

Method of producing reinforced composite racket frame

This invention relates to an improved method of producing fiber glass or fiber graphite reinforced racket frames in which a shell made of a plurality of layers of resin-impregnated oriented graphite fibers is squeezed during the heating period to contact completely with the inner surface of a mold cavity by means of two interior pressure separately generated by compressed air and a foamable elastomer or rubber composition wrapped within the shell.

Recently, many methods of producing composite laminated fiber reinforced racket frames have been developed. To produce such known racket frames, a sheet of oriented fiber impregnated with the thermosetting resin is generally rolled to form a shell of the racket frame and put into a mold cavity, and then, by means of an interior expansion pressure the shell is squeezed to contact with the cavity while being heated in the mold cavity. There are two conventional methods which have been adapted to generate the interior expansion pressure. One is called direct method namely compressed air type, and the other is called indirect method namely foamable core type.

Figs. 1 and 2 are used to illustrate the known direct method in which a shell 2 of the racket frame comprising crown, head, throat, shaft and grip portions of the racket is placed within a half mold cavity and wraps a corresponding ^{RTM} Gellophane tube 3 therein. A sealed end 30 of the cellophane tube 3 is sealed in the grip

portion 25 of the racket, and the other end 31 of the cellophane tube openly extends through the frame and protrudes out of the mold 1. When the mold is heated to gel and cure the shell, a desirable amount of compressed air will be sent into the cellophane tube 3 from the open end thereof by an air compressor so as to supply a radial interior pressure which makes the shell 2 expand to contact with the surface of the mold cavity so that a desired racket frame can be obtained after completion of the curing process. Racket frames produced by this known method have a hollow portion within the shell resulting that the whole frame has a great vibration retention when used to hit a ball. Some lightweight foamable thermoplastic materials, such as polyvinylchloride, polyethylene and polypropylene, are injected into the hollow portion of the racket frame to overcome the above-described drawback, but a second procedure of injection required to produce a racket frame will inevitably increase the production cost. Furthermore, since most outstanding vibration absorbing materials such as elastomer or rubber are very difficult to be injected into the cured shell, the materials injected into the hollow portion of the shell are generally limited to thermoplastic materials.

Fig. 3 is used to illustrate the indirect method namely foamable core type which has been disclosed in the U.S. Pat. No. 4,070,021 to Andrew W. Cecka et al, and U.S. Pat. No. 4,070,020 to Pol Dano respectively, in which a racket frame is prepared by arranging within a mold cavity an outer shell made of a plurality of layers

of unidirectionally oriented graphite fibers and a core comprising a seamless sleeve having a foamable resin composition therein, sealing the mold and activating the foamable resin composition to cause squeeze and generate pressure within the mold cavity and thereby provide intimate bonding of the core to the shell. This method reduced substantially the manufacturing steps, however, it requires an accurate controlling of the compounding of the resin composition so as to generate a sufficient interior pressure before completion of the curing process. Unfortunately, in the general practice, there are many factors, such as curing temperature, kind and amount of the foaming agent, kind and amount of the cross-linking agent, kind of the resin composition, etc., influencing the value of the interior squeeze pressure. Thus, it is relatively difficult to produce a desired product if these factors are not accurately controlled.

An object of the present invention is to provide an economical method of producing racket frames which have an outstanding vibration absorption property and a fine outer surface.

The invention provides a method of producing a reinforced composite racket frame composed of an outer shell made of a thermosetting material and a foam core, comprising the steps of:

(a) inserting a foamable material in a shell of thermosetting material the outside dimensions of the material being less

than the inside dimensions of the shell so as to create a space between said shell and said foamable material;

(b) inserting the shell and the foamable material into a mould;

5 (c) initially pressurising the space with pressurised gas to force the shell intimately to contact the inner surface of the mould; and

(d) after the initial pressurising step, heating the mould to a temperature at which the foamable material expands
10 subsequently to fill said space and to pressurise said space by said foamable material.

Advantageously the foamable rubber or elastomer composition is also thermosetting so that it prevents the foamed core from softening when the racket frames are re-heated
15 in coating process. The softened plastic would be squeezed out from the string holes by the reactivated residual foaming agent in the plastic and this would cause much elaborate work in finishing.

These and other objects and advantages of the
20 invention will become apparent from the following description of a preferred embodiment with reference to the accompanying drawings. It will be understood that the description is given by way of example only.

Fig. 1 is a schematic view of a half mould with a
25 racket frame for illustrating the producing process of fiber reinforced racket frame;

Fig. 2 is a sectional view taken substantially along

the lines A-A' of Fig. 1 for illustrating the construction of a racket frame made by the known direct method;

Fig. 3 is a sectional view taken substantially along the lines A-A' of Fig. 1 for illustrating the construction of the other racket frame made by the known indirect method; and

Fig. 4 is a partial longitudinal sectional view of a racket frame in accordance with the present invention before the mold thereof is heated.

According to this invention, there is provided an improved method of producing graphite fiber reinforced racket frames wherein a strip of foamable elastomer or rubber composition 6 is inserted into a Gellophane^(Registered Trade Mark) tube 3 and then wrapped by preregs 20 which are made of thermosetting resin-impregnated graphite fibers so as to form a longitudinal article whose sectional view is shown in Fig. 4; then, the longitudinal article is arranged within a mold cavity and one open end thereof is kept protruding out of the mold; afterwards, during the initial period when the mold is heated, a desirable amount of compressed air is sent into the Gellophane tube 3 from its open end by an air compressor so as to supply a first interior pressure to cause the longitudinal article expanding to contact intimately with the inner surface of the mold when the heating temperature is high enough to activate the foamable elastomer or rubber, the supply of the compressed air has been stopped and a second interior pressure starts to be generated by the expansion of the foamable elastomer or rubber composition, therefore, by means of the two successive interior squeeze pressure the longitudinal article can be formed into the shape of the mold cavity.

Referring to Fig. 4, it is clearly shown that the foamable elastomer or rubber composition is in a

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(18)

solid state and does not occupy the whole space within the Gellophane tube so that the compressed air can be easily sent into to have the longitudinal article expand uniformly to get a desired configuration.

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A preferred example of the foamable elastomer or rubber composition, according to the present invention, is disclosed in the following table:

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Component	% by weight
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Rubber

styrene butadiene rubber	84.9
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Blowing agent

di-nitrosopentamethylene tetramine	1.3
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Cross-linking agent

dicumylperoxide	1.0
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Filler

zincoxide	6.0
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Filler

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carbon black	6.8
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100.00



CLAIMS:

1. A method of producing a reinforced composite racket frame composed of an outer shell made of a thermosetting material and a foam core, comprising the steps of:
 - (a) inserting a foamable material in a shell of thermosetting material the outside dimensions of the material being less than the inside dimensions of the shell so as to create a space between said shell and said foamable material;
 - (b) inserting the shell and the foamable material into a mould;
 - 10 (c) initially pressurising the space with pressurised gas to force the shell intimately to contact the inner surface of the mould; and
 - (d) after the initial pressurising step, heating the mould to a temperature at which the foamable material expands
 - 15 subsequently to fill said space and to pressurise said space by said foamable material.
2. A method according to claim 1 wherein the foamable material is a foamable elastomer.
3. A method according to claim 1 wherein the foamable
- 20 material is a foamable rubber composition.
4. A method according to claim 1 wherein the foamable material is thermosetting.
5. A method of producing a reinforced composite racket frame, substantially as hereinbefore described with
- 25 reference to and as shown in Figures 1 and 4 of the drawings.

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