar, glass or mixed fibres.

6. A bat according to claim 4 or claim 5, characterized in that said blade is made from a multilayer material with a number of layers equal to or greater than three.

7. A bat according to claim 1, characterized in that said blade comprises a light, elastic and flexible part or zone and a heavier and stiffer edge compared to said central part.

8. A bat according to claim 7, characterized in that said blade is made from materials such as wood, plastic materials such as polyvinyl chloride, polyurethane or the like, metals such as light alloys and the like, plastic materials reinforced with glass, carbon fibres and the like, and/or by the union of two or more of said different materials.

9. A bat according to claim 7, characterized in that said central part or zone is constituted by a constant thickness flat slab from homogeneous or composite or multilayer material, and said peripheral edge is constituted by an edge which surrounds said central part fully or partly, which edge is made from a different stiffer material having a specific weight greater than the material of said central part, and is fastened to said central part by glueing, riveting, pressure, or the like.

10. A bat according to claim 7, characterized in that said central part and said peripheral edge are shaped like a constant thickness flat slab, said edge being realized by means of the application of reinforcing elements in the peripheral zone, suitable to stiffen the edge, so that the inertia and elastic characteristics of said central part and said edge are different from one another.

11. A bat according to claim 7, characterized in that said central part and said peripheral edge are made from the same material and in one only piece, said central part being provided with local lightenings and/or unevennesses along substantially annular and concentric lines, evenly or unevenly spaced, which concern the external surfaces of said central part fully or partly, or are substantially concentrated in the core area of said central part.

12. A bat according to claim 7, characterized in that said central part and said peripheral edge are realized from the same material and in one only piece, said central part being corrugated on one or both external surfaces, so that said surface has alternatively a different thickness in the radial part or, while having a constant thickness, the straight section of said central part has not a rectangular shape.

13. A bat according to claim 7, characterized in that said blade comrpising said central part and said peripheral edge is realized in one only piece of an evenly variable thickness along its radial section or a thickness at times constant and at time variable.

14. A bat according to claim 7, characterized in that said blade comprising said central part and said periph-

eral edge is realized in one only piece of evenly variable thickness along its radial section or a thickness at times constant and at time variable, and is provided of suitably arranged reinforcements.

15. A bat according to claims 7 through 14, characterized in that said blade is realized by suitably combining the embodiments of claims 9 through 14.

16. A bat according to claim 7, characterized in that the share of surface occupied by said peripheral edge is comprised between 2% and 55% of the total blade surface, that the bending stiffness of said peripheral edge is comprised between 15% and 60% of the total bending stiffness of the straight section of the blade and that the weight of said edge is comprised between 15% and 16% of the total weight of said blade.

17. A bat according to claim 1, characterized in that said frame can bend elastically following external stresses in the blade plane, while it is stiff in the plane orthogonal to the plane of said blade, and is also such as not to undergo torsional elastic deformations relatively to its longitudinal axis.

18. A bat according to claim 17, characterized in that said handle is provided with a wide through-opening of elongated shape in the direction of the frame longitudinal axis, and such that the resistant section of said handle is constituted by two leaves substantially parallel to one another and to the plane orthogonal to the blade plane.

19. A bat according to claim 18, characterized in that said handle provided with an opening is provided with inserts from metal or other materials, suitable to constitute reinforcing elements and to increase the stiffness of the frame in the direction orthogonal to the blade plane.

20. A bat according to claim 18, characterized in that said handle provided with an opening is made from homogeneous material, or from composite layered materials such as wood and/or plastic materials and/or glass and/or carbon fibres.

21. A bat according to claim 18, characterized in that said through-opening is of elongated shape in the direction of the frame longitudinal axis and has different profiles, such as elliptical or in the form of 8 or rectangular.

22. A bat according to claim 18, characterized in that said opening if fully or partly filled with soft materials that do not show an appraisable resistance to deformation.

23. A bat according to claim 1, characterized in that said handle comprises at least a vibrating elastic element fastened to said structure and/or said handle in one or more points and resonant with a suitable range of frequencies generated by the vibrations ensuing from the stressed imparted on said structure, so as to amplify said vibrations and transmit them to said handle and therefore the user through suitable contact points.

24. A bat according to claim 23, characterized in that said vibrating elastic element is made from different materials and has different shapes, and is fastened to said structure and/or said handle by mechanical fastening and/or glueing or is formed from a piece of said structure or said handle.

25. A bat according to claim 23, characterized in that said vibrating elastic element is constituted by at least a leaf housed in spaces or cavities obtained within said handle.

26. A bat according to claim 23, characterized in that said vibrating elastic element is constituted by at least a leaf located externally to the handle.

27. A bat according to claim 23, characterized in that said vibrating elastic element is constituted by at least two associated leaves, said leaves being housed in spaces or cavities obtained within said handle.

28. A bat according to claim 23, characterized in that said vibrating elastic element is constituted by at least a cantilever leaf fastened to the handle and protruding outside the handle and the structure.

29. A bat according to claim 23, characterized in that said vibrating elastic element is constituted by at least an oscillating fluid.

30. A bat according to claim 23, characterized in that said vibrating elastic element is constituted by a whole of electric and/or electronic and/or electromechanical units for the detection, amplification and transmission either associated or not to cantilever leaves and/or bridge-leaves located either inside or fully or partly externally to the handle.

31. A bat according to claim 23, characterized in that the shape, size, arrangement, type of said elastic element are experimentally chosen according to the equipment or the article and its use conditions.

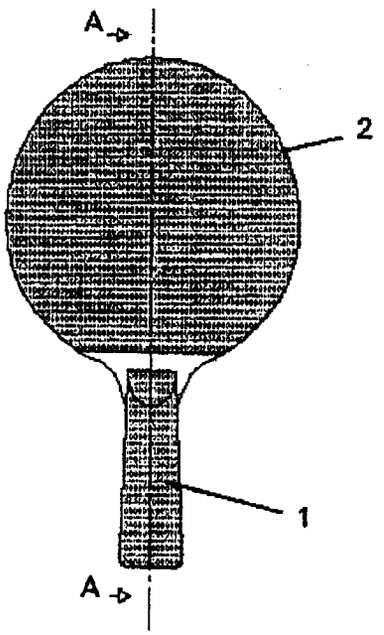


Fig.1

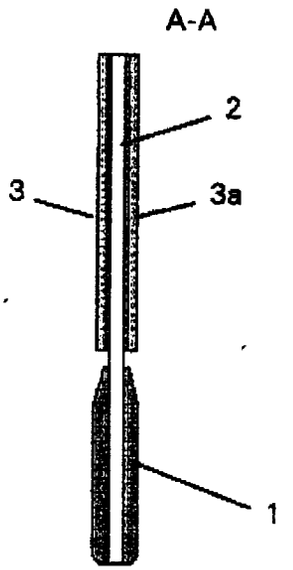


Fig.2

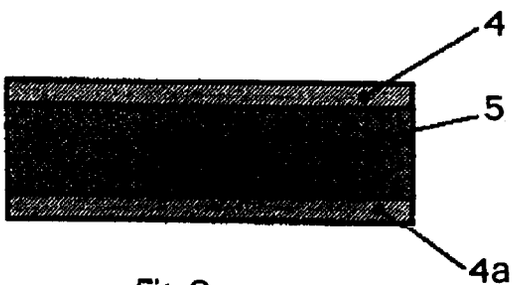


Fig.3

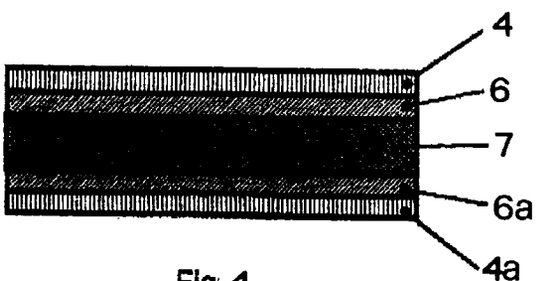


Fig.4

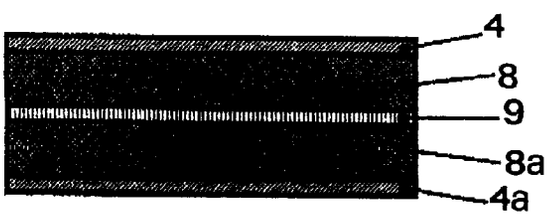


Fig.5

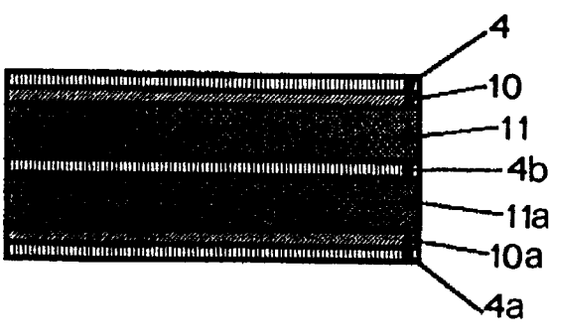


Fig.6

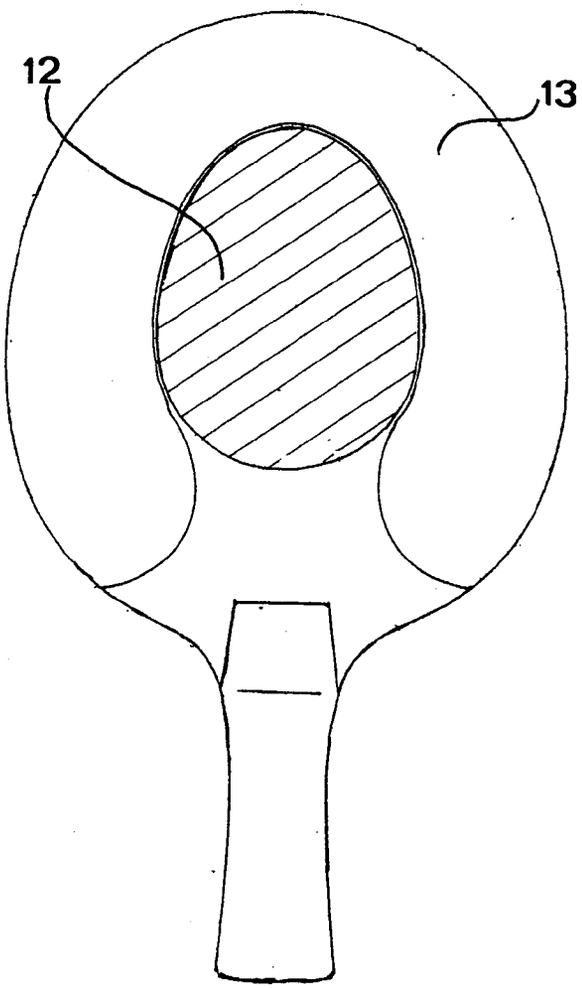


fig.7

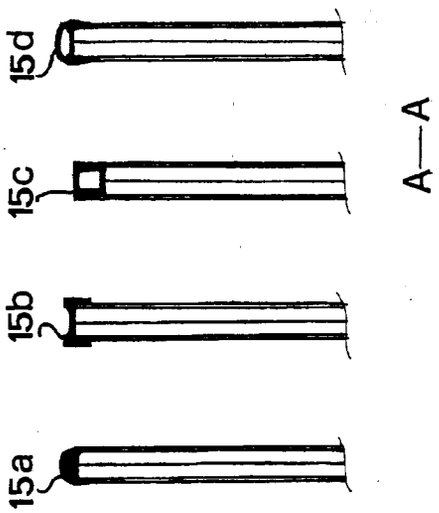


fig.10

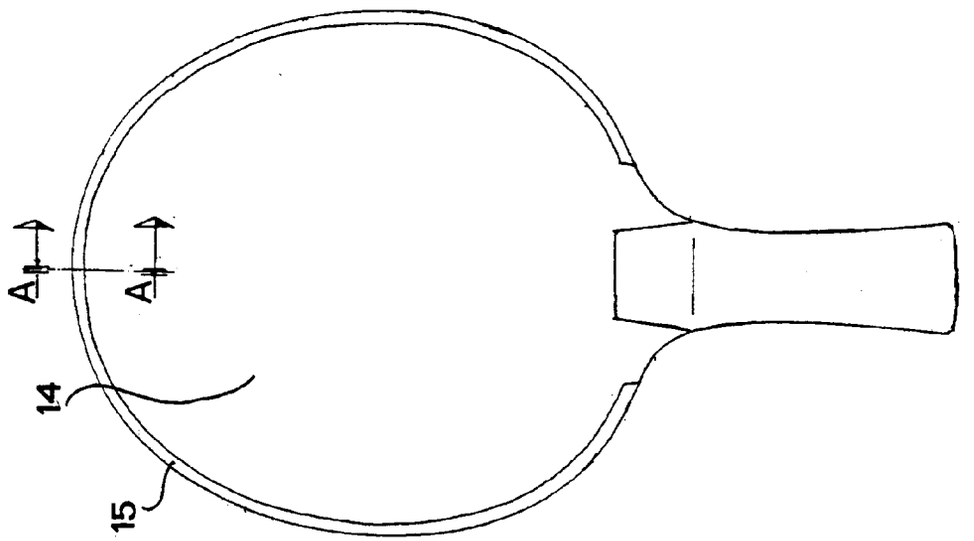


fig.9

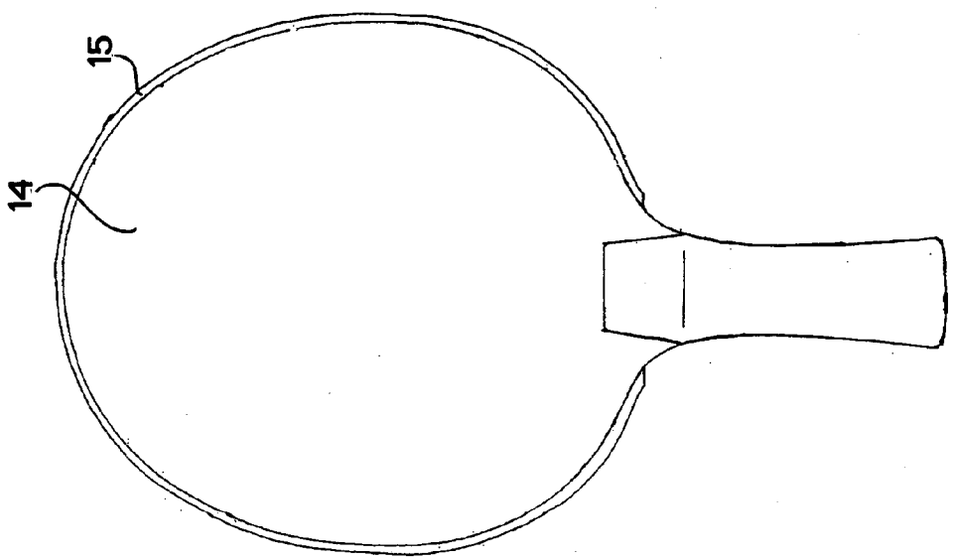
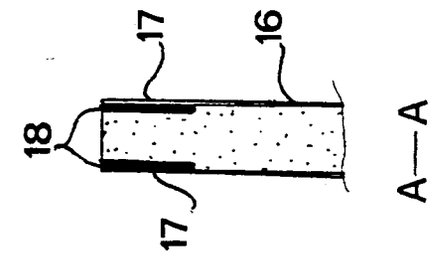


fig.8



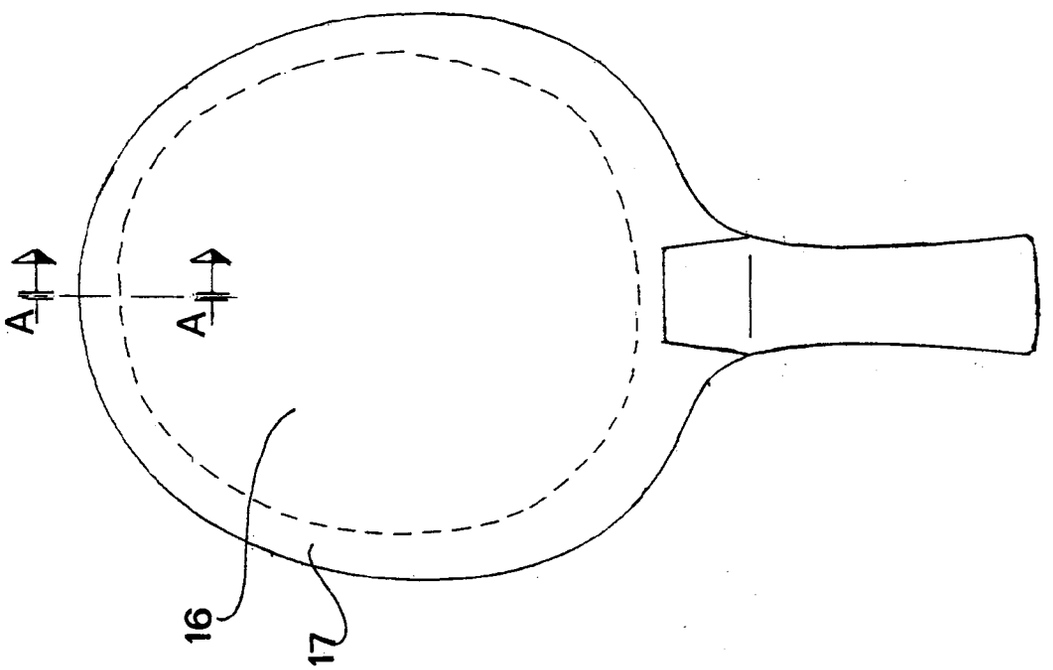


fig.11

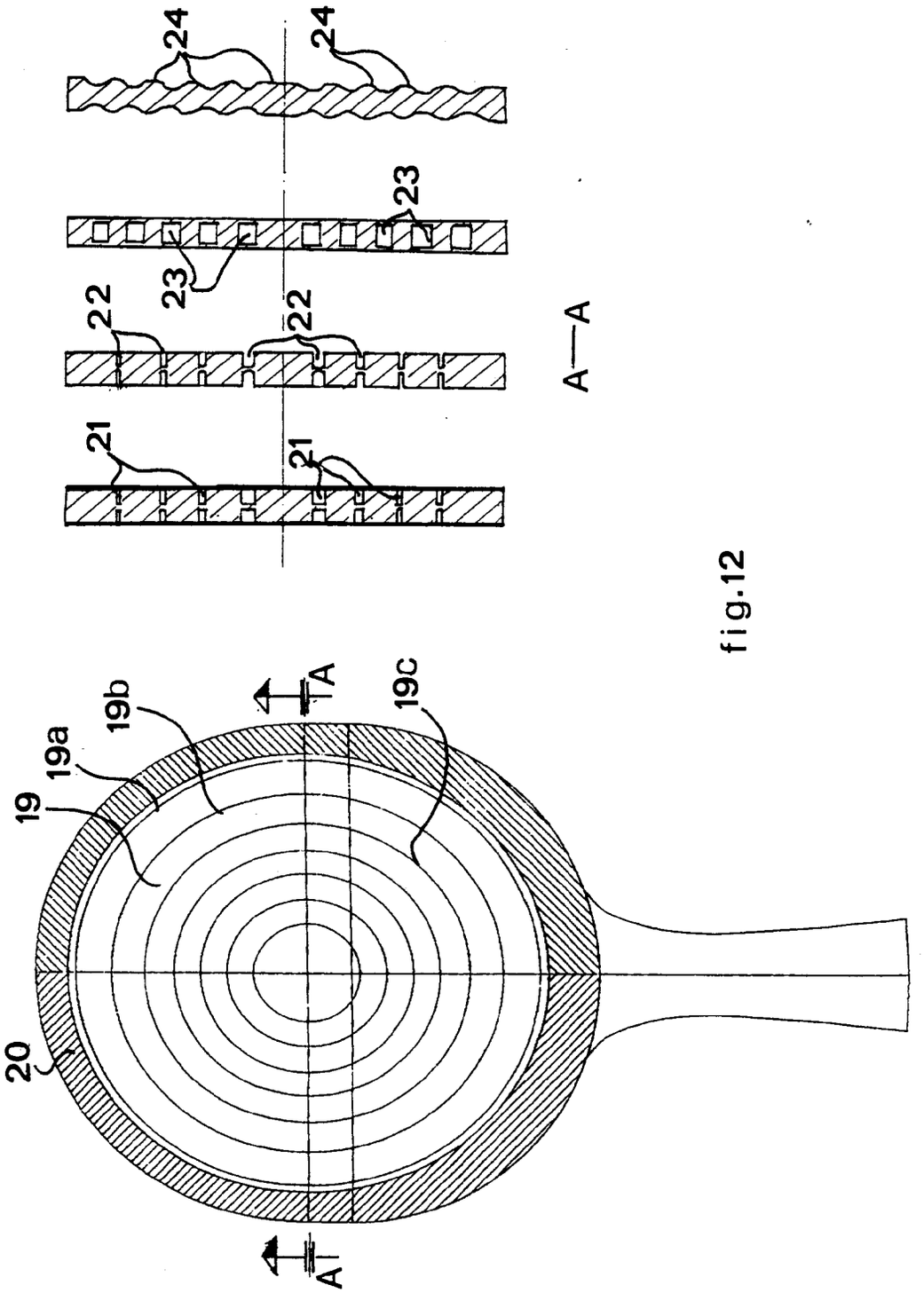
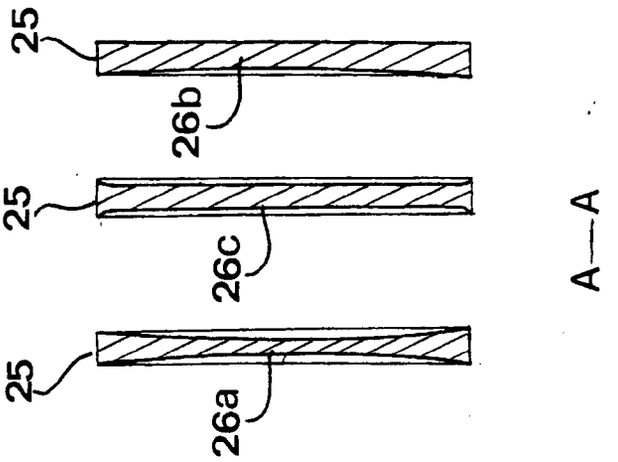


fig.12



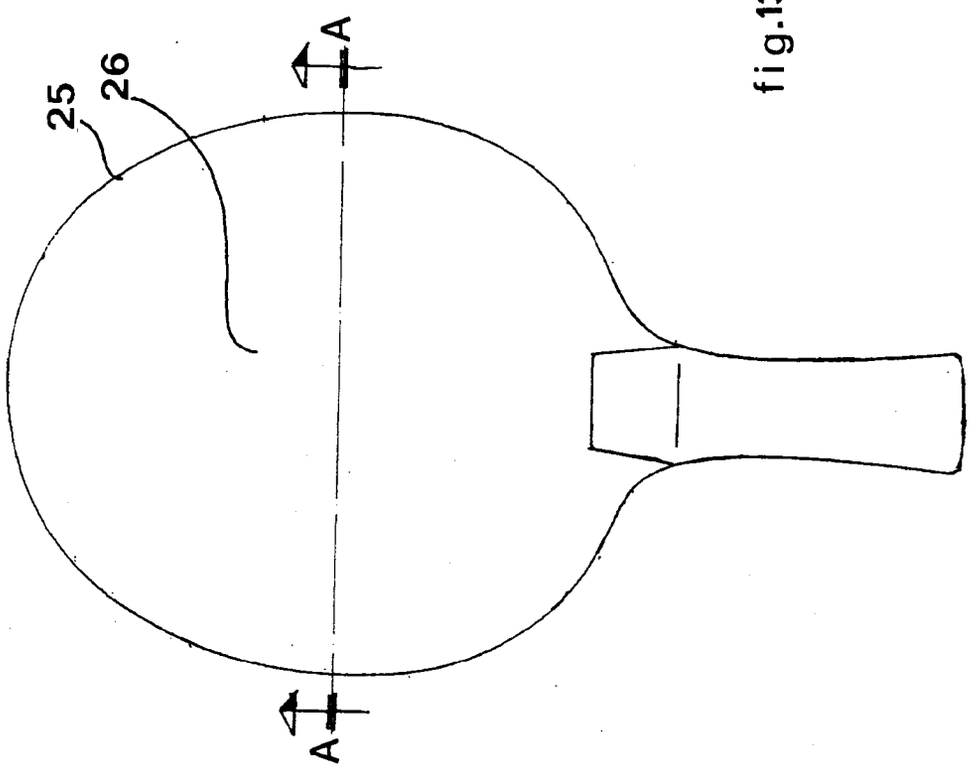


fig.13

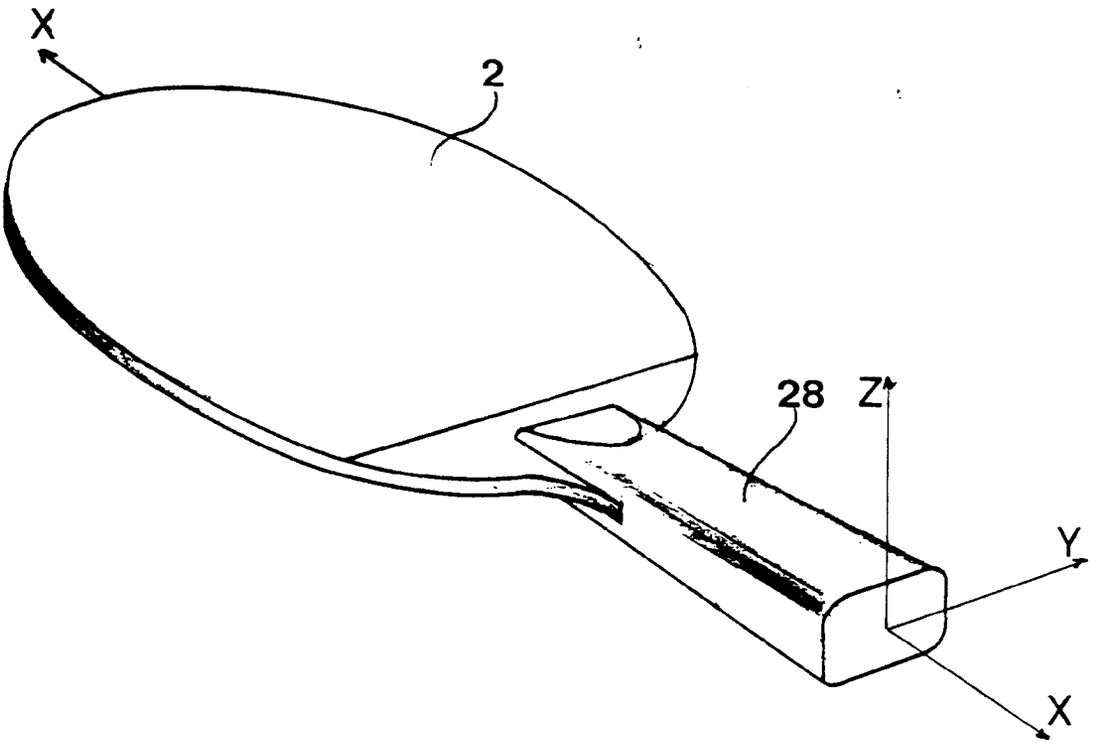


fig.14

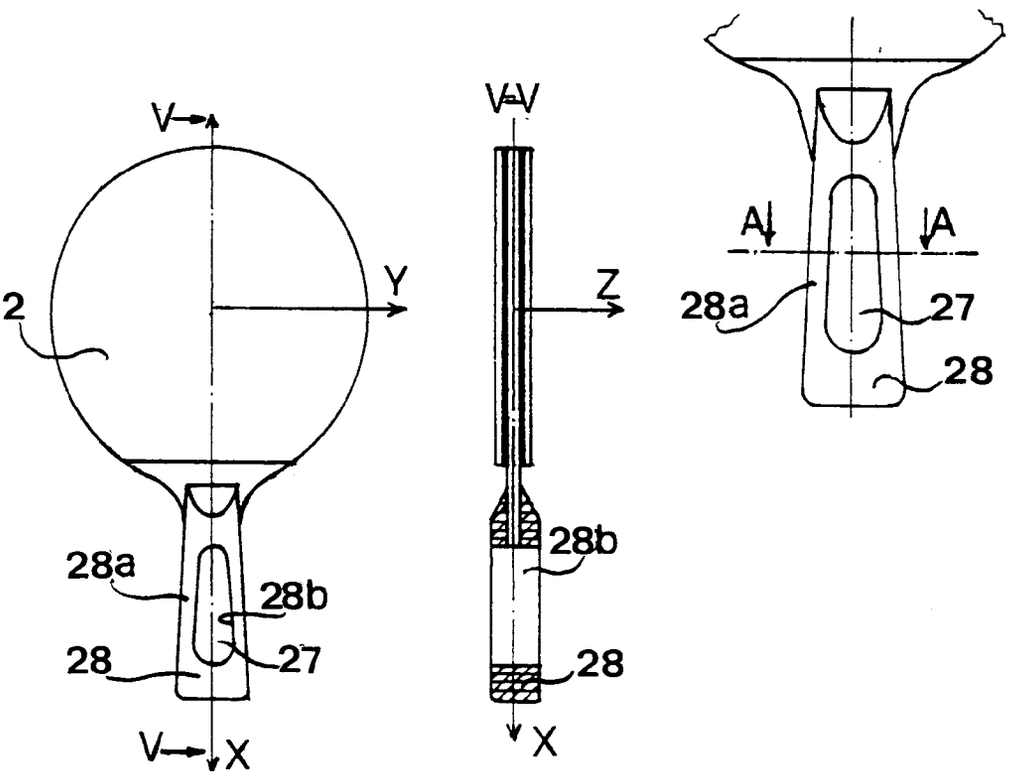


fig.15

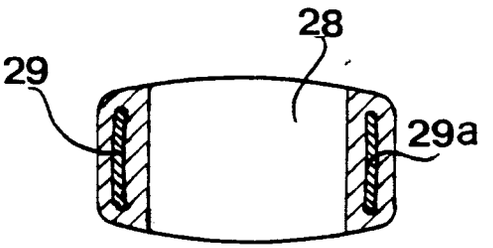


fig.16

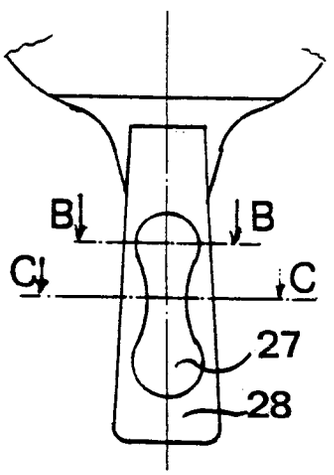


fig.17

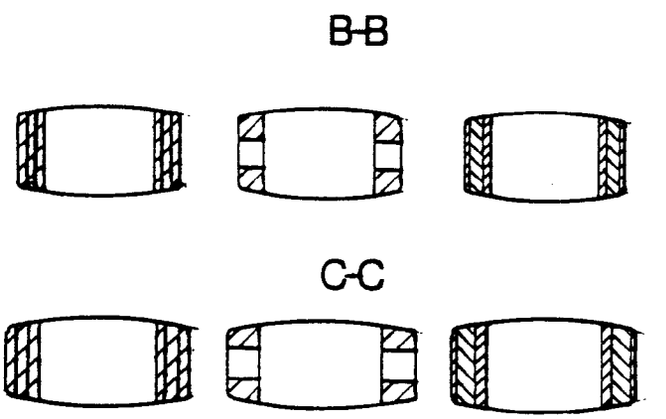


fig.17a fig.17b fig.17c

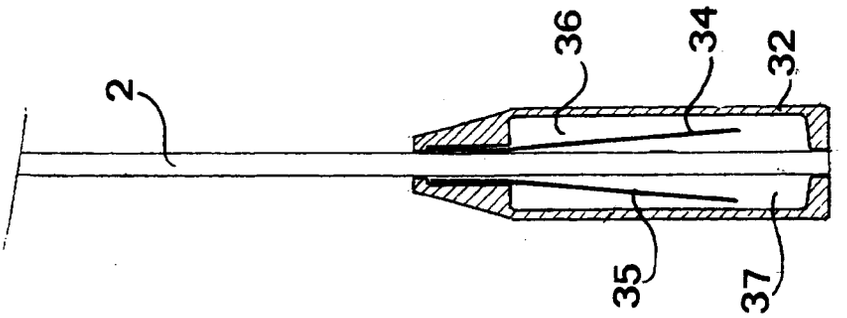


fig.19

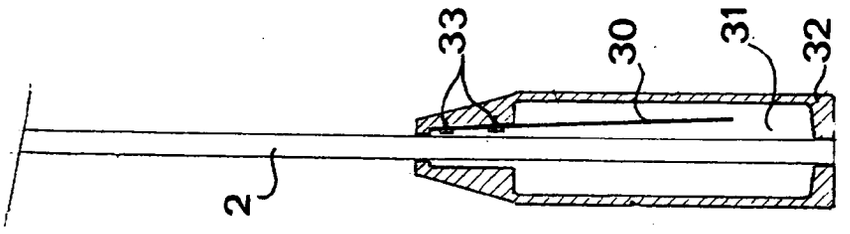


fig.18

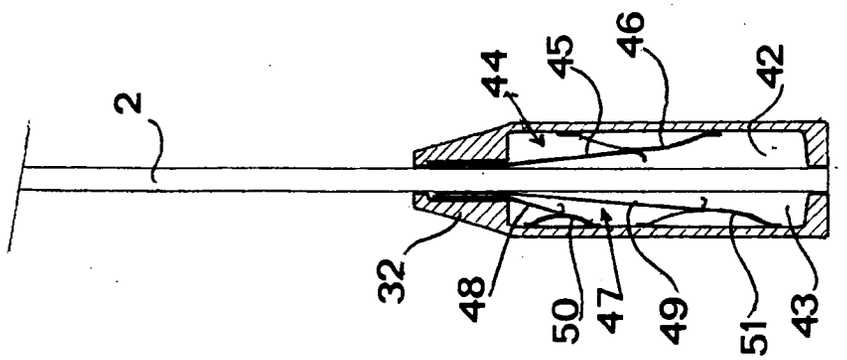


fig.22

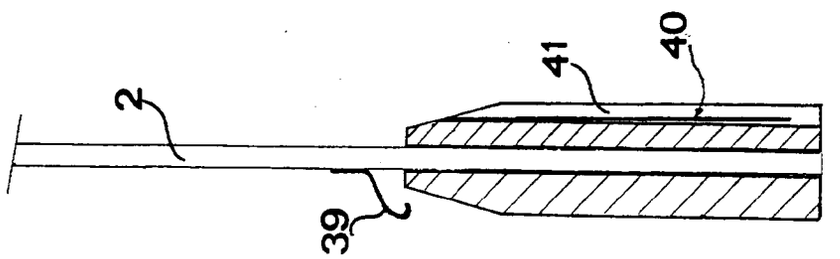


fig.21

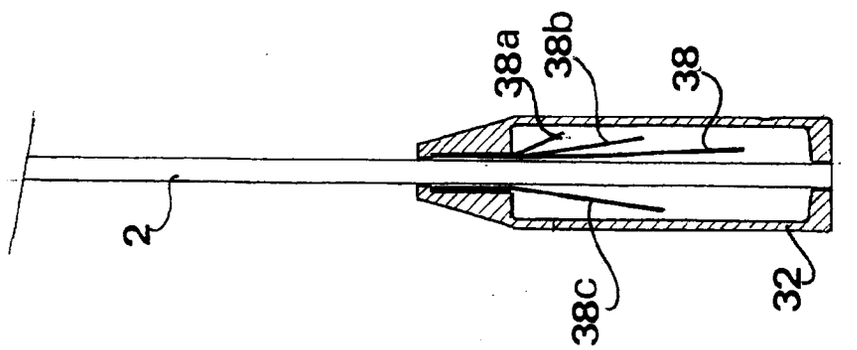


fig.20

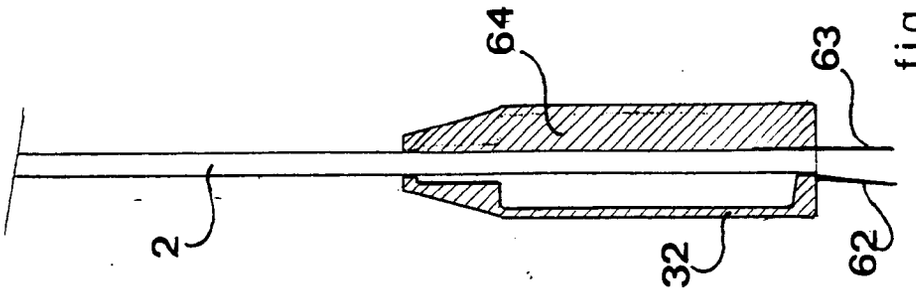


fig.25

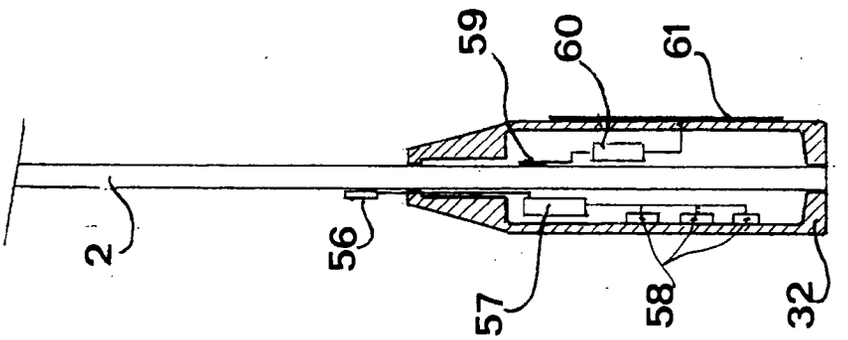


fig.24

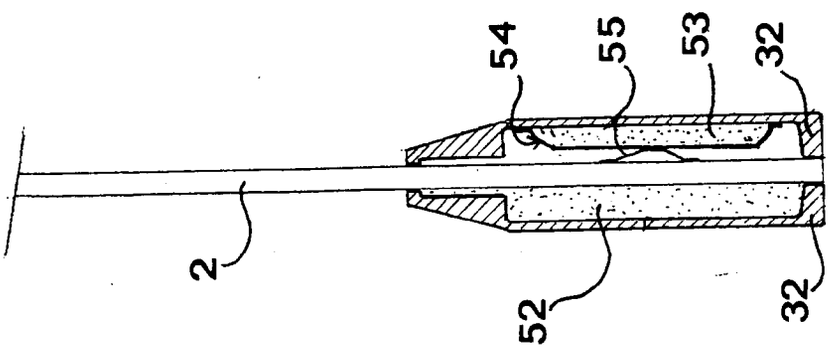


fig.23