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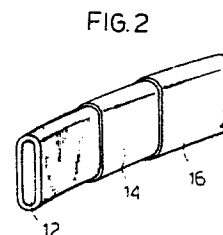
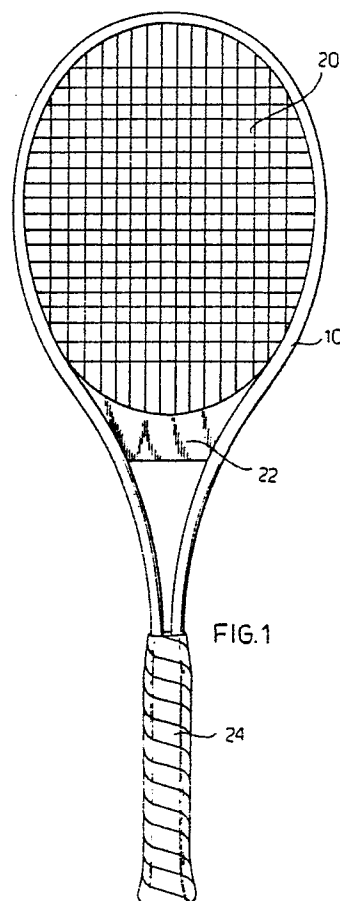
(54) **Tennis racket frame and process.**

(57) A new tennis racket frame (10) made up of a tubular metallic core (12) tightly wrapped in one or more layers (14, 16) of fiber fabric.

According to a first manufacturing process, the frame lined with fabric is inserted into a bag under vacuum and is heated up for a polymerization treatment.

According to another manufacturing process, the lined metallic core is placed in a mold with interposition of a pressure distributing material and then the mold plates are closed under pressure and heated up.

According to a variation of the process, the wrapped up metallic core is placed inside the inner tube of two flexible tubes inserted one into the other and a pressure is created in the hollow space between the two tubes.



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"TENNIS RACKET FRAME AND PROCESS"

The present application refers to the field of frames for tennis rackets.

In recent years there has been an evolution in the size of the oval surface of tennis rackets, which from the 440-450 cm² of the traditional types has increased to 550-600 cm² (Mid-size rackets) and up to 660 cm² (Over-size type). The tension of the strings has consequently increased from 18-20 kgs to about 25-30 kgs. (from about 180-200 N to 250-300 N).

The rackets, that had to keep their weight and balancing characteristics unchanged, have become much more stressed.

There has been therefore an acceleration of the technological evolution indispensable to maintain an impact strength and a fatigue strength acceptable for the new types of rackets having an increased surface.

The market presents at the moment various types of rackets. "Wooden" rackets present a frame made up of wooden strips between which layers of carbon fibers are inserted, while the two faces of the oval portion of the frame are plated with linings of glass and carbon fibers impregnated in resins and polymerized before or at the time of glueing, to improve stiffness and resistance to stringing and playing. When of high quality, these rackets have the drawback of being too costly; moreover they still maintain, even when plated, a certain fragility to an accidental knock with the ground or a violent impact with a ball off centered towards the top; they are generally not sufficiently stiff; if stiffened too much with fibers, they lose the touch sensitivity which is typical of the wood and are subject to annoying vibrations; they are vulnerable to dampness and because of expansion in the wood, do not offer sufficient guarantee as regards to the glueing of the reinforcing fibers.

Another type of racket presently on the market is the metal racket. The most common types are made of an aluminium or magnesium alloy banded section extruded and subject or not to heat treatments according to their quality and price level. They are rackets of moderate price and not fragile, but they have the drawback of being too flexible and hence of little control and efficiency, or when stiff and powerful they transmit physiologically annoying sensations.

A third type of racket on the market is a synthetic racket made of fibers impregnated with thermosetting resins, generally epoxy resins. These rackets can be manufactured according to various technologies, for example by utilizing 3-7 layers of fiber tissues pre-impregnated with epoxy resins, which, wrapped over a plastic tube, are inserted in

the racket mold; the plastic tube is inflated with air during heating which is carried out till polymerization (curing) of the manufacture is reached. According to another process, the pre-impregnated tissues are wrapped on an elastomer or polyurethane core which expands under heat, pressing the tissues against the mold; curing is then carried out. As an alternative, several layers of tissues can be placed in the mold and it is then possible to inject under vacuum a very fluid resin which is then cured.

The rackets obtained by means of the above mentioned processes are generally expensive and vulnerable to knock on the ground. The most powerful types, having a high efficiency and a good ball control are very stiff and tire out the average player. The less expensive types are of a high glass percentage contents, very comfortable, less fragile on impact, but suitable only for beginners because they are too flexible, with excessive torsional unsteadiness and therefore insufficient directional ball control and insufficient power; furthermore they are not very resistant to a powerful ball hitting off center on the upper part of the racket.

Finally, there is a type of synthetic racket made of thermoplastic material with a filler of short oriented fibers and made of fiber molded around a metallic core which is then melted and removed. This racket, while is suitable to mass production requires expensive machinery and complicated molds; the racket is very good, completely free of vibrations but very delicate, liable to heat distortion when, for instance, it is left in a closed car under the sun.

Therefore, there is in the field the requirement for a racket incorporating the fundamental qualities of power (ability to convert the whole power of the player into ball acceleration), efficiency (ability to return the absorbed energy with a minimal dispersion), ball control (ability to accurately aim the ball), sensitivity (good ball contact), comfort (ability to take up the ball impact without transmitting physiologically annoying sensations such as counterblows and vibrations), easy adjustment (the racket should not require a long adjusting period before performing at its best), handiness, streamline, good allowance (ability to "pardon" faults like off centered balls).

The aim of this application is to carry out a frame for such a racket.

The new racket frame is made up of a combination formed by a magnesium or aluminium alloy section core, of the types normally used for metal rackets, covered by one or more layers of glass, or graphite or carbon fiber fabric or tissue, or by aramid fibers, such as Kevlar (registered trade

mark), impregnated in epoxy resins and cured with strong adherence to the metal core itself. More precisely, the frame is made from laminated or extruded metal alloy section, on which the fabric layers are made to adhere, possibly reinforced by additional layers in the most stressed areas; the layers of fabric are made to adhere to the metal with any process whatever. As an example the frame, on which the layers of impregnated fabric, in the form of strip or bag are beforehand wrapped or slipped over, can be subjected to a process called "aeronautical curing treatment or cycle" known to the technicians, that is to a polymerization or curing process carried out within molds similar to the ones used in the present manufacturing process for synthetic rackets having thermosetting resins impregnated fibers, with the variation of the insertion of a layer of profiled silicone rubber or other similar heat-resistant material, acting as a resilient pad, so as to evenly distribute the pressure deriving from the closing of the mold.

The mold plates can be heated by heating elements or by circulation of diathermic oil or by infrared rays or by contact with the hot plates by a press, that in this case will also keep the mold closed, or by any other means.

As an alternative, the frame wrapped in the fabric layers can be subjected to a process similar to the one previously illustrated but with the variation of creating an air cushioning which takes the place of the silicone rubber; this can be done by slipping the sheathed metal section into two heat-resistant plastic tubes one of which is coaxially pre-inserted into the other. When the whole structure is closed into the mold, the hollow space between the two tubes is inflated to 5 to 9 atm. and possibly a vacuum is created in the inner tube which adheres to the fabric outer surface.

Finally, other treatments are possible for the frame wrapped in fabric layers.

Pressure, temperature and timing of the process can vary notably in accordance with the method and type of resin used but normally they remain between:

pressure 5 to 9 atmospheres

temperature: 120°C to 175°C

heat timing: 15 minutes to 4 hours.

The new frame cancels the negative aspects of the rackets previously described, by presenting the following special characteristics: optimum flexibility owing to the possibility of varying the moment of inertia for the sections along the frame, by changing the type of fabric and adding reinforcing pieces of fabric; remarkable fatigue strength and impact strength; very good power, sensitivity, rigidity, ball control and comfort; good resistance of the oval portion to deformations under the stretch of the strings also at high temperature conditions; ex-

cellent damping of vibrations due to the combination of the two different materials; with resulting consequent greater facility of use and elimination of the "tennis elbow" risk, common when using powerful metal or fiber rackets.

A further advantage is the racket moderate cost, considering its high performance and long duration.

The frame, subject of this invention, will be herewith described on the basis of an exemplary embodiment with reference to the enclosed drawings, wherein:

Fig. 1 is a global view of the racket;

Fig. 2 is a perspective view of a first type of sheathed metalli tubular section;

Fig. 3 is a perspective view of a second type of sheathed metallic tubular section;

Fig. 4 is a perspective view of a third type of sheathed metallic tubular section;

Figs. 5-5a are section illustrations of further types of sheathed tubular section.

With reference to the drawings, a racket frame 10, according to this invention, comprises a core 12 (or 12a, 12b, 12c or 12d) in metal section of whatever shape. The sections utilized in particular, besides the elongated oval shape with parallel sides of Fig. 2, have a dual tube shape illustrated by 12a in Fig. 3 comprising two tubes joined by a diaphragm, an elongated mono tube shape, narrowed at the center, illustrated by 12b in Fig. 4, or a substantially triangular shape with rounded edges (12c, Fig. 5) possibly with a central depression - (12d, Fig. 5a). The metals generally utilized are magnesium or aluminium alloys.

On the metallic core 12 are tightly wrapped one or more layers of fiber tissues or fabrics indicated by 14 and 16, so as to form a whole with the core. In particularly stressed areas it is foreseen the possibility of inserting further fabric layers. Materials utilized for the fabrics can be glass, graphite or carbon fibers, aramid fibers (for instance Kevlar, Reg. trademark), etc.

According to a preferred manufacturing process, the section 12, 12a or 12b is bended beforehand to form the oval of the racket, the metallic structure is then pickled, possibly protected with chemical products, or varnishes or adhesive tapes to prevent an electrocorrosive condition, and then wrapped in one or more layers of the fabric made of the fibers indicated above or of a combination of different fibers. These tissues are preferably pre-impregnated in epoxy resins and are generally known on the market with the name "prepreg" tissues. In the alternative, non impregnated tissues can be utilized which are subsequently impreg-

nated by immersion after their wrapping on the metallic core. At critical points, as already said, it is possible to add tissue reinforcements to vary the rigidity along the profile.

The racket so set is inserted in an envelope, bag or tube generally in silicone nylon and connected by valves to a vacuum pump for evacuation of the air. The whole is then placed in an autoclave where it undergoes the treatment called "aeronautical curing treatment or cycle".

When in autoclave the pressure reaches 1,5 kgs/cm² (150.000 Pa), the bag is detached from the vacuum pump. The pressure is brought to 5 kgs/cm² (500.000 Pa) and the temperature at 175°C for two hours. The combination of the pressure, temperature and timing parameters vary according to the type of resin chosen for the impregnation.

Subjected to this cycle, the fabric adheres to the metal core and the epoxy resin polymerizes - (cures) firmly adhering to the surface of the internal metal section. The frame thus obtained, comprising in combination a metal core and a fiber coating, can be pierced for the anchoring of the strings, can be plastered and varnished according to the normal treatments for fiber rackets and completed for example by a nylon bridge 22; which is screwed up in a manner similar to the one utilized for metal rackets. The frame is then completed with whatever handle 24.

According to another racket manufacturing process, the core bended and wrapped in the impregnated fabric layers is inserted in a mold with a layer of profile silicone rubber, or similar heat-resistant material, interposed between it and the mold, so as to evenly distribute the pressure deriving from the closing of the mold. The mold is then heated with whatever system.

According to a third method for the manufacturing of the racket, the core bended and sheathed by the fabric layers is slipped into two heat-resistant plastic tubes, coaxially inserted into one another, and the whole structure is placed in a mold. The hollow space between the two tubes is then inflated at 5 to 9 atmospheres and eventually a depression is created within the inner tube which thus comes to adhere to the outer surface of the fabric on the core.

Obviously, it is possible to use other per se known methods for manufacturing the racket.

Claims

1. A tennis racket frame, characterized in that it is made up of a metallic core (12, 12a, 12b, 12c, 12d) lined or coated with one or more layers - (14,16) of fiber fabric tightly wrapped on it, so as to form a single body.

2. A frame according to claim 1, characterized in that the metal core has one of the following shapes in section: an elongated oval shape (12) with parallel facing longitudinal sides; a dual tubular shape (12a) with two tubes bridged by an intermediate part; a mono tubular shape (12b) with one straight side, and rounded edges and a narrowing in the center; a mono tubular triangle shape (12c) with rounded edges; a mono tubular triangle shape (12d) with rounded corners and a depression on one side.

3. A frame according to claim 1, characterized in that the metal core is in one of the following materials: magnesium or aluminium alloy.

4. A frame according to claim 1, characterized in that the fiber coating is made of one or more of the following materials: glass fibers, carbon fibers, aramid fibers.

5. A frame according to claim 1, characterized in that it comprises additional fiber layers placed in the parts of the frame particularly subject to stress.

6. A frame according to claim 1, characterized in that it is obtained by slipping the fabric layers - (14, 16) over the frame core (12), the layers being of a material pre-impregnated with epoxy resins, and by subjecting the whole to a polymerization treatment.

7. A frame according to claim 1, characterized in that it is obtained by slipping non-impregnated fabric layers over the core, impregnating then the fabric and subjecting the whole structure to a polymerization treatment.

8. A tennis racket frame according to claim 1, characterized in that it is carried out by a process comprising the following steps: introduction of the fabric covered core (12) inside a bag or similar, making a vacuum inside said bag, carrying out a pressure around said bag, and heating.

9. A frame according to claim 8, characterized in that said pressure reaches 500.000 Pa and the heating temperature is about 175°C and kept for about 2 hours.

10. A tennis racket frame according to claim 1, characterized in that it is manufactured by a process comprising the following steps: placing the fabric lined core in a mold, with interposition of heat-resistant material between the mold and the fabric so as to evenly distribute the pressure, and heating the mold.

11. A tennis racket frame according to claim 1, characterized in that it is carried out by a process comprising the following steps: placing the fabric lined core inside a pair of heat resistant flexible tubes, one received into the other, placing the whole assembly in a mold, establishing a pressure difference between the inside of the inner tube and the hollow space between the tubes, so that the inner tube tightly adheres to the tissue layers on the core.

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12. A process for manufacturing tennis racket frames according to claim 1, characterized by the following steps:

- placing a metal frame core, lined with at least one layer of fiber fabric, into a mold, having interposed a pressure-distributing material between the mold and the lined core;
- heating the mold;

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13. A process for manufacturing tennis racket frames according to claim 1, characterized by the following steps:

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- placing the fiber fabric lined metal core of the frame into the inner tube of a pair of heat resistant flexible tubes, one being received into the other;
- placing the so obtained assembly into a mold;
- establishing a pressure difference between the inside of the inner tube and the hollow space between the tubes, so that the inner tube tightly adheres to the fabric lined core.

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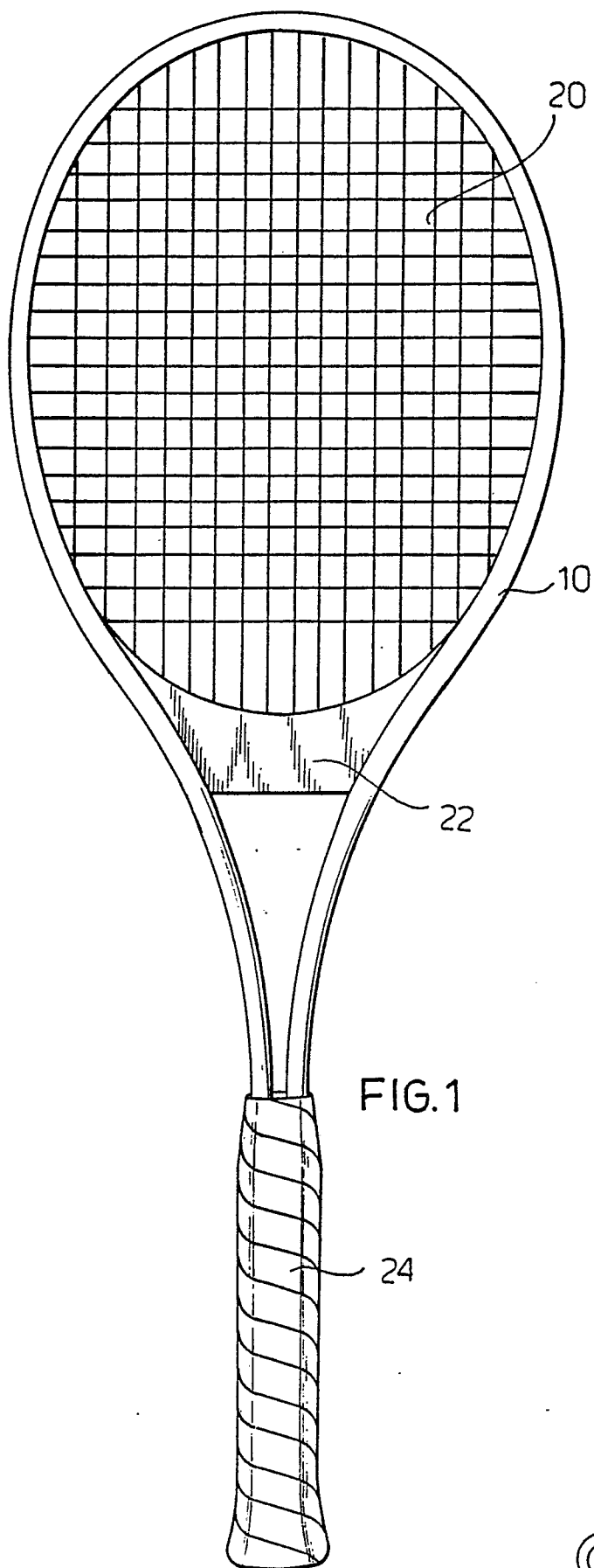


FIG. 2

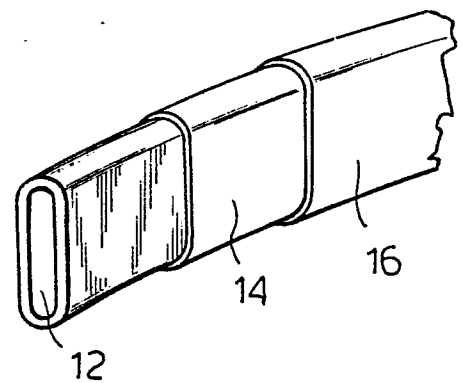


FIG. 3

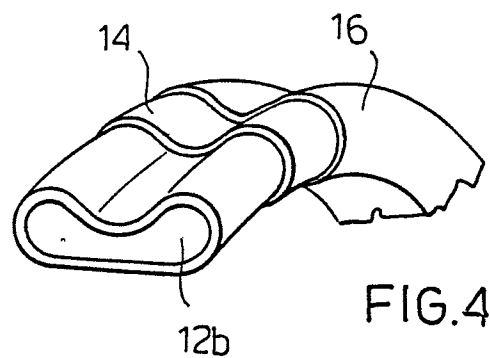
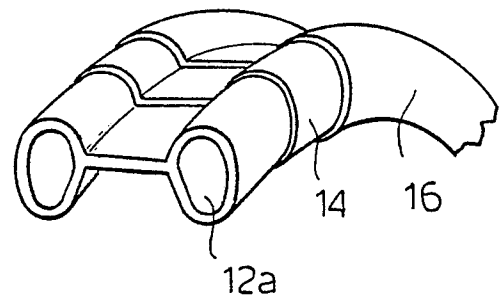


FIG. 4

FIG. 5

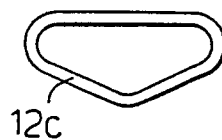


FIG. 5a

