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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ³ : A63B 49/02, 49/06, 51/00, 51/02		A1	(11) International Publication Number: WO 81/03431 (43) International Publication Date: 10 December 1981 (10.12.81)		
(21) International Application Number: PCT/AU81/00066		(81) Designated States: AT (European patent), AU, DE (European patent), FR (European patent), GB (European patent), JP, NL (European patent), SE (European patent), US.			
(22) International Filing Date: 2 June 1981 (02.06.81)					
(31) Priority Application Numbers: PE 3837 PE 6561		Published <i>With international search report</i>			
(32) Priority Dates: 2 June 1980 (02.06.80) 20 November 1980 (20.11.80)					
(33) Priority Country: AU					
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<p>(54) Title: RACQUET STRINGS AND RACQUETS</p> <p>(57) Abstract</p> <p>Strings are provided for use in racquets for sports such as tennis, squash, badminton, racquetball and the like. The strings have a main section of string (10A, 10B, 10C, 10D, 10E, 10F) with a string retaining means (11A, 11B, 11C, 11D, 11E, 11F) located at or near each end of the string. Some forms of string may be fitted to conventional racquet frames. Others require novel racquet head frame constructions. The strings may also be formed as a woven mesh (13), for fitting to a racquet head. One form of mesh (13) has a peripheral loop (15) to enable it to be fitted into a racquet head containing a groove (25a, 25b, 32), a series of hooks (40) or a C-shaped channel member (41). Other racquet head constructions include head frames fitted with slots (33, 34, 35, 37), and head frames formed as two head members (60, 61) containing interlocking projection members (64) and projection receiving members (65). Dismantleable racquets, string dampeners and replaceable racquet grips are also disclosed, as are racquets produced by the moulding of the racquet frame around a mesh of strings.</p>					

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TITLE"RACQUET STRINGS AND RACQUETS"TECHNICAL FIELD

5 This invention concerns racquets of the type used in the sports of tennis, badminton, squash, racquet-ball and the like. In particular, it concerns strings for use in such racquets, and racquet frames and racquets of novel construction.

BACKGROUND ART

10 Racquets used in tennis, squash, badminton and racquet ball have changed very little since these games were devised. Racquets are still produced by the long-established method of making a racquet frame, then "stringing" the racquet. The "stringing" of the racquet has always been a labour-intensive task requiring both manual dexterity and acquired skills. Even an expert, using the latest equipment that is available, takes from 30 to 45 minutes to string (or re-string) a racquet. Consequently, racquet stringing and racquet re-stringing has long been an expensive operation.

15 Part of the skill in stringing a racquet is in knowing how much tension to apply to a string. To apply too little tension results in a "dead" racquet being produced. To over-tension the string is to risk stretching the string beyond its elastic limit, and breaking the string (with the attendant waste in time of having to begin to string the racquet again) or damaging the racquet by over-tensioned strings.

DISCLOSURE OF THE INVENTION

30 One objective of the present invention



is the production of a novel form of "string" for a racquet, which can be easily and quickly fitted to a racquet head, without risk of snapping the string and yet ensuring that the string, when in the racquet head, has sufficient tension to ensure that the racquet plays well.

This objective is achieved by providing a racquet string of predetermined length which has, near to each of its ends, means for retaining the string within a racquet head.

This concept can then be extended to a set of pre-woven strings for a racquet, the terminations of each of the strings within the woven set being provided with means for retaining the set of strings within a racquet frame.

The string retaining means referred to above may take any suitable form, depending on the nature of the racquet head to which the string or set of strings is to be attached. If the strings are to be attached to a conventional form of racquet, the string retaining means will typically be a compressible and resilient wedge-shaped, arrowhead shaped or generally conical member affixed to or formed integrally with the string, or each string in the set of strings. The point of the wedge, arrowhead or cone will be directed towards its nearest string end, but a short length of the string or a similar material will usually extend from the point of the wedge, arrowhead or cone to the end of the string.

As will be seen later in this specification, the string retaining means may also be a loop, a spade-like member, a toggle, a sphere, a hemisphere, a ring or any other suitable configuration. One particular construction that may



be used with a set of strings is a peripheral loop of relatively heavy gauge, but preferably elastic, material.

5 Yet another form of construction of strings for a racquet is a woven mesh of strings, adapted to be clamped between cooperating parts of the head of a racquet frame.

10 The strings may be of any suitable material for use in racquets, including nylon, polyester and other mono-filaments and multi-filaments, and racquet gut, including materials that can be shrunk by the application of heat or other physical or chemical treatment. Examples of shrinkable polyester materials are those marketed under the trade names "DACRON",
15 "CREONITE" and "SECONITE".

As indicated above, the present invention also encompasses racquet constructions adapted to receive the novel strings and woven mesh of strings of the present invention.

20 It will be appreciated by those skilled in this art that the basic form of the single string of the present invention, with its wedge-shaped, arrowhead shaped or conical string retaining member, can be fitted into a conventional
25 racquet head having holes drilled in it through which the strings pass. In addition, the woven mesh of the present invention, with such string-retaining members fitted to or formed with each string of the mesh, will be seen to be adapted to
30 be attached to a conventional racquet head.

35 However, other forms of string-retaining members do not permit the strings of the present invention, in the single string or woven mesh configuration, to be used with conventional racquets and it is primarily to allow such strings



to be used in racquets that novel racquet frames have been devised by the present inventors. In particular, according to one aspect of the present invention, a racquet frame has a head portion which is formed to have:

- 5 (a) a groove formed around the outer edge or one of the face edges thereof;
- (b) a plurality of substantially equi-spaced hooks located around it;
- 10 (c) a plurality of substantially C-shaped slots formed in one of the face edges thereof; or
- (d) a generally C-shaped channel member formed of malleable or resilient material located around its
- 15 inner face.

In one form of alternative (c), the substantially C-shaped slots may be in the shape of three sides of a rectangle, with two sides of each slot common with a side of the adjacent slots, in which case the racquet head will have a generally castellated appearance.

With the "slotted" form of racquet head, means may be provided to prevent the strings from being removed from the racquet after they have been fitted to the racquet head. A convenient form of such means is a generally planar member, adapted to fit over the racquet head and cover the groove or slots in the racquet head frame.

30 As will be seen later in this specification, there are numerous possible variations in the implementation of racquet frames having a racquet head which is adapted to receive the strings of the present invention.

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5 A further aspect in the present invention is the provision of a racquet construction in which the racquet head is constructed as two interlocking members, adapted to retain a woven mesh between them to form the strings of the racquet.

10 According to this aspect of the present invention, a racquet head is characterised in that it comprises two generally oval head frame members, the head frame members being provided with at least one projection member and at least one projection receiving member, the or each projection member being adapted to cooperate with a respective projection receiving member to interlock or intermesh therewith, said head frame members being adapted to retain the strings of the

15 racquet between them when the or each projection member is interlocked or intermeshed with its respective projection receiving member.

20 Note that the word "oval" used throughout this specification (including the claims) encompasses any shape of racquet head - including the almost rectangular racquet head shapes being introduced into racquet sports and recreational activities.

25 Conveniently, one of the head frame members will have a single projection member extending around substantially its entire oval form, and the other head frame member will be provided with a single projection receiving member extending around substantially all its oval form and adapted to receive the projection member of the first head frame member. However, there may be any suitable number of projection members and/or projection receiving members on a head frame member, provided that they cooperate with their complementary members on the other head frame member.

30 As will be seen later in this specification, the head frame members of this aspect of the present invention may be constructed to retain a woven mesh of



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"strings" between them by a clamping action, or they may be constructed so that single strings or a woven mesh of strings, constructed as described above, may be fitted to the interlocked or intermeshed head frame members. Alternatively, racquet head frames which are intermeshed to provide holes for the racquet strings may be strung by conventional stringing techniques.

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A particular form of the present invention is a racquet in which two moulded half-frames are brought together with a woven mesh of strings between their head regions, and the three component parts are secured together to form the racquet.

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Yet another form of the present invention is the provision of a moulded racquet, with the strings of the racquet held in the moulding. This form of the invention is realised by locating a mesh of strings in a mould, (in the shape of a racquet or racquet head), then injecting molten plastics material into the mould to form the racquet (or head) and to simultaneously bond the strings into the head portion. The mould for this type of racquet (or head) is preferably formed as two cooperating mould members, between which a mesh of strings can be clamped.

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Other aspects of the present invention include (a) the construction of a racquet as a multi-component unit, with a separate head member detachably secured to a neck member, which is, in turn, detachably secured to a grip member; (b) the provision of other pre-moulded laminated racquets; (c) the provision of removable grips for a racquet; and (d) the provision of a novel form of dampener, for reducing the transfer of vibrations in the strings of a racquet to the handle of the racquet, and thence to the arm of the user of the racquet. This last aspect of the present

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invention is the use of dampeners which comprise two substantially parallel, generally planar, elongate, plate-like members, which are dimensioned to fit over one string or a plurality of strings of the racquet, with a vibration-damping material carried on the opposed faces of the plates.

Embodiments of the various aspects of the present invention will now be described, by way of example, with reference to the accompanying drawings.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows, schematically, a selection of forms of the single string concept of the present invention.

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Figure 2 illustrates four examples of woven mesh sets of strings for a racquet, each set provided with a different edge construction, for mounting the set of strings on a racquet head frame.

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Figure 3 is a perspective sketch of three short lengths of racquet head frame, each provided with means for mounting one of the sets of strings illustrated in Figure 2 on the racquet head frame.

Figure 4 shows four short lengths of racquet head frames, constructed to accept strings of the type illustrated in Figure 1 or Figures 2(b) or 2(d).

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Figure 5 illustrates four different racquet head frame constructions adapted to receive woven mesh sets of strings as illustrated in Figure 2(c).

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Figure 6 depicts a short length of two head frame members, adapted to be intermeshed to form a racquet head.

Figure 7 is a section through the head frame members of Figure 6 when (a) the head frame members are separated and (b) the head frame members are interlocked.

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Figure 8 illustrates the use of a string



clamp with the head frame members of Figures 6 and 7.

Figure 9 is a series of sections through other forms of head frame member combinations, with (in each case) the two head frame members partly intermeshed.

Figure 10 illustrates one form of dismantlable racquet.

Figure 11 shows the construction of dampeners for use with racquets.

DESCRIPTION OF ILLUSTRATED EMBODIMENTS

Each of the single strings that are illustrated in Figure 1 has a main section 10A, 10B, 10C, 10D, 10E, 10F that is of length d which is determined by the intended location of the string in a racquet of specified shape and dimensions. At or near each end of the string is a string retaining member 11A, 11B, 11C, 11D, 11E, 11F. The string retaining members will be described in more detail below. Some of the strings have a short end length of thread, string material or the like 12A, 12B, 12C, 12D at their ends.

The strings shown in Figures 1(a), 1(b) and 1(c) may be used to string or re-string a conventional racquet frame. As will be seen, the string retaining members 11A, 11B and 11C are, respectively, wedge-shaped, arrowhead shaped and conical, with the pointed end of each member directed away from the other string retaining member of the string, when the strings are laid out as shown in Figure 1. In each case, the string retaining member 11A, 11B, 11C is made of a compressible but resilient material, and is bonded to or formed integrally with its respective main section 10A, 10B, 10C. If, for example, the main section 10A, 10B, 10C is of nylon or other synthetic material, the string retaining member may be of the same material, and attached to the string by a combined pressure moulding and welding



technique, using a small quantity of molten material.

Because the illustrations are schematic only, the dimensions of the string retaining members, especially in Figures 1(a), 1(b) and 1(c), are substantially exaggerated.

5 The end lengths of thread or the like, 12A, 12B and 12C, are typically the ends of the main sections 10A, 10B and 10C, respectively. They may, however, be of smaller cross-sectional area than the main sections
10 (formed, for example, by applying heat to the end regions of the strings to make the end regions ductile, then stretching the end regions). Alternatively, the end lengths may be a short length of thread, monofilament, metal wire or other suitable material bonded to the main
15 sections of their strings, or bonded to their adjacent string retaining members. The end lengths 12A, 12B, 12C should be long enough to extend through a racquet frame and provide sufficient material to be comfortably gripped by a pair of pliers or the like when the other end of
20 the string is already connected to the racquet frame.

In use with a conventional racquet frame, one end length 12A, 12B, 12C of a string is threaded through the appropriate hole in the racquet head. It is then gripped by a pair of pliers and pulled until its
25 adjacent string retaining member 11A, 11B, 11C has passed completely through the hole. The string retaining member is compressed as it passes through the hole in the racquet frame, but regains its uncompressed shape afterwards, due to its resiliency. The other end length
30 of the string is then passed through its associated hole in the racquet head, is gripped by the pliers, and then is pulled until the second string retaining member has passed completely through the racquet frame. The string retaining members are then effective to retain the string
35 in its required location in the racquet head.



If the string is of nylon, or of other material used, conventionally, for racquet strings, the act of pulling the second string retaining member through its associated hole in the racquet head frame will tension the main section of the string. A particularly beneficial feature of this aspect of the present invention now becomes apparent. Provided the string was correctly chosen for the racquet size and string location, the string will be correctly tensioned. Furthermore, the string cannot be over-tensioned, and thus there is no likelihood of breaking the string (which, as already noted, is a problem in the conventional method of stringing a racquet).

If the main section 10A, 10B, 10C of the string is made of a shrinkable material, the string can be tensioned, after both string retaining members have been pulled through their respective holes in the racquet head frame, by the application of heat or other means.

After mounting a string in a racquet head frame, the end lengths 12A, 12B, 12C can be cut off.

If a hole in a conventional racquet head frame is so large that a string retaining member is ineffective to hold a string in position in the head frame, a grommet, washer, or the like can be used to prevent the string retaining member from re-entering its associated hole in the racquet head frame.

The strings illustrated in Figures 1(d) and 1(e) are not adapted to be used in conventional racquets. They are, however, adapted to be fitted in racquet head frames which are illustrated in the drawings. For example, the string of Figure 1(d) can be used in the head frame shown, as a short length thereof, in Figure 4(c). It will be fitted into the racquet head frame by a technique similar to that



described above, but with each spade-shaped string retaining member 11D fitted into a respective recess 36 of the racquet head frame after being pulled through its associated slot 35.

5 The string of Figure 1(e), having a toggle-shaped (that is, generally cylindrical) string retaining member 11E may be fitted into racquet head frames of the type illustrated in Figures 3, 4 and 5. The string of Figure 1(f) is particularly adapted to be fitted to a racquet head frame of the type illustrated by Figure 3(a) of Figure 4(d).

10 Extending the string concept to a woven mesh of strings, adapted to be quickly and easily inserted into a racquet head frame, produces sets of strings of 15 the general type illustrated in Figure 2.

20 Each set of strings illustrated in Figure 2 has a shape which corresponds to the shape of the head of a racquet frame, but the edge of the set of strings is constructed so that the set of strings can be fitted into a particular design of racquet head frame.

25 The woven mesh 13 of Figure 2(a) is constructed as a mesh of strings of the type shown in Figure 1(a). It is constructed, for example, by forming a mesh of strings, then applying the string retaining members 11A and cutting the mesh to shape to leave end lengths 11C for use in fitting the set of strings into 30 a racquet head frame. This formation of the string retaining members 11A and cutting to size can be achieved in a single operation with an appropriately designed tool, especially if the strings are constructed of nylon or other synthetic material.

35 The application of a thin band 14 (or a series of thin bands) of synthetic material to the mesh 13 is optional, but is preferred, to hold the mesh intact during storage and handling prior to fitting to a racquet head



frame. The nature of the material of band (or bands) 14 will determine whether the or each band 14 can be manually removed from the mesh 13 after fitting the mesh to a racquet head frame (such fitting will usually cause the or each band 14 to be severed in a number of places), or whether heat treatment, or dissolution of the band material is required to remove the band material from the mesh 13 after fitting the mesh to a racquet head frame. As an alternative to the use of a band 14, the set of strings may be held together during storage and handling prior to the assembly of a racquet by a water-soluble glue. Another alternative is to store the assembled woven meshes in shaped bags of polyethylene, or like containers.

The woven mesh of strings depicted in Figure 2(b) has a similar construction to the mesh of strings illustrated in Figure 2(a), but each string of the mesh of Figure 2(b) has two string retaining members (one at each end) in the form of a loop 11F, as shown in Figure 1(f).

The mesh of strings shown in Figure 2(c) is different from the other sets of strings that are illustrated in Figure 2, in that it has a peripheral loop 15 at the edge of the mesh. The peripheral loop 15 is bonded to the individual strings of the mesh 13, and is made from an elastic material. A woven mesh constructed as shown in Figure 2(c) is adapted to be fitted to racquet head frames that are constructed as illustrated in Figures 3, 4(a) and 5. This form of woven mesh of strings does not require the additional shape-retaining assistance of a band 14, which is a feature of the other woven meshes illustrated in Figure 2, though such a band 14 may be applied if desired.



The mesh of strings illustrated in Figure 2(d) is constructed in a manner similar to the mesh of Figure 2(a), but with a toggle-shaped string retaining members 11E, as used with the string illustrated in Figure 1(e).

It will be clear that other mesh configurations, incorporating other types of string-retaining members at the individual string ends, may be constructed as alternatives to the exemplary embodiments illustrated in Figure 2, without departing from the inventive concept of this aspect of the present invention. For example, the mesh of Figure 2(b) could be constructed from a single string, woven to form the loops at the edges of the mesh of strings (instead of by weaving a mesh of individual strings, with each string terminating in loops 11F).

Various racquet head frame constructions which permit the mounting of a set of strings of the form illustrated in Figure 2 are shown in Figures 3, 4 and 5, which each depict small portions of the rim of the frame of a racquet head and show the construction features of the means for mounting the strings on, in or through the racquet head frame. In each of these illustrations, the two face edges of the racquet frame are references 21 and 22, and the outer and inner edges of the head frame are referenced 24 and 23, respectively.

To position the woven mesh of strings illustrated in Figure 2(b) or Figure 2(c) within a racquet head frame of the type illustrated in Figure 3(a), the peripheral loop 15 of the mesh is positioned so that it is held by hooks 40, or the loops 11F are fitted over respective hooks 40. If the racquet frame is to be used with a mesh of Figure 2(c), the hooks 40 can be substantially equi-spaced, but if the mesh of Figure 2(b) is to be used, the hooks 40 will usually be spaced apart by a



distance which allows the filaments of the woven web 13 to be correctly located in the racquet head frame.

To retain the strings of Figure 2(c) within the racquet head frame illustrated in Figures 3(b) or 5 3(c), the peripheral loop 15 is positioned within the C-shaped channel 41 of an extrusion of metal or other suitable material, mounted on the inner edge 23 of the head frame, or formed integrally with the head frame (in the case of a frame made from metal or a plastic material). If the extrusion is of maleable metal, the 10 members defining the channel are then brought together to the point where their edges are separated by the thickness of a single filament of the woven mesh or web 13. If the extrusion is of a resilient material, 15 the peripheral loop 15 may be snapped into position within the channel. The base plate 42 of the extrusion is securely mounted on to the racquet frame using screws, or any other suitable means.

As will have been appreciated already, the 20 racquet head frame of Figure 3(c) is formed as a moulding or extrusion of metal, a plastics material, fibreglass, or any other suitable material.

Racquet head frame structures which are 25 adapted to support both single strings and a woven mesh of strings are illustrated in Figure 4.

The racquet head frames of Figures 4(a) and 30 4(b) are particularly suitable for the mounting of individual strings which have string retaining members in the shape of a bead or toggle. The strings are positioned (stretched, if necessary) to lie in slot 33 (Figure 4(a)) or slot 34 (Figure 4(b)) with the string retaining member located, respectively, in cup 34a or in cylindrical hole 34b.

If the individual strings have a loop at 35 each end, as shown in Figure 1(f), the loops may be



positioned to lie in a C-shaped slot 37 of the type illustrated in Figure 4(d). Alternatively, the loops may be passed through slots 33, 34 and 35 and retained in position by a pin, thread or the like, passed through the eyes of the loops 11F.

If the strings have string retaining members in the form of a ring, a flat spade, or similar flat, rigid member, the string may be mounted in a racquet head frame having the structure of Figure 4(c). The ring, spade or the like is taken through the elongate slot 35 (the elongate direction of which need not be parallel to the planes of edge faces 21 and 22, as shown in Figure 4(c)) from inside the racquet head frame, and then the ring, spade or the like is rotated and positioned in an elongate slot 36 which is formed in the outer edge of the frame and extends for only a short distance into the frame. The elongate direction of slot 36 is not necessarily perpendicular to the elongate direction of slot 35, as shown in Figure 4(c).

If two strings of a racquet are formed together, as a single loop, the racquet frame structure of Figures 3(a), 4(a), 4(d) and 5 may be used to support such strings. The dimensions of, and spacing of, slots 26, and 31, and individual C-shaped slots 37 must, of course, be carefully selected to ensure that the individual strings, when positioned in the frame, form a regular woven matrix.

It will be readily appreciated that, as noted above, the structures of Figure 4 are adapted to receive a woven mesh of strings, as well as of single strings.

Racquet head frame structures which have been designed specifically to receive a woven mesh of strings of the type illustrated in Figure 2(c) are shown in Figures 3, 4(a) and 5.



5 In the racquet head frame embodiment illustrated in Figure 5(e), the peripheral loop 15 of the woven set of strings of Figure 2(c) is located within groove 25a with individual filaments of the woven web 13 lying in slots 26. If the strings are of a material which is not shrinkable, then it will be necessary to stretch the strings slightly to enable the loop 15 to be inserted into slot 25a. Once loop 15 is located within slot 25a, 10 which has a generally wedge-shaped cross-section, the tension on the strings forming woven mesh 13 (and in loop 15) pulls the loop 15 into the innermost corner of slot 25a. The web 13 and loop 15 must be so dimensioned that when the strings are so located, 15 the strings have the required tension in the racquet.

20 If the woven web 13 is made of shrinkable filaments, then applying heat or other shrinking means to the assembled racquet will tension the strings and pull the peripheral loop 15 into the innermost corner of slot 25a.

25 Whichever of these alternatives is used, the final product is a racquet with strings which cannot be accidentally removed from the racquet head frame while the racquet is being used for sporting purposes, but if the strings are damaged, the entire set of strings, or an individual string or pair of strings, can be replaced quickly, easily, and without complicated or expensive equipment being required.

30 It should be clear that a similar sort of head frame structure is illustrated in Figure 5(b), but with the groove 25a (having a wedge-shaped cross-section) being replaced with groove 25b, which has an L-shaped cross-section.

35 The racquet head frame of Figure 5(c) has a straight groove 25c formed in it, and includes a retain-



ing plate 28 to ensure that the peripheral loop 15 cannot inadvertently be removed from the groove 25c during play with the racquet. The retaining plate 28 is shown screwed to the face edge 21 of the racquet head frame. A feature of the retaining plate 28 of the embodiment illustrated in Figure 5(c) is the presence of flanges 30 and 29, which extend from retaining plate 28 into, respectively, groove 25c and slots 26. These flanges 30 and 29 are optional features. Normally, however, if a groove which is of the form of groove 25c is cut in the racquet head frame, either flange 30 (which need not be continuous but may comprise a series of short sections of flange extending from plate 28) or flanges 29 will be used to ensure that the bead 15 does not move from the bottom of slot 25c when the racquet is used.

Although screws have been shown in Figure 5(c) as the means for mounting retaining plate 28 on the racquet head frame, alternative methods of mounting may be used. For example, flanges 30 and/or 29 may be adapted to be a press-fit or a snap-fit into their respective groove or slots. Other mounting means may, of course, be used.

It will be noted that grooves 25a and 25b extend to a point just below the middle of the racquet head frame. This is to ensure that the strings are located in a plane mid-way between the planes of face edges 21 and 22. To further assist in the racquet construction, there may be a step between the bottom of slots 26, and the bottom of groove 25a (or 25b) so that the peripheral loop 15, when positioned within slots 26, rests against the bottom surface of the slots. Groove 25c (Figure 5(c)) will also be preferably sufficiently deep that the plane of the web of strings 13 lies in a plane mid-way between the planes of the upper face.



of retaining plate 28 and edge face 22.

The head frame of Figure 5(d) is a laminated structure. A shallow groove of semi-circular cross-section is formed in the edge faces of each of the two laminates of the head frame, and these semi-circular grooves form a groove 32 of circular cross-section when the two laminates are brought together. Slots 31, typically of circular cross-section but of smaller diameter than groove 32, are created by the joined laminates, extending from the inner face of the frame to groove 32. Slots 31, which correspond to slots 26 of the embodiments of Figures 5(a), 5(b) and 5(c), will normally be formed as slots of semi-circular cross-section in each laminate. The two laminates may be held together, when loop 5 of the string structure has been positioned within groove 32, by any suitable means, including adhesive and by use of screws, clips, press-fittings and snap-fittings.

The racquet head frame structures of Figures 5(a), 5(b) and 5(c) may also be used to support double strings, formed as a single filament loop. In these circumstances (and for the purpose of this specification), two adjacent slots 26, together with that portion of groove 25a (or 25b, or 25c) which interconnects them, form the equivalent of a C-shaped slot.

Referring now to Figures 6, 7 and 8, there is illustrated a racquet head frame constructed of two interlocking head frame members, 60 and 61. Each head frame member has a main body 62, which is planar in form, having a planar edge 63 which forms a face edge of the racquet. Projection member 64 and projection receiving member 65 are formed integrally with their respective main bodies 62 (typically by extruding an aluminium alloy, a plastics material, or any other suitable material to form the basic components for the head frame members 60 and 61).



Projection member 64 of the embodiment of Figures 6 and 7 is a single rib which has a thickened "ridge" 64A at its edge. Projection receiving member 65 is a channel member formed with two channel arm members defining a channel into which the rib 64 may be inserted.

5 When the rib first enters the channel, the arms of the channel member are displaced slightly by the ridge 64A, until the ridge reaches the groove 65A formed at or near the innermost part of the channel of member 65.

10 The ridge 64A is "snapped" into groove 65A to hold the two head frame sections together.

15 The embodiment illustrated in Figure 9(a), which shows two partly-intermeshed head frame members, operates in a similar manner, except that the rib 64B has no ridge at or near its edge, and channel member 65B has no groove within its channel. The embodiment of Figure 9(a) would require glue or screws, or other means, to hold the two head frame members firmly together. Such "other means" may be associated with the flanges 66 which depend from 20 the edges of the main bodies 62 and which, when the head frame members are intermeshed, form a closed racquet head frame structure.

25 Reverting now to Figure 6, it will be seen that slots 67 and 68 are provided, respectively, in the rib 64 and channel member 65. These slots are used to provide holes for the racquet strings. The rib and channel member may be so constructed that they form a string clamp when the racquet head frame members are interlocked. Alternatively, the strings of the racquet 30 may be held in position using one of the arrangements described above. Another alternative is to use a string clamp in each cooperating pair of slots 67, 68.

35 One form of string clamp is shown in Figure 8, which is a section through a pair of head frame members at a slot. The rib 64 has a slot 67 which



extends only to the point 69 of the rib. A small block 70 of any suitable material (including a resilient, compressible material) fits inside the channel member, and is held in the location of the slot 68 by a pair of lugs 71, which fit into the slot. A string 72 will be clamped by the rib at point 69 and the top of block 70 when the head frame members of Figure 8 are fully interlocked.

Figure 9 illustrated seven schematic sectional views of alternative constructions of the racquet head embodiment of Figures 6, 7 and 8, with the head frame members partly intermeshed. The main bodies of the racquet head frame members of Figure 9 are rectangular in cross-section (Figure 9(a)), half-annular in cross-section (Figure 9(b)), any required complex shape (Figure 15 9(c)), or are formed as box sections (Figures 9(d) to 9(g)).

From the foregoing description, it should be apparent that the various techniques for "stringing" a racquet that are mentioned and/or described above may be used with a racquet head frame made from main bodies of the form illustrated, in several (non-exhaustive) configurations, in Figure 9.

Yet other variations of the racquet head frame constructions described above are possible, without departing from the present inventive concept. For example, the clamping of the strings of the racquet between the racquet head frame sections may be effected by constructing the head frame with a cross-section of the form illustrated in Figure 9, but with the inner flanges of the head frame members of the racquet (in the case of constructions of the type illustrated in Figures 9(a) to 9(c)), or the inner regions of the opposing faces of the head frame sections (in the case of constructions of the type illustrated in Figure 9(d) to 9(g)), constructed in such a manner that they form a clamp for the strings of the



racquet. This clamp arrangement may comprise a pair of planar surfaces, formed one on each of the head frame sections. Alternatively the clamp arrangement may comprise cooperating opposed surfaces (such as a concave surface on one racquet head frame section forming a clamp with a convex surface of the other head frame section), or a pair of matched corrugated surfaces. Another alternative is for the clamping arrangement to comprise a series of smaller clamping regions, each adapted to clamp one string of the racquet or a small plurality of strings of a racquet. There are clearly many alternative clamping arrangements which may be used in this manner, and if required, they may utilise glue or be effective only when screws joining the racquet head frame members are tightened.

Referring now to Figure 10, a racquet is illustrated which is formed of three parts, namely a head member 80, a neck member 81 and a grip member 82. The individual parts are formed to fit together using the equivalent of a tongue-and-groove arrangement 84, 86. The "tongue" of the head member 80 is threaded at 85 to receive the threaded end of a metallic rod 83 which is adapted to pass through colinear cylindrical bores 87, 88 formed in neck member 81 and grip member 82, respectively. Note that bore 88 has a short, wider-diameter region 89 at its end remote from neck member 81, into which the enlarged end of metal rod 83 fits.

Other means of rigidly interconnecting the three parts of the racquet may, of course, be used.

The advantage of this type of racquet is that if any part of the racquet is damaged, it may be quickly replaced at considerably less expense than the cost of a new racquet. Furthermore, the racquet may be dismantled for better packing when being transported (particularly when parcelled for sending by mail) and it is possible for



a purchaser of a racquet to select the weight of the component parts, and the grip configuration, which best suits the purchaser.

5 Certain variations of the concept of the racquet illustrated in Figure 10 are possible. For example, the racquet illustrated may be made of only two parts - that is, a handle and a head section, so that the head is, essentially, a disposable item. Another variation is the use of a grip of cloth, leather or other suitable material, which is lined with "velcro" or a similar material to removably join it to the end of the racquet handle. Such grips can be readily replaced. Furthermore, the rod 83 of the racquet illustrated in Figure 10 may be adapted to be tightened to different degrees within the threaded region 85 of head 80, thereby providing means for varying the stiffness of the racquet shaft.

10 15

20 A still further variation in racquet construction, reflecting yet another aspect of the present invention, is the provision of dampeners of a novel design, for use with racquets, particularly with tennis racquets and squash racquets.

25 A dampener is used to reduce the extent to which vibrations in the strings of a racquet are transferred to the racquet handle, and hence to the arm of the person using the racquet. Reduced vibration transferral will result in reduction of tennis-related and squash-related complaints and injuries, such as muscle strain and tennis elbow. One form of dampener is illustrated in Figure 11. As will be seen, it comprises two substantially parallel, generally planar, elongate, plate-like members 90, 91, dimensioned to fit over one string or a plurality of strings of a racquet. Each plate-like member 90, 91 has a layer of vibration-damping material 92 bonded to it.

30 35



The interconnection of the plate-like members may be effected by any suitable means (not shown), including small screws, bolts, end-encircling caps, rubber bands, press-studs, or other forms of snap-connectors.

5 The elongate plate-like members 90, 91 may be made from any suitable material, including generally rigid but resilient plastics materials, and the vibration-dampening material 92 includes rubber, cloth, neoprene, felt, and certain plastics materials.

10 In use, a dampener will generally be dimensioned so that it is long enough to fit over three, four or five strings of a racquet, near to where the head of a racquet is connected to its handle. The transverse dimension of the elongate members of a dampener will normally be approximately equal to the distance separating adjacent parallel strings. Variations from such dimensions are, of course, possible, to suit the requirements of a user of a racquet.

15 As already noted above, the present invention also encompasses, in one aspect, the provision of moulded racquet, in which the racquet frame is formed by injection moulding of a plastics material, with a woven set of strings positioned in the mould, across the head portion of the racquet frame. To effect this form of the present invention, the mould for the racquet is preferably formed as two "half-racquet" moulds, adapted to be clamped or otherwise held together, with a set of strings stretched across the head portion of the mould. Injection of hot plastics material (or a resin/hardener combination) 20 fills the mould and in so doing, effectively bonds the strings to the moulded frame material. When the mould halves are removed, the ends of the strings of the woven mesh are removed and the moulded racquet is ready for use.

25



INDUSTRIAL APPLICABILITY

The present invention, in its basic string concept, will enable a user of racquets to quickly, easily and inexpensively re-string a racquet. Spare strings or sets of strings will form part of the equipment of players of racquet games. Racquet-game court owners may be expected to carry supplies of low-cost racquets made using the concepts illustrated in Figures 6 to 9, or the moulded racquet technique, for supply to patrons of the court as "disposable" or "throw-away" racquets.

Players of racquet games will benefit from the cost savings associated with the adoption of the various aspects of the present invention.

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CLAIMS

1. A string for a racquet, characterised in that it comprises a main string portion (10A, 10B, 10C, 10D, 10E, 10F) of predetermined length and, at each end thereof, means (11A, 11B, 11C, 11D, 11E, 11F) for retaining the string within a racquet head.

2. A string for a racquet as defined in claim 1, further characterised in that each means for retaining comprises a toggle (11E), a loop (11F), a sphere or a hemisphere.

3. A string for a racquet as defined in claim 1, further characterised in that:

(a) each said string retaining means comprises a wedge-shaped member (11A), an arrowhead-shaped member (11B), or a generally conical member, the narrow end of which is directed away from said main string portion; and

(b) said string also includes a length of string material, thread or the like (12A, 12B, 12C) extending from the narrow end of said string retaining means.

4. A string for a racquet as defined in claim 1, further characterised in that:

(a) each said string retaining means comprises a generally spade-shaped member (11D) or a ring; and



(b) said string includes a length of string material, thread or the like (12D) extending from the string retaining means from a location thereon which is distant from said main string portion (10D).

5. A string for a racquet as defined in claim 3 or claim 4, in which said length of string, thread or the like (12A, 12B, 12C, 12D) is an extension of said main string portion (10A, 10B, 10C, 10D).

6. A string for a racquet as defined in any preceding claim, further characterised in that:

(a) said main string portion is made from a synthetic material and said string retaining means is made from the same or a compatible synthetic material; and

(b) said string retaining means is formed integrally with said main string portion or is bonded thereto by the application of heat and/or pressure.

7. A set of strings for a racquet, characterised in that it comprises a woven mesh (13) of racquet strings of generally oval shape, each string in said mesh being a racquet string as defined in any one of claims 1 to 6.

8. A set of strings for a racquet as defined in claim 7, further characterised in that at least one band (14) is applied to said mesh (13) to retain the strings therein in a required location relative to each other prior to the application of the set of strings to a racquet.



9. A set of strings for a racquet as defined in claim 7, further characterised in that said mesh (13) is coated, at least in part, with a soluble glue to retain the strings of the mesh in a required location relative to each other prior to the application of the set of strings to a racquet.

10. A set of strings for a racquet comprising a woven mesh (13) of racquet strings having a generally oval shape, each string of said mesh (13) being bonded, at each end thereof, to a peripheral loop (15) surrounding said mesh (13).

11. A set of strings as defined in claim 10, in which said peripheral loop (15) is made of an elastic material, which is of heavier gauge than the strings of the mesh.

12. A string for a racquet as defined in any one of claims 1 to 6, or a set of strings for a racquet as defined in any one of claims 7 to 11, further characterised in that the or each string is made from a material which is shrinkable on the application of heat, or by the application of other physical or chemical treatment.

13. A racquet frame having a head portion which is adapted to receive a plurality of strings as defined in one of claims 1 to 6 and 12, or a set of strings as defined in one of claims 7 to 12, said head portion having face edges (21, 22) in a plane parallel to the plane of the racquet head, an inner face (23), and an outer face (24), characterised in that a plurality of hooks (40) are inserted into said inner face (23).



14. A racquet frame as defined in claim 13, further characterised in that said hooks (40) are substantially equispaced around said inner face (23), whereby said racquet frame is adapted to receive a set of strings as defined in claim 10 or claim 11.

15. A racquet frame having a head portion which is adapted to receive a plurality of strings as defined in one of claims 1 to 6 and 12, or a set of strings as defined in one of claims 7 to 12, said head portion having face edges (21, 22) in a plane parallel to the plane of the racquet head, an inner face (23), and an outer face (24), characterised in that a generally C-shaped channel member (41), formed from a resilient or a malleable material, is located around the inner face (23), whereby said racquet frame is adapted to receive a set of strings as defined in claim 10 or claim 11.

16. A racquet frame as defined in claim 15, further characterised in that said channel member (41) is mounted on a plate (42), which is affixed to said inner face (23).

17. A racquet frame having a head portion which is adapted to receive a plurality of strings as defined in one of claims 1 to 6 and 12, or a set of strings as defined in one of claims 7 to 12, said head portion having face edges (21, 22) in a plane parallel to the plane of the racquet head, an inner face (23), and an outer face (24), characterised in that a plurality of grooves (33) are formed in one of said face edges (21), said grooves extending from said inner face (23) to said outer face (24), and a second groove is formed in said outer face (24), said second groove being located at substantially the lowest point of said plurality of grooves/being parallel to the planes of the face edges (21, 22).



18. A racquet frame having a head portion which is adapted to receive a plurality of strings as defined in one of claims 1 to 6 and 12, or a set of strings as defined in one of claims 7 to 12, said head portion having face edges (21, 22) in a plane parallel to the plane of the racquet head, an inner face (23), and an outer face (24), characterised in that a plurality of grooves (33) are formed in one of said face edges (21), said grooves extending from said inner face (23) to said outer face (24), and an equal plurality of dished indentations (34a) are formed in said outer face (24) at the lowermost points of said grooves.

19. A racquet frame having a head portion which is adapted to receive a plurality of strings as defined in one of claims 1 to 6 and 12, or a set of strings as defined in one of claims 7 to 12, said head portion having face edges (21, 22) in a plane parallel to the plane of the racquet head, an inner face (23), and an outer face (24), characterised in that a plurality of slots (34) are formed in one of said face edges (21), each said slot (34) extending from said inner face (23) towards said outer face (24), but terminating before said outer face (24) in a cylindrical hole (34b) extending from said one face edge (21) towards the other face edge (22) and of depth substantially the same as the depth of said slot (34).

20. A racquet frame having a head portion which is adapted to receive a plurality of strings as defined in one of claims 1 to 6 and 12, or a set of strings as defined in one of claims 7 to 12, said head portion having face edges (21, 22) in a plane parallel to the plane of the racquet head, an inner face (23), and an outer face (24), characterised in that a plurality of



of generally C-shaped slots (37) are formed in one of said end faces (21), the arms of each C-shaped slot (37) terminating at the inner face (23) of the frame.

21. A racquet frame having a head portion which is adapted to receive a plurality of strings as defined in one of claims 1 to 6 and 12, or a set of strings as defined in one of claims 7 to 12, said head portion having face edges (21, 22) in a plane parallel to the plane of the racquet head, an inner face (23), and an outer face (24), characterised in that:

(a) a plurality of first elongate slots (35) are formed in said portion, each said elongate slot (35) extending from said inner face (23) to said outer face (24); and

(b) an equal plurality of second elongate slots (36) are formed in the outer face (24), each of said second elongate slots (36) extending only partly between said outer face (24) and said inner face (23), being located to coincide with a respective one of said first elongate slots (35), and having its elongate direction located in a plane which is not parallel to the plane of the elongate direction of its associated first elongate slot (35).

22. A racquet frame having a head portion which is adapted to receive a plurality of strings as defined in one of claims 1 to 6 and 12, or a set of strings as defined in one of claims 7 to 12, said head portion having



face edges (21, 22) in a plane parallel to the plane of the racquet head, an inner face (23), and an outer face (24), characterised in that a groove (25a, 25b, 25c) is formed in one of said face edges (21), said groove (25a, 25b, 25c) having a similar curvature to the curvature of said inner face 23 and said outer face (24), and a plurality of slots (26) extend from said groove (25a, 25b, 25c) to said inner face (23).

23. A racquet frame as defined in claim 22, in which said groove (25a) increases in width with its depth.

24. A racquet frame as defined in claim 22, in which said groove (25b) is substantially L-shaped.

25. A racquet frame as defined in any one of claims 22, 23 and 24, further characterised in that a retaining plate (28) is adapted to fit over said one face edge (21).

26. A racquet frame as defined in claim 25, further characterised in that said retaining plate (28) is provided with a flange (30) adapted to fit into said groove (25c).

27. A racquet frame as defined in claim 26, further characterised in that said retaining plate (28) is also provided with a plurality of second flanges (29), each said second flange (29) being adapted to fit into a respective one of said slots (26).

28. A racquet frame having a head portion which is adapted to receive a plurality of strings as defined in one of claims 1 to 6 and 12, or a set of strings as



defined in one of claims 7 to 12, said head portion having face edges (21, 22) in a plane parallel to the plane of the racquet head, an inner face (23), and an outer face (24), characterised in that:

(a) said head portion is formed of two overlapping members, one of said edge faces (21) being located on one of said overlapping members, the other of said edge faces (22) being located in the other of said overlapping members;

(b) a first groove (32) of substantially semi-circular cross-section is formed in each of the abutting faces of said overlapping members, said first groove (32) having an elongate curvature which follows the curvature of said inner face (23) and said outer face (24), whereby, when said overlapping members are brought into overlapping juxtaposition, a continuous groove of substantially circular cross-section is formed within said head portion; and

(c) a plurality of second grooves (31) are formed in the abutting face of each said overlapping member, each of said second grooves extending from its respective first groove to said inner face (23), said second grooves being located in corresponding positions on said overlapping members.

29. A racquet frame having a head portion which is adapted to receive a plurality of strings as defined



in one of claims 1 to 6 and 12, or a set of strings as defined in one of claims 7 to 12, characterised in that said head portion comprises two generally oval-shaped head members (60, 61), one of said head members (60) being provided with at least one projection member (64), the other of said head members (61) being provided with at least one projection receiving member (65), the or each projection member (64) being adapted to cooperate with a respective projection receiving member (65) and to interlock or intermesh therewith.

30. A racquet frame as defined in claim 29, in which said one head member (60) has a single projection member (64) extending around its entire oval form, and said other head member (61) has a single projection receiving member (65) adapted to receive the projection member (64).

31. A racquet frame as defined in claim 29 or claim 30, further characterised in that the or each projection member (64) is a flange or rib and the or each projection receiving member (65) is a channel member.

32. A racquet frame as defined in claim 31, in which the edge of the flange or rib is provided with a ridge (64A) which is adapted to be fitted into a groove (65A) formed in the channel of the channel member.

33. A racquet frame as defined in claim 31 or claim 32, including a plurality of slots (67) formed in the projection member (64) and an equal plurality of slots (68) formed, in corresponding locations, in the projection receiving member (65).

34. A racquet frame as defined in claim 33, further characterised in that a string clamping member (70) is



provided within the channel of the projection receiving member (65).

35. A racquet frame as defined in claim 29, in which each head member is semi-circular in cross-section.

36. A racquet frame as defined in claim 29, in which each head member is a box section.

37. A racquet having a frame as defined in any one of claims 13 to 36, characterised in that said racquet is formed as a plurality of inter-connectable parts.

38. A racquet as defined in claim 37, in which said plurality of parts is three, said parts being a head member (80), a neck member (81) and a grip member (82).

39. A racquet as defined in claim 38, further characterised in that said parts are held together by a metal rod (83) which passes through aligned bores (87, 88) in said neck member (81) and said grip member (82) and engaged a threaded bore (85) in said head member (80).

40. A racquet as defined in any one of claims 38 to 39, including a replaceable grip, affixed to said grip member (82) by a "Velcro" fastening arrangement.

41. A racquet as defined in any one of claims 37 to 40, further characterised by the inclusion of a string dampener, said string dampener comprising two substantially parallel, generally planar, elongate, plate-like members (90,91), said plate-like members (90,91) being adapted to be connected to each other, each plate-like member (90,91) carrying a layer of vibration damping material (92) on its face which opposes the other plate-like member.



42. A racquet frame as defined in claim 15, further characterised in that the racquet frame material is moulded or extruded and the channel member (41) is formed integrally with the head portion of the racquet frame.

43. A racquet comprising a woven mesh (13) of strings, bonded to the head portion of a racquet frame, said head portion being moulded on to or about the woven mesh of strings.

44. A racquet as defined in claim 43, characterised in that the racquet frame is formed by injecting material into a frame mould, said frame mould being formed as two cooperating mould members, adapted to hold a set of woven strings (13) across the head portion of the frame, whereby injection of the material to form the racquet frame causes the injected material to surround and bond to that part of the woven strings which is located within the mould.

45. A racquet as defined in claim 44, in which the woven set of strings is tensioned prior to the injection of the racquet frame material into the mould.



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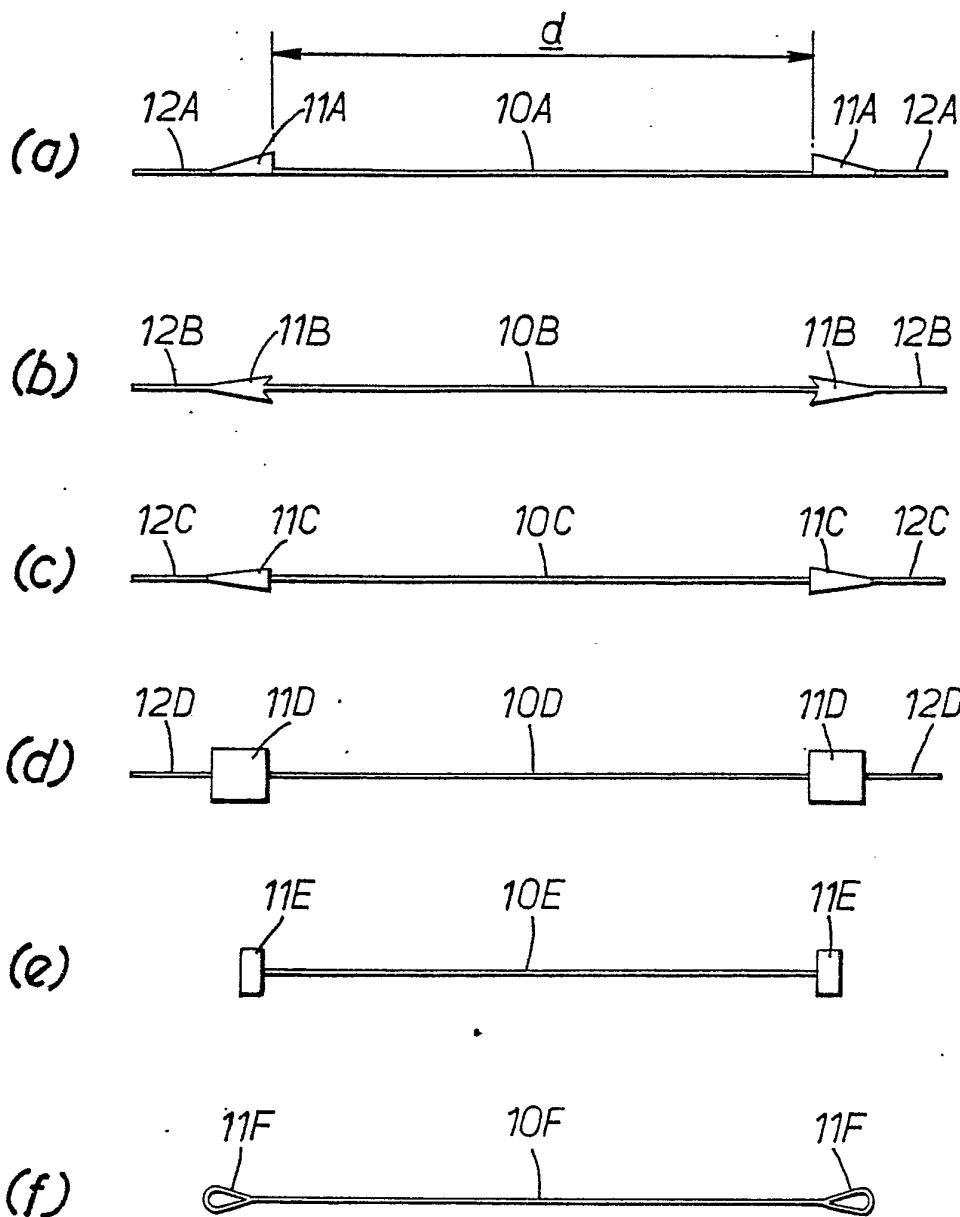
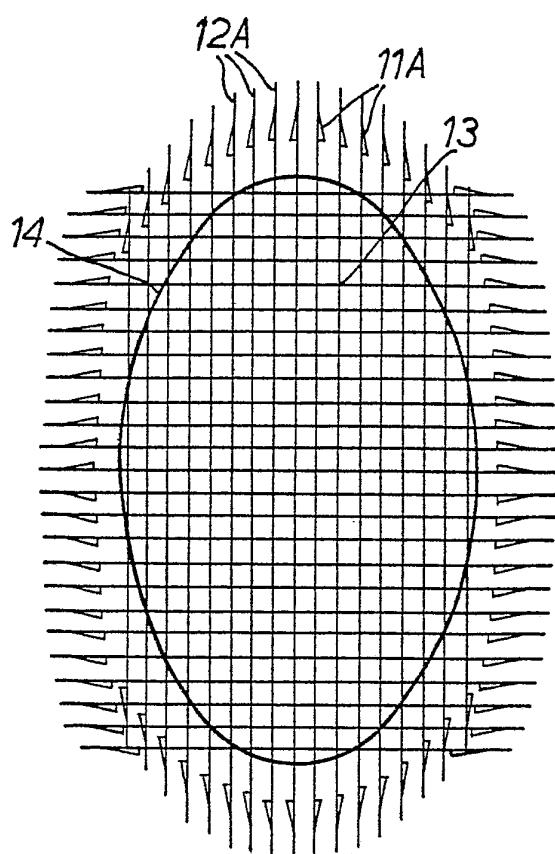


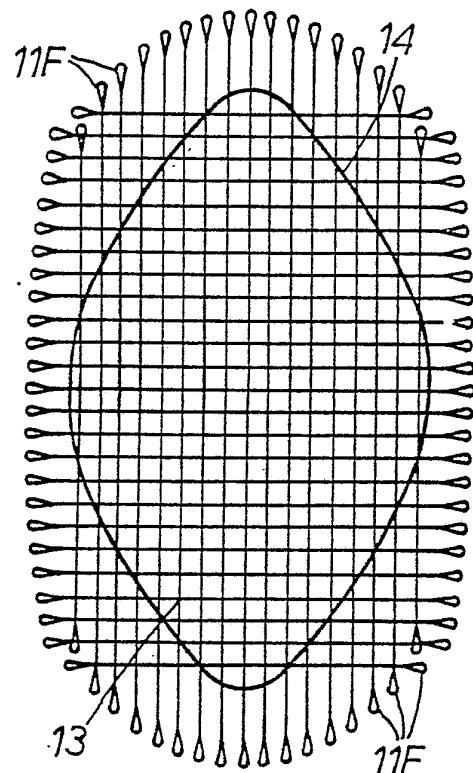
FIG. 1.



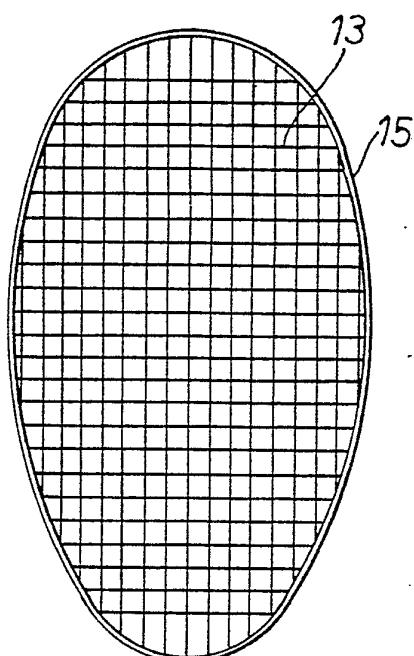
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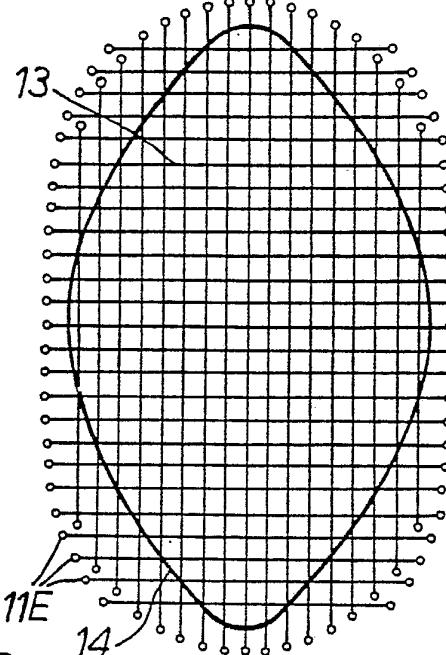
(a)



(b)



(c)



(d)

FIG. 2.

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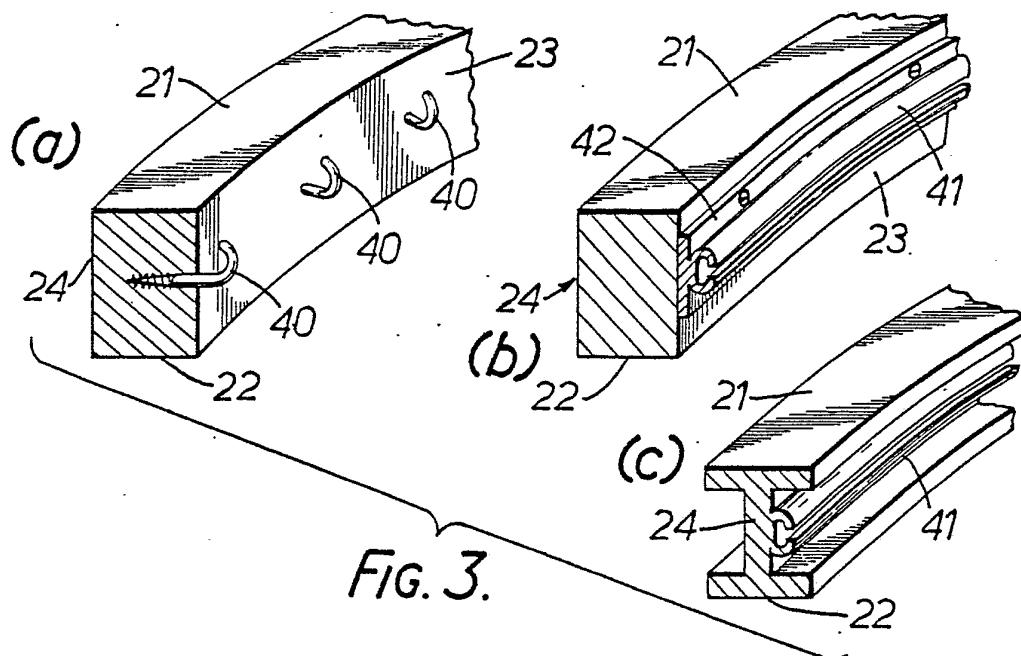


FIG. 3.

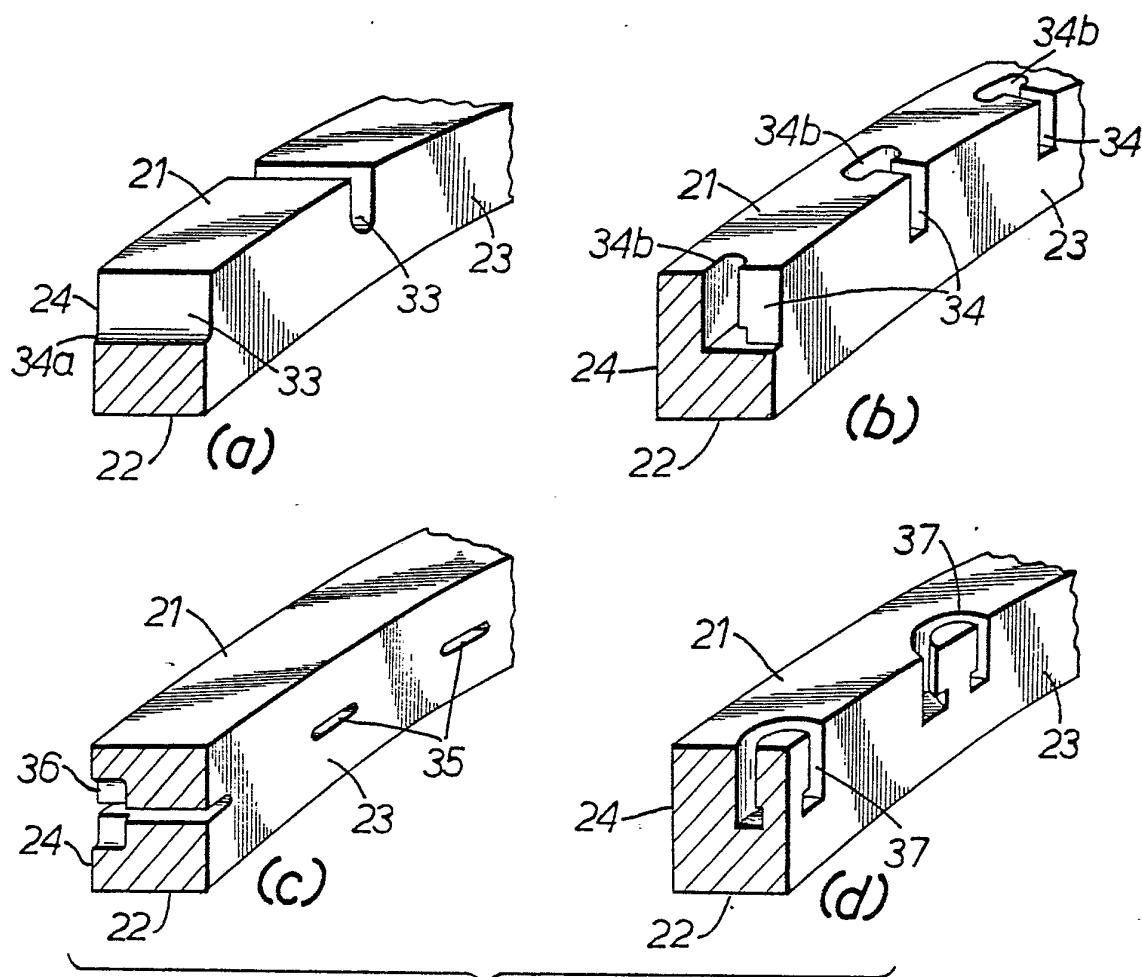
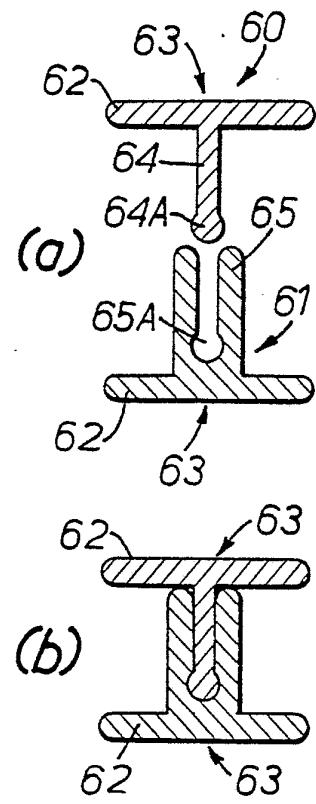
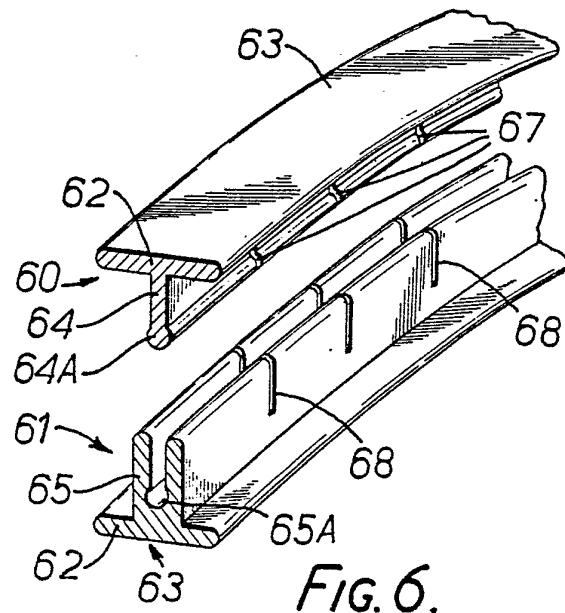
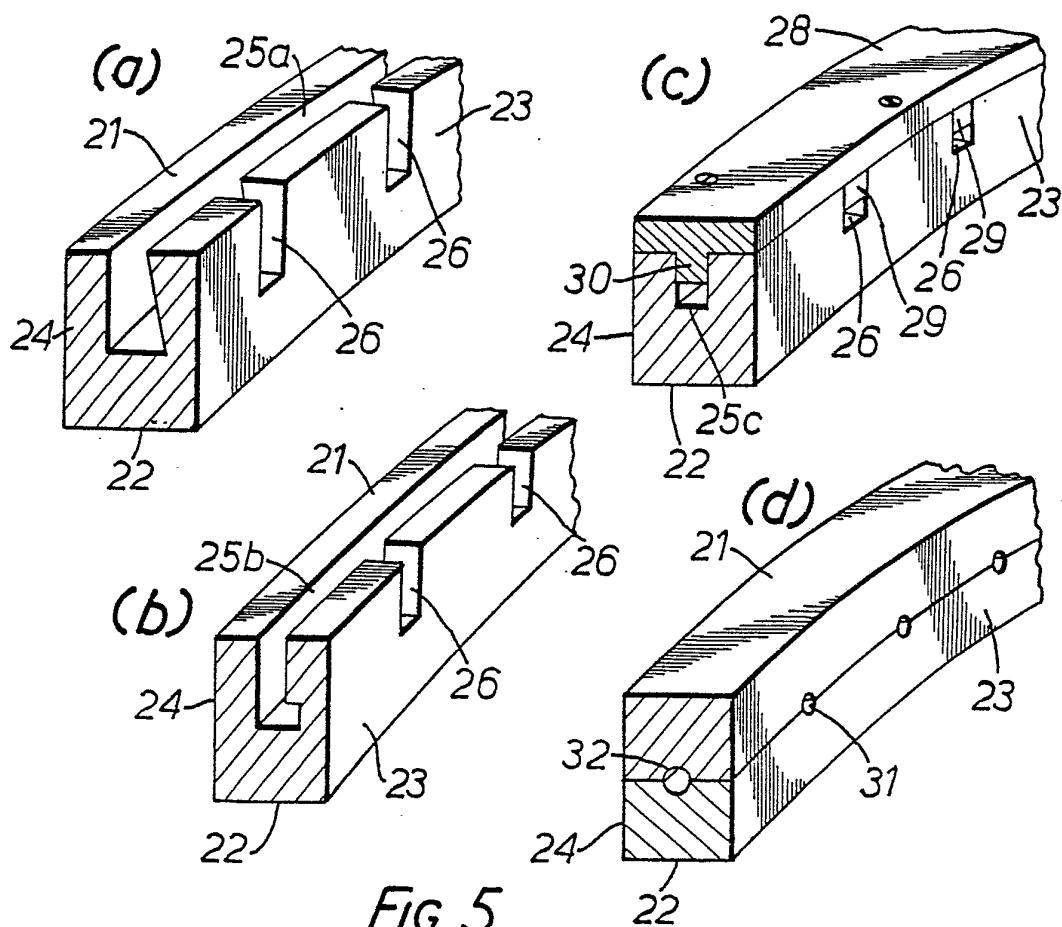


FIG. 4.

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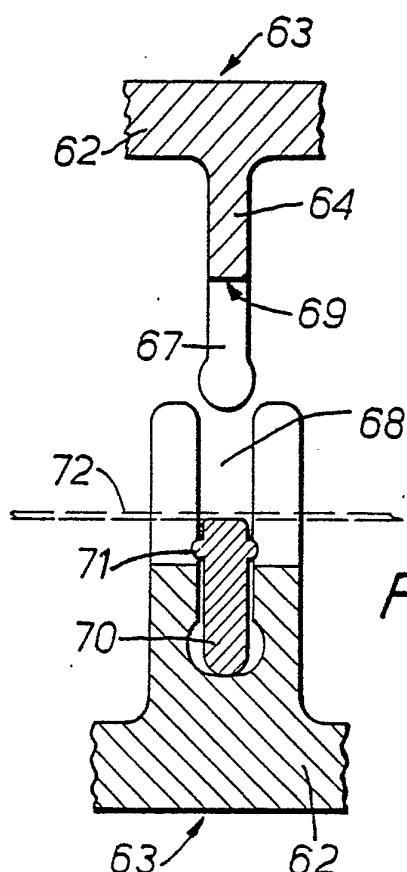


FIG. 8.

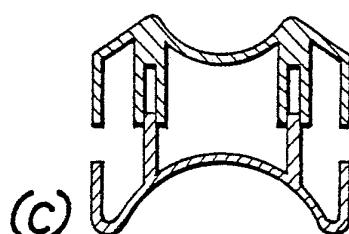
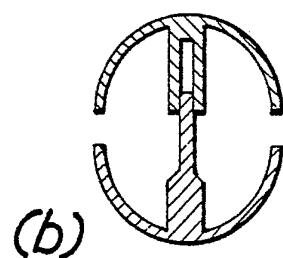
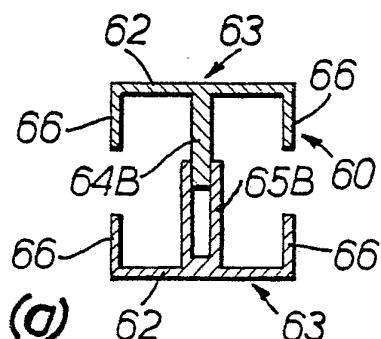
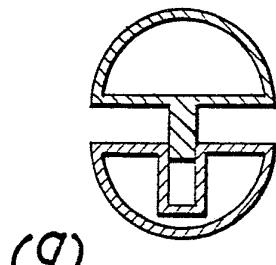
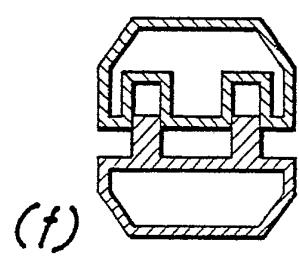
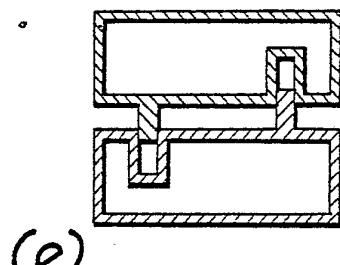
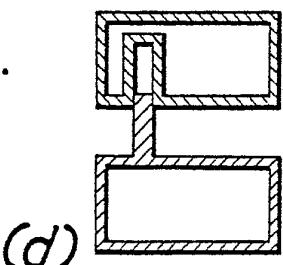


FIG. 9.



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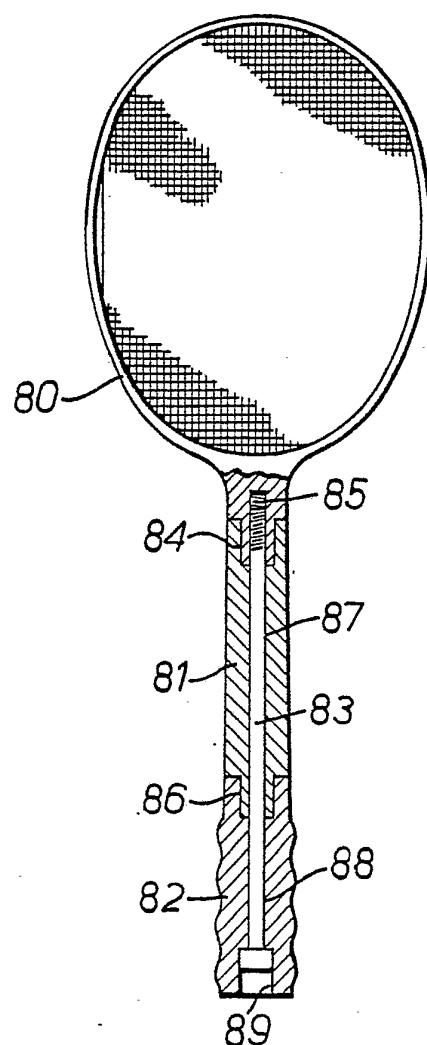


FIG. 10.

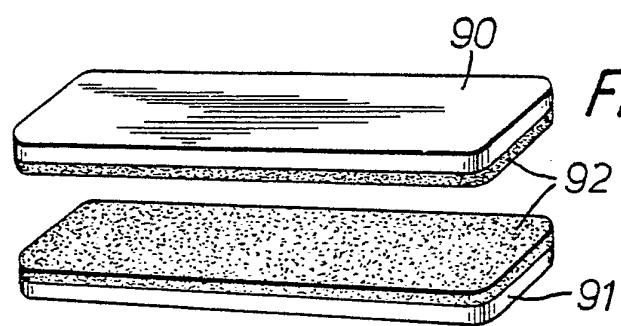


FIG. 11.

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INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 81/00066

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ³

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl. ³ A63B 49/02, 49/06, 51/00, 51/02.

II. FIELDS SEARCHED

Minimum Documentation Searched ⁴

Classification System	Classification Symbols
IPC	A63B 49/02, 49/06, 49/10, 51/00, 51/02, 51/14, 51/16

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched ⁵

AU:IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴

Category ⁶	Citation of Document, ¹⁰ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
X	AU, B, 20525/76 (503429), published 1978, June 22, see Claim 1 and Figure 2, Pepsico Inc., (& CA, A, 1069957)	29
X	AU, B, 18363/34, published 1935, Spencer	1
X	AU, B, 21611/45 (125055), published 1946, see Figure 6, Spencer	1
X	AU, B, 20475/70 (443906), published 1972, March 30, see Figures 3, 4, Latham et al.	15
X	AU, B, 11154/76 (506258), published 1977, September 1, see Figure 6, Septier, (& US, A, 4118029, & DE, A, 2605638)	7
X	GB, A, 1481640, published 1977, August 3, Malstrom, (& US, A, 4029317)	43
X	GB, A, 1201649, published 1970, August 12, Carlton Sports Company Limited, (& DE, A, 1816112)	29

(Continued on Extra Sheet)

* Special categories of cited documents: ¹⁵

"A" document defining the general state of the art

"E" earlier document but published on or after the international filing date

"L" document cited for special reason other than those referred to in the other categories

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed

"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search ²	Date of Mailing of this International Search Report ²
11 August 1981 (11.08.81)	17 August 1981 (17-08-81)
International Searching Authority ¹ AUSTRALIAN PATENT OFFICE	Signature of Authorized Officer ²⁰ A.S. MOORE <i>A.S. Moore</i>