July 4, 1939. R. ABELL 2,164,631

RACKET

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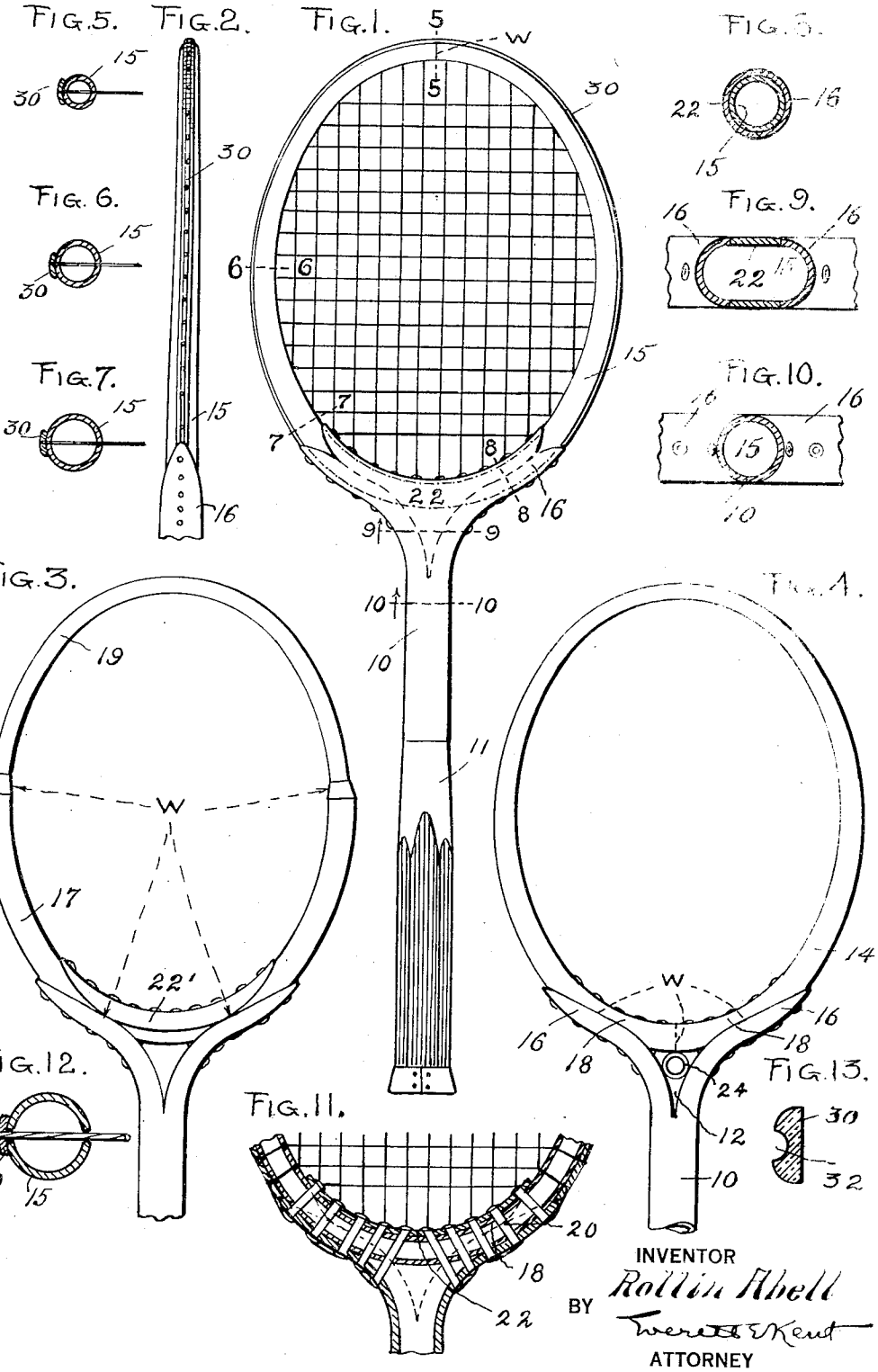

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RACKET

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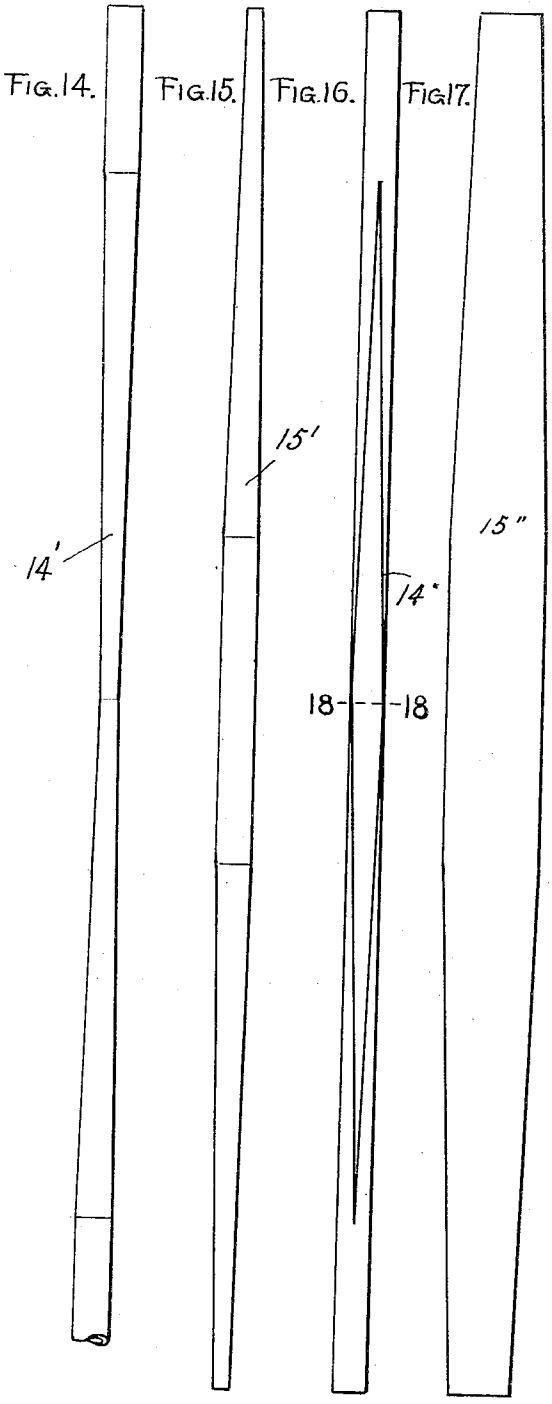

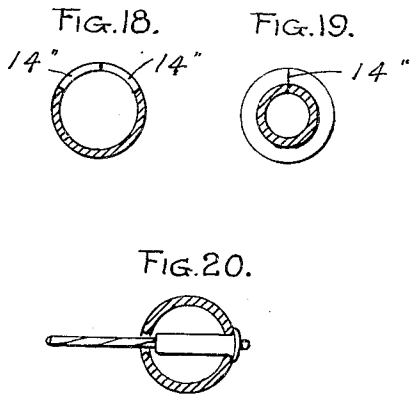

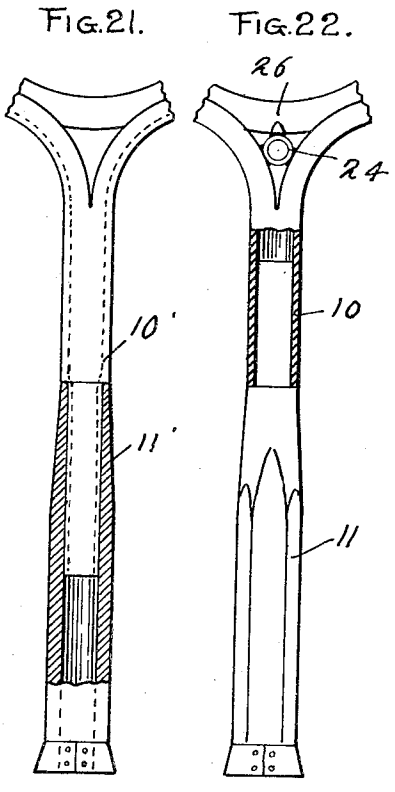

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2,164,631

RACKET

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6 Claims. (Cl. 273—73)

This invention relates to improvements in rackets, such as may be used in tennis, squash, badminton and other games.

More particularly it provides for making the frame of hollow metal construction, either of tubing or of sheet metal.

Such rackets are subject to limits of weight and size which are standardized in the various types of rackets, as for example the permissible range for a tennis racket is, approximately, between twelve and fourteen ounces. A chief object of the invention is to achieve abundant playing strength of frame, within the weight limits, coupled with a high degree of rigidity of frame, and with a distribution of weight between head and handle so that the balance point will be approximately mid-way of the length, which must total twenty-seven inches.

One feature is the combining of a tubular head frame, of closed loop form, with a handle which has a single large tube, split open at one end, in the hollow halves of which the head loop is rigidly cradled, so that this bifurcated handle part forms a stiff throat, and outlying shoulders that reinforce the head frame. The other end of this handle tube can be a socket for the attachment of a hand grip of wood or other material by a pressed fit, which permits of a selection among different sizes of grips; and provides for the secure attachment of a grip made of molded plastic compound or other material which is unaffected by moisture, if such be desired.

One object of the invention is to reduce greatly the amplitude of vibration of the racket resulting from a playing stroke upon the ball. It has been proven that maximum rigidity is desirable; and that flexibility or resilience of the frame or handle reduces the speed of the ball and the accuracy of play. It has also been proven that a racket made according to the present invention has under measured load a deflection about one-half that of the best wood and metal rackets found in current practice; and that the amplitude of vibration of the racket is reduced so low that reaction occurring between ball and racket does not cause objectionable rebound or vibration of the racket, nor materially reduce the speed of the ball, nor effect the direction of its flight,—even though the ball be struck at a point off from the center of the head.

One feature in the solving of this problem consists in a due proportioning of the cross-sectional area of the frame member, at different points of the head and handle. In order to produce maximum strength and rigidity within the weight limit, these sections must vary from each other; and the result cannot be attained with a head whose frame member is made from material having cross sections which are uniform throughout its length, nor from material which is tapered in one dimension only. The racket of the invention may be considered as a beam supported at one end, so proportioned that at every point throughout its length the rigidity and strength for resisting bending stresses received in play offer a resistance to deflection whose relation to the stresses received is approximately uniform with the similar relation at all other points, and, in particular is so proportioned that the deflection at the throat and shoulders will be no greater than at any other point.

Rackets made according to the invention have been found by exhaustive experiment to attain a maximum of strength and rigidity, irrespective of the material used, by following three definite rules, reference being made more particularly to metallic frames made of aluminum, duralumin or steel tubing of round cross section, tapered in the head from the shoulders or base of the head to the tip of the head loop.

First, the head and handle members must be of tubular form. They may be of either seamless or welded tube constructions, or may be of two piece sheet metal constructions, die stamped into half-round shell form in the contour of the racket, put together and welded on their junction lines. Neither channel, T or I-beam section will accomplish the result. Nor is it permissible to have locked joints or seams at which there is even a minute movement of lost motion under torsional or other stress.

Second, the frame member in the head must taper in both planes, that is, as it proceeds from base to tip of the loop it both must taper toward the plane of the strings and must taper in that plane. Reversely, its cross section should increase from the tip of the head toward the handle in definite proportion, the cross sectional area of the loop frame member at the shoulders approximating twice that at the tip of head.

Third, the handle member must be of greater beam strength and torsional strength than the head member, and be rigidly connected to the head so as to reinforce it without lost motion or looseness in the connection.

It is another feature of the invention, while retaining a convex cross section of tube, because of the superior strength, to provide a non-metallic grooved strip as of leather, fibre, rubber or

fabric on the outside of the metallic loop. In this groove the strings are buried to prevent them from injury during play, and also to prevent abrasion during the process of stringing. The grooved strip can be reversed, to face the groove inward on the outside of the frame to completely cover the loop bends of the strings and there be fastened to the frame with glue or bindings.

It is another object to provide for the easy stringing of gut through the two walls of a tubular head member. This is done by fitting a long eyelet which runs from its flange at that wall of the tube which constitutes the outer side of the frame, nearly to the inner wall thereof, constituting a sort of nozzle which directs the end of gut to the hole already drilled through the inner wall of tube. This will be held tight, without rattle, by the tension of the stringing.

The invention also includes the other novel features which are incidental to the construction shown or described. It is intended that the patent shall cover, by suitable expression in the appended claims, whatever features of patentable novelty are disclosed herein. The accompanying drawings illustrate embodiments of the invention; and it will be understood that variations in other respects may be made, from the specific embodiment chosen to illustrate the invention, within the scope of the claims.

In the accompanying drawings:

Figure 1 is a plan or face view of one form of a tennis racket embodying the invention;

Figure 2 is a partial side view of the head member of the racket;

Figure 3 is a face view of another construction of racket embodying the same principles;

Figure 4 is a face view of still another construction of racket embodying the principles of this invention;

Figures 5, 6 and 7 are cross sections, somewhat diagrammatical, of the frame of the head member of the racket shown in Figure 1, being a tube, viz, at the tip of the head, on line 5—5; at the mid-length of the head, on line 6—6; and near the shoulder, on line 7—7;

Figure 8 is a cross section of the tubes which comprise the shoulder, on the line 8—8;

Figure 9 is a cross section of the handle member of the racket at the throat, on the line 9—9;

Figure 10 is a cross section of the handle member on the line 10—10;

Figure 11 is a section parallel to the face of the racket showing the throat construction of the type seen in Figure 3;

Figure 12 is a cross section of the head tube on a larger scale illustrating the non-metallic strip which protects the string;

Figure 13 is a section of the protecting strip, on large scale;

Figure 14 shows the form of tapered tube for making a frame for a head of the style seen in Figure 4; before that tube is bent into a loop whose ends are to be welded together at the throat end of the head;

Figure 15 is a view of the form of tapered tube from which the head seen in Figure 1 is made, ends to be welded together at the tip end of the head;

Figure 16 indicates a tube having a double tapered section cut out of its side, being a midstage of another way of forming the tapered tube of the head of the ultimate shape of Figure 4;

Figure 17 is a view of a flat sheet metal strip from which a tapered tube of the ultimate shape seen in Figure 1 can be made for the head of the racket;

Figure 18 is a cross section on line 18—18 of Figure 16;

Figure 19 is a cross section of the same tube at the same place after the cut-out space has been closed, making a tapered tube of the type seen in the loop of Figure 4;

Figure 20 is a cross section of the head tube having interiorly of the tube an eyelet constituting a stringing guide, as if such an eyelet were inserted in the region of the section 6—6 in Figure 1;

Figure 21 is a face view, partly in section, of one form of the handle and grip construction;

Figure 22 is a face view, partly in section, of an application of the same principle with the relation of the parts reversed.

The drawings show construction by which the characteristic features of the invention may be attained within the prescribed limits of weight and balance, viz, the necessary strength; the improved rigidity; the freedom from vibratory reaction.

One form of the completed racket is shown in Figure 1, but the construction is shown more clearly by the slightly different form seen in Figure 4, which is the form I at present prefer. Referring to Figure 4, the head frame is a round tube whose cross section diminishes toward the tip of the racket, being at the tip about half what it is at the shoulders, in area, which in turn is about half the area of the cross section of the handle as it approaches the throat, the material in the racket represented being aluminum seamless tubing, both for handle and for head frame. The handle 10 is split as at 12 and the two halves are bent open into a bifurcated end 16, 16, into the hollows of which the shoulders 18, 18 of the head frame rest and are firmly cradled. They can be held by welding, which is preferable, which can be reinforced by rivets 20 as seen in Figure 11, where there is also seen another reinforcing shell plate 22, on the inner side of the head frame.

For the making of the head frame Figure 4 illustrates a tube 14 made from a tube whose intermediate stage of manufacture is seen in Figure 14. The initial stage of this being a straight round tube of say three-quarter inch diameter, the cylindrical shape has to be converted to that of Figure 14; and it is preferred at the same time to control the thickness of wall. If, for example, the original tube as seen at the upper end of Figure 14, have a diameter of three-fourths inch and a wall thickness of .065 inch, the first step may be to taper this in a lathe by removing material until, at the smallest part of the taper, being in this instance at the middle of the tube's length the wall thickness is about half what it was originally, say about .033. Then the pronounced taper in the tube may be produced by subjecting the tube to the action of a swedging machine which, by a multiplicity of blows on all sides of the tube produces a taper from the initial .75 to about .50, incidentally increasing the thickness of the wall where its diameter is reduced, so that at the point of minimum diameter the wall thickness will be about .05. Experience shows that in undergoing this operation no lengthening occurs if the material were an aluminum tube. If it were steel a slight lengthening occurs; and if the swedging be done by hammering out by hand a shrinkage of aluminum has been observed of about an inch in the whole two feet of length, for which allowance must be made.

The preliminary removal of metal from the part which ultimately will be the tip portion of the racket, followed by the condensation into a smaller circumference, of the metal which remains there, helps the attaining of the hitherto baffling objective of a racket which is sufficiently strong and yet is not "head-heavy". Also it permits the retention, elsewhere in the racket where playing stresses are strong, of metal which is useful for strength, without such retention resulting in an exceeding of the weight-limit.

In the form shown in Figure 4 the metal is initially continuous at the tip of the racket; and the large ends of the tube 14 are welded together at the throat.

In the form shown in Figure 1 the small ends of the tube 15 which constitute the head frame are welded together at the tip of the head, this being made from a tube whose intermedate stage 15', seen in Figure 15, has a taper toward its ends. This is preferably made by starting with a cylindrical tube, thinning the wall on a taper and then concentrating the metal remaining in the tapered section, to the smaller diameter illustrated, by swedging, preferably in a machine.

Gradations of size in the tube constituting the head frame are indicated by the cross sections seen in Figures 7, 6 and 5, at which points, in a successful racket, the diameters may be respectively three-quarter inch, five eighths inch and one-half inch, thus producing areas of cross section which are approximately in the relative proportions indicated above; supplementing which a one inch diameter of handle tube, at the cross section 10—10, approximately has double the area of the head frame tube at the shoulders, and provides an interior hollow, when split and bi-furcated, into which the head frame will fit snugly and can be secured by welding as indicated by the reference symbol W. The union of handle with head frame can be strengthened by the insert welding of a tubular brace 24 as seen in Figure 4, whose fastening may be supplemented by a fillet 26, as seen in Figure 22. This part also may be strengthened if desired by the inner reinforcing plate 22', fitting around the shoulder part of the head frame, as seen in Figure 3, or as in Figures 1 and 11, where such a plate 22 is cut and shaped so as to fill the space in the bi-furcated end of the handle, and is welded to the two parts of the handle which are thus spread.

Another way of making the head frame tubular and tapered to the tip is indicated in Figure 16 which represents a cylindrical aluminum tube from whose walls a section tapered toward each end has been cut, leaving the edges 14'', seen in Figure 16 and Figure 18, which can be closed together as in Figure 19 by a reshaping of the tube to the general outline indicated in Figure 14 where they may be welded together. Another type of construction is indicated in Figure 17 where a stamping of sheet metal, flat and tapering endwise as indicated by the piece 15'' can be bent and formed into a tapered tube of the shape of Figure 15, to become a frame of the type seen in Figure 1.

The choice among these methods of construction and these ultimate shapes is a matter of discretion; and while it is preferable that the taper should be uniform, the benefits of the invention may be attained in some degree without the taper being uniform, as in the type of head frame illustrated in Figure 3, where tubes of different sizes are telescoped together, a tube 19 of small diameter for the tip portion of the head being telescoped into and welded in a larger tube 17 for the shoulders portion of the head frame.

The handle tube 10 preferably does not constitute the whole of the handle of the racket but extends only a short distance from the throat, as indicated in Figures 1, 21 and 22, and forms one member of a socket connection to a grip portion 11 which may be of wood or of synthetic resin or other material securely held by being fitted with a pressed fit. The aluminum tube of the handle may be the female member as in Figure 22 or may be longer and shaped down to a smaller diameter in order to be a male member as indicated at 10' and 11' in Figure 21. This affords apportunity for the racket to be made complete except for an optional selection of size or kind of grip, to be added at the choice of the owner; with cement and other means of securing supplementing the tight fit if desired. This arrangement, particularly that of Figure 22, permits of heat and drying before the parts are put together, and sealing when assembled, to avoid effect of moisture. And the grip is replaceable.

The invention also provides especial advantages relative to the stringing. The thickening of walls by concentration of metal by the swedging operation permits of the holes which are drilled for the string having rounded entrances, because the metal is thick enough for that, notwithstanding small diameter; and the unreduced metal may also be rounded because it is thick as compared with metal used in rackets previously proposed. Thus silk or standard gut may be used.

An important feature of the invention is the maintaining of a convexity of contour of the tube which constitutes the head frame, throughout its taper, the cross sections illustrated being circular. This permits of there being less metal and lighter weight for producing the needed strength and rigidity, but it has the disadvantage that it leaves the outer loops of the stringing projecting beyond the metal part of the frame, where they are subject to abrasion by external contact. The invention provides for the protecting of these loops, and for the protecting of the string beyond the roundings of the entrances of the metal holes above described, by providing a strip preferably of non-metallic material as leather or fibre overlying the metallic frame around the edge of the head. This may be secured by glue, prior to the stringing, and will in any even be held by the stringing, and may have grooves in which the loops of the string may be protected. This strip is indicated at 30 in Figures 1 and 2 and is seen much enlarged in Figure 13 where the groove in it is marked 32 and the form is adapted for the flat side to lie against the metal tube, being flexible and bent into conformity, as indicated diagrammatically in Figures 5, 6, 7 and 12, the loop being outside; but if desired the strip might be made with the side which is flat in Figure 13 set outside, the groove turned inward covering the stringing and wholly encasing it. In this case the stringing would not pass through the strip, but would rest against the metal.

The invention also provides further for the convenient and rapid stringing under the difficult circumstances that here the string must pass through a hole in one side of the tube, through the large hollow interior, and then find the hole on the other side. As seen in Figure 20 an eyelet having a flange at one end, fitting tightly in the outer hole and reaching nearly but not quite to the inner hole, is set. These guide the points of

the gut, which usually are curved, directly to the inner hole; their curved outboard flange protects the gut from being cut on the metal of the tube at the entrance to the hole; and they cannot rattle because they are held tight by the tension of the string.

At the shoulders and throat if reinforcement is desired for strength, tubular rivets can be used through which the stringing can pass.

Considering the racket as a whole, the discovery has been made that the center of percussion can be made to coincide with the middle region of the stringing. That is, the region where, if the racket receives a blow, the strings and frame coact to make a direct or normal vibratory response, can be located practically at the middle of the middle strings. The making of this region of direct or normal rebound of ball to coincide with the region where the ball is mostly received and struck in play is an achievement which is believed to have been never before attained in a racket having full strength and suitable balance for playing, although it is known that this result has long been desired. Its successful attainment in the racket of the invention is believed to be due to the structural characteristic by which the tapered convex tubular head save so much weight at the tip while providing adequate strength and permitting desired distribution of weight. Contribution to this end is made by considering the racket as a beam with load at its end and having strength which is uniform for meeting such a load.

Another of the objects of the invention is to provide a structure of racket which can be made in mass production with great precision and at low cost. For this the preferred construction is of that type in which a head frame made of a tubular closed loop is cradled and welded securely in the end hollow of a bi-furcated tubular handle. But the possible constructions are not limited to the particular types illustrated. The handle and the head frame may be integral together, made of two stamped hollow half shells of sheet metal, joined together in the plane of the stringing, as if the whole of the shape seen in Figure 9 were of only two pieces, welded together on a medial horizontal line which may be imagined in that figure. This can embody the specified taper and graduated relation of cross sectional size, but it involves a very long line of welding, around the edge of the head and handle, and is believed more expensive.

I claim as my invention:

1. A game racket comprising a head-frame of tubular metal the tube thereof being of circular cross-section extending in continuity in an oval course all around the head of the racket and having the cross-section of the tube graduated smaller in size at the tip portion of the head; combined with a single tube of larger diameter, constituting the handle, split and spread at its head end; the said head-frame being embraced and secured in the grooves of the hollow half-round branches of the split handle.

2. A game racket comprising a head-frame of tubular metal the tube of which extends continuously all around the head, having graduated cross-section smaller at the tip portion of the head; and a bi-furcated handle of which the two branches are grooved and embrace between themselves that end portion of the head frame whose tube is of the larger diameter, said head-frame being seated in said grooves.

3. A game racket comprising a head-frame extending continuously all around the head; a tubular handle, split-forked, embracing and secured to the head-frame, and having a grip member telescopically and removably secured on the tube of the handle.

4. A game racket comprising a head-frame of tubular metal the tube thereof being of circular cross-section extending in continuity in an oval course all around the head of the racket and having the cross-section of the tube graduated smaller in size at the tip portion of the head; combined with a single tube of larger diameter, constituting the handle, split and spread at its head end; the interior diameter of said handle tube being approximately equal to the exterior diameter of said head-frame tube at the base of the head, whereby the spread portions provide grooved seats for securing the head-frame on the handle.

5. A game racket comprising a head-frame of tubular metal the tube thereof being of circular cross-section extending in continuity in an oval course all around the head of the racket and having the cross-section of the tube graduated smaller in size at the tip portion of the head; combined with a single tube of larger diameter, constituting the handle, split and spread at its head end; the said head-frame being embraced and secured in the grooves of the hollow half-round branches of the split handle; and a short tubular brace inserted in the fork of the split handle, across the axis of the racket, and secured to each spread branch of the handle, and to the head-frame.

6. In a game racket having a head-frame of tubular metal, the tube thereof being of convex curvature on its inner side, toward the playing surfaces of the strings, and also convex on its outer side, remote from those surfaces; and a handle; there being inner and outer holes for the stringing arranged in pairs through the tube walls having said curvatures; the combination therewith of flanged string-tubes mounted loosely in the outer holes of the respective pairs, with their flanges seated against the said outer convex curved surface of the head frame tube, and with their tubes extending thence within the frame tube but free from engagement with the inner side of the frame tube; said holes at the inner side of the frame tube having diameter enough larger than the strings to afford space for the strings to yield freely under impact of play and said tubes being slightly tiltable in their said loose mounts, whereby shearing and abrading stresses incident to normal flexures of the strings in play are minimized.

ROLLIN ABELL.