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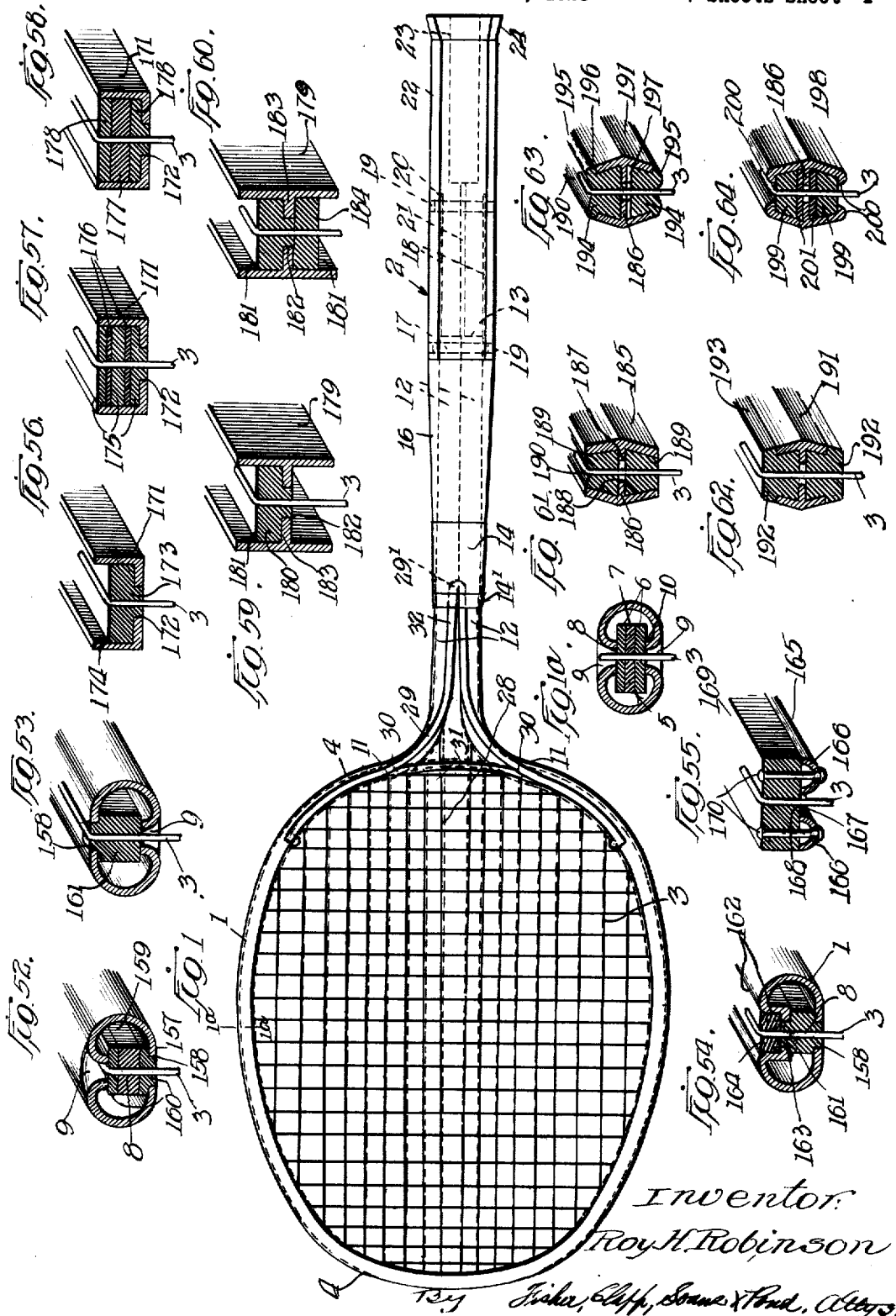
R. H. ROBINSON

1,937,787

TENNIS OR SQUASH RACKET

Filed June 13, 1928

7 Sheets-Sheet 1



Inventor:

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By Fisher, Cliff, Stone & Ford, Attys.

Dec. 5, 1933.

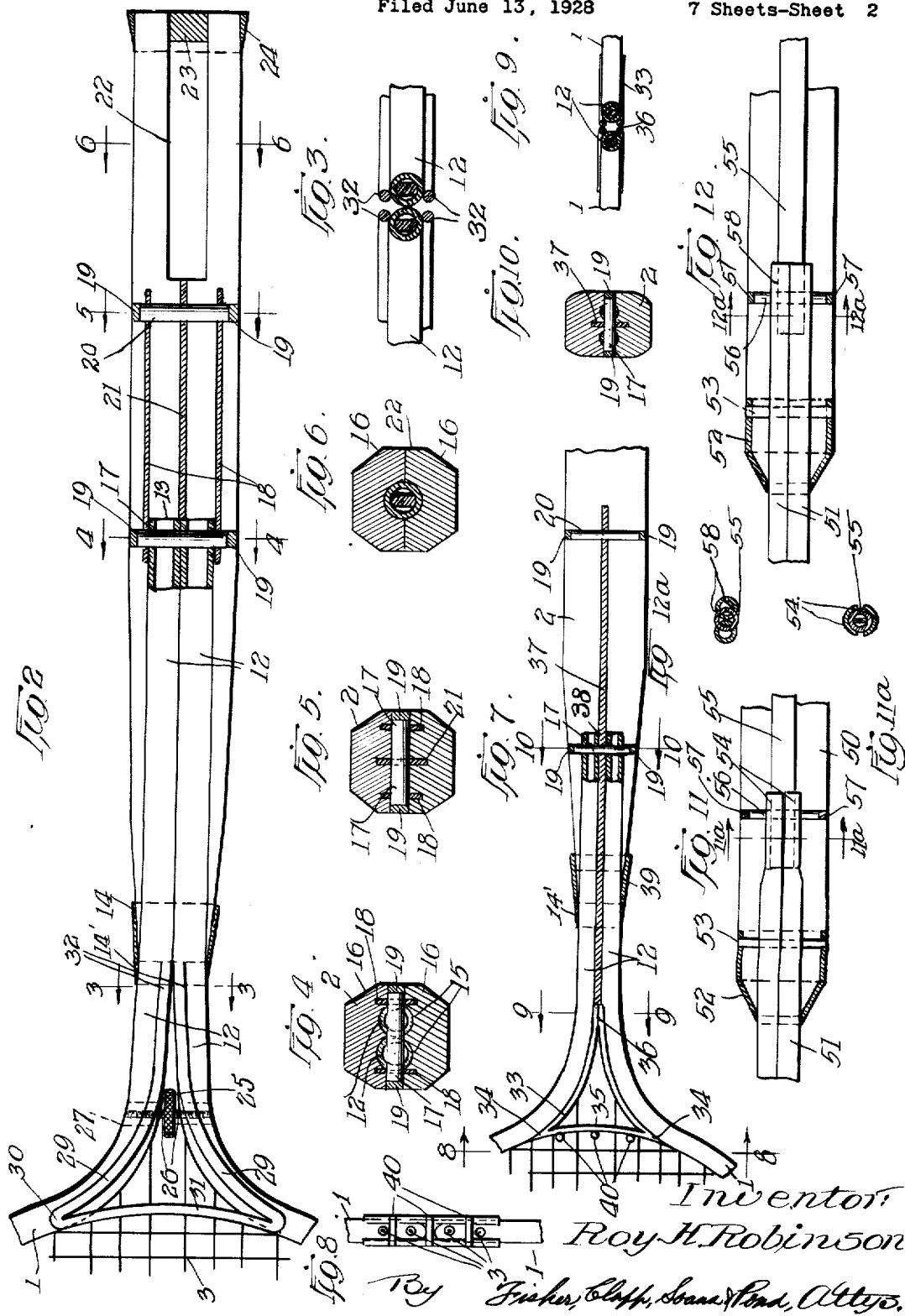
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TENNIS OR SQUASH RACKET

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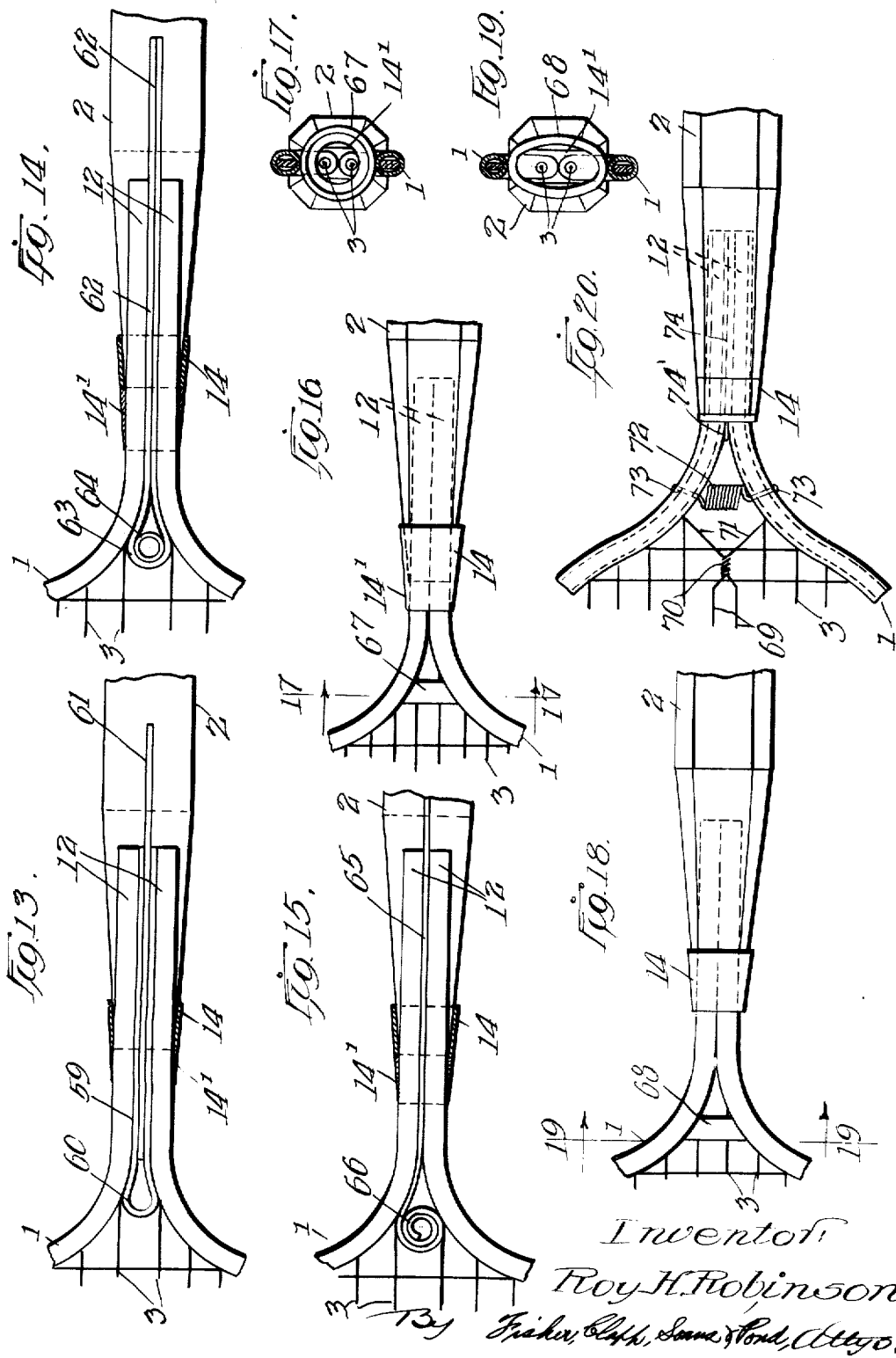
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TENNIS OR SQUASH RACKET

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7 Sheets-Sheet 3



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TENNIS OR SQUASH RACKET

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7 Sheets-Sheet 4

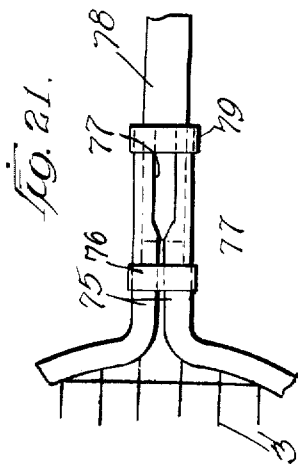
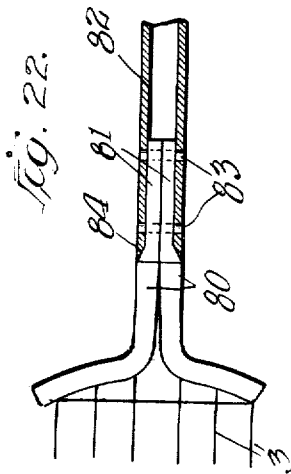
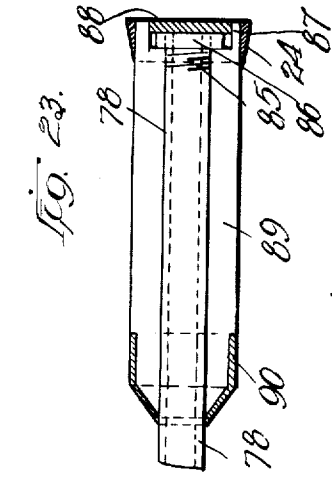


FIG. 25.

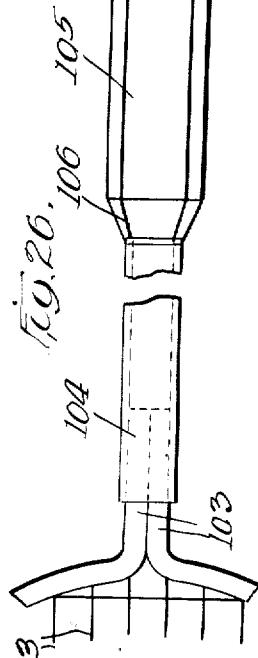
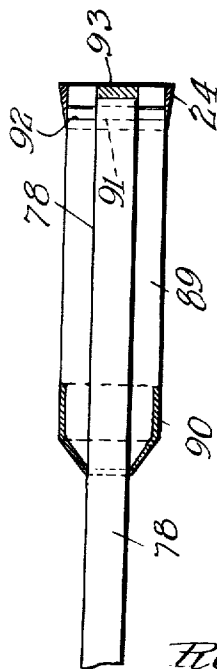
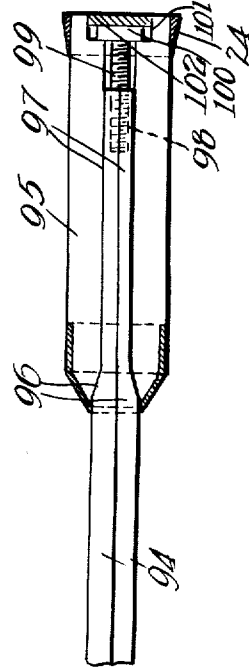
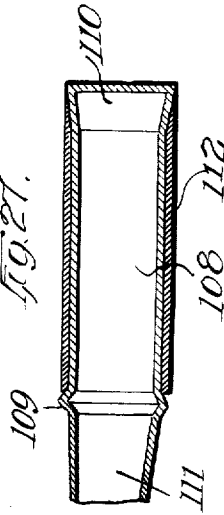


FIG. 27.



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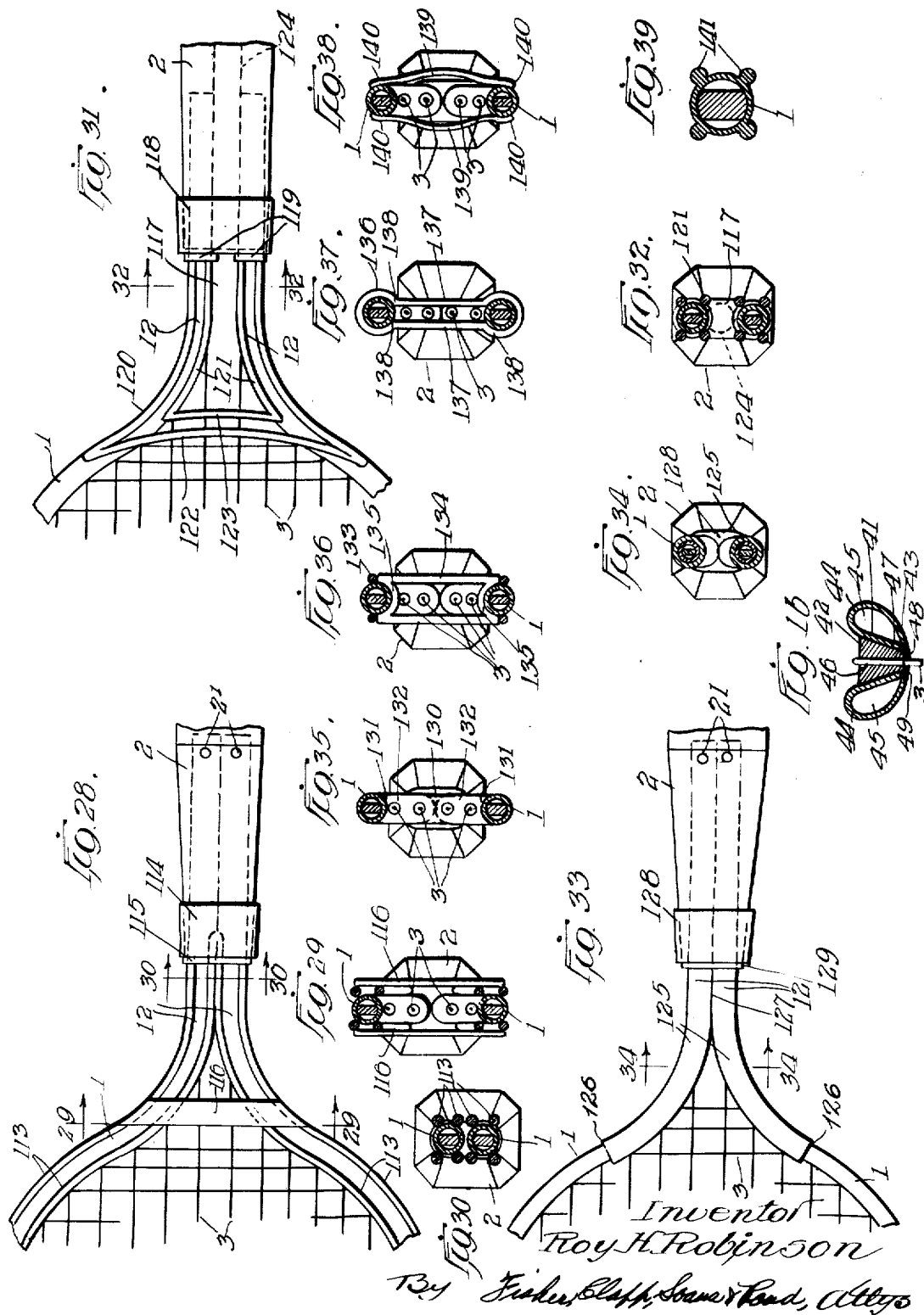
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TENNIS OR SQUASH RACKET

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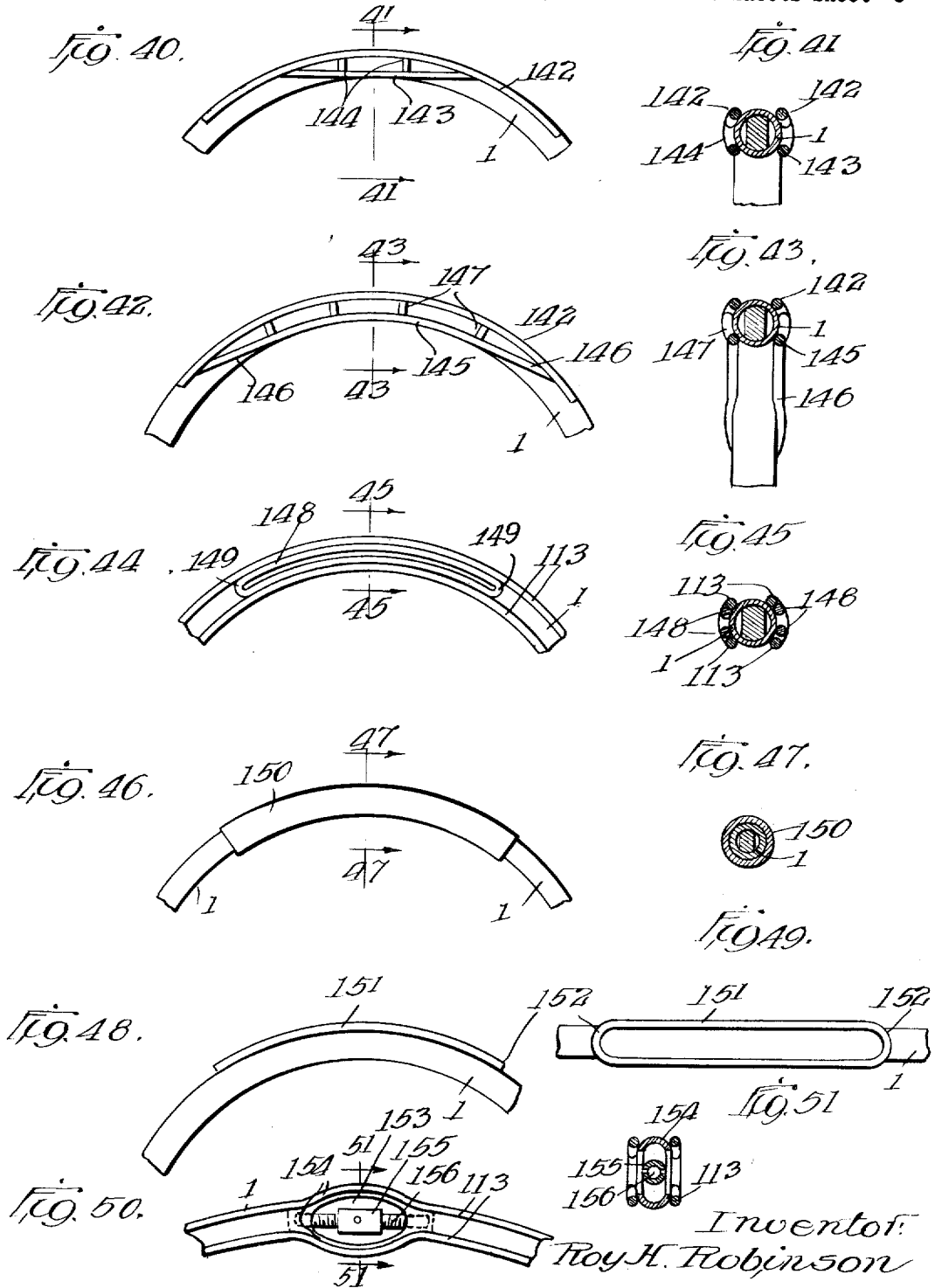
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TENNIS OR SQUASH RACKET

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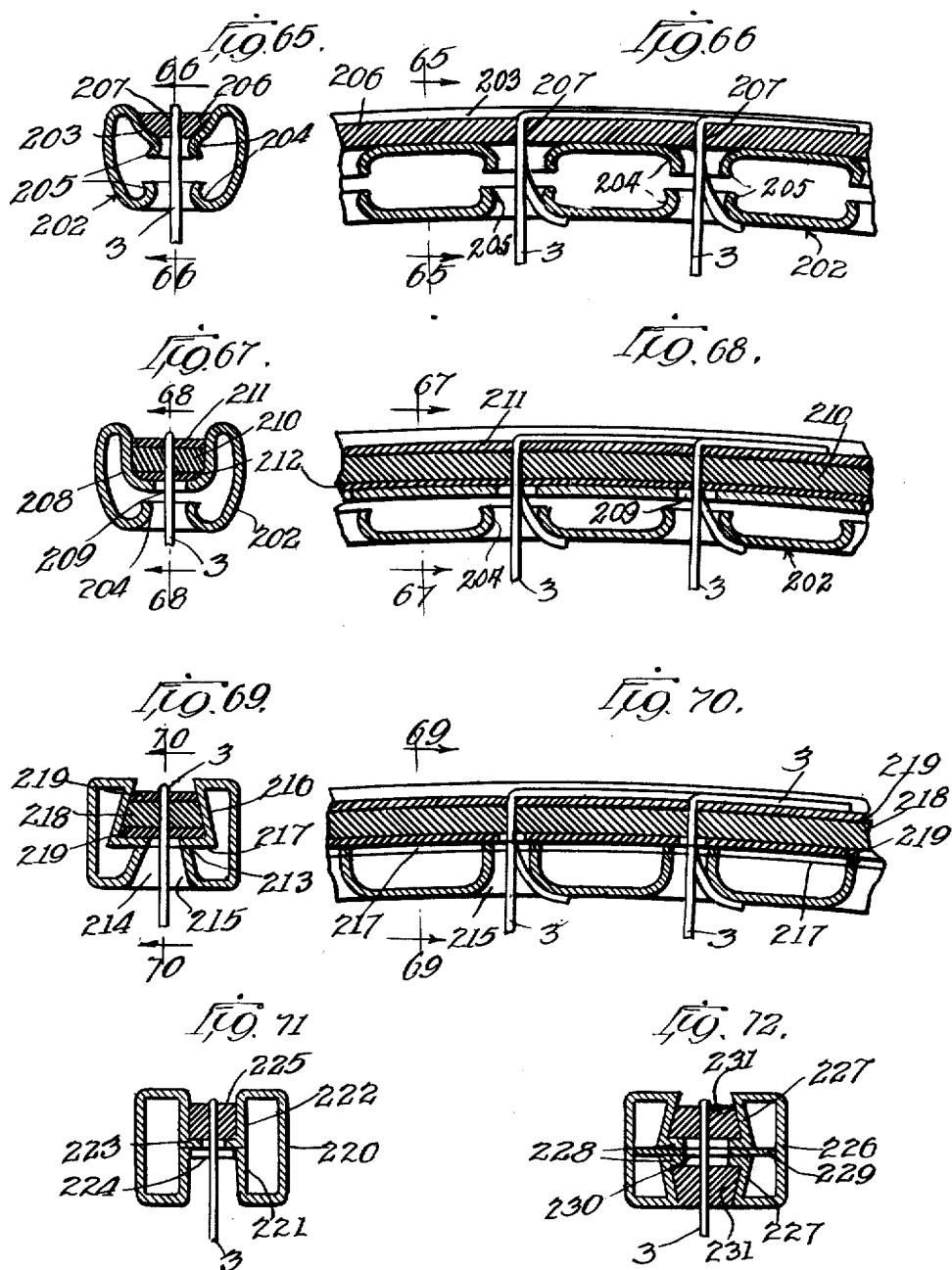
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TENNIS OR SQUASH RACKET

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7 Sheets-Sheet 7



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UNITED STATES PATENT OFFICE

1,937,787

TENNIS OR SQUASH RACKET

Roy H. Robinson, Chicago, Ill.

Application June 13, 1928. Serial No. 284,981

42 Claims. (Cl. 273—73)

This invention relates to tennis or squash rackets and more particularly to such as are provided with a metal frame, and has for its primary object the production of a faster racket—that is, one which enables the player to obtain greater speed in playing with least resistance to strokes, which embodies a frame or head of novel shape which insures greater accuracy in the strokes both in serving or in the return of the ball and in volleying, which provides a racket having extraordinary perfect balance and which permits the use of a smaller head; to provide novel means for reinforcing the head or frame and giving sufficient rigidity and proper elasticity thereto with resultant life or snap in the service and return of the ball, particularly by the use of metals of different physical properties; to provide facility in the stringing of the racket by permitting the head or frame to be restricted or reduced in size and then released for enlarging or expanding the same, said means, if desired, including spring means for normally expanding the head at the open and unobstructed throat portion thereof or other suitable place on the same; to provide means for contracting the head and holding the same contracted in the stringing thereof so that upon the pressure on the frame sides being released after being strung, the frame sides will automatically tend to expand to insure that the stringing is tight and will remain tight; to provide a frame construction which will eliminate the cutting of the stringing by the frame, as well as to provide a novel arrangement of stringing.

The invention further consists in certain novel improvements upon the constructions disclosed in my prior Patent No. 1,470,878, of October 16, 1923, and my co-pending applications, Serial Nos. 680,956, filed December 15, 1923, and 170,777, filed February 25, 1927, as well as embodying other features which improve the racket and simplify the construction and thus permit manufacture more expeditiously and with greater economy.

While I have referred to a tennis racket, it is understood that the invention has reference to amusement or game apparatus generally and is equally applicable to rackets or bats for playing squash or similar games as well as tennis.

A still further object of the invention is to provide a racket frame or head having novel means for reinforcing the same and adding elasticity thereto, so as to make the racket and stringing thereof more responsive to the impact of the ball and in causing a quicker rebound as compared to an ordinary frame which is comparatively dead, and to improve the method of stringing and means for maintaining the stringing absolutely taut so that the life of the stringing will be considerably extended while always

remaining tight and at the same time so construct the frame that gut stringing may be used without readily breaking or cutting. This latter object is also carried out in my prior patents and applications above referred to and the present construction retains all of the advantages of the metal frame while combining therewith features to prevent cutting of the strings and at the same time add to the lightness and rigidity thereof as well as enhancing the ability of the racket to absorb shocks and vibrations and preventing the transmission thereof to the handle and hand of the player.

A still further and no lesser object of the invention is to so construct the frame head that while the head is smaller in size and the framing smaller in cross-section, still it is so shaped that its measurements are maximum at desired points necessary to the highest efficiency of the racket in use, the small cross-section of the frame also allowing the ball to be played closer to the frame at all points.

Other objects are to improve the construction of the handle and frame, particularly in respect to the cross-section and material of which the latter is made and at its throat portion or juncture with the shanks or outturned ends forming the shank of the racket and its connection with the handle, as well as in the provision of resilient means for giving impetus or kick to the ball in play, with the result that the highest possible speed and efficiency is rendered possible and a player's game manifestly improved.

With the above and other objects in view, the invention consists in certain novel combinations and arrangement of parts, the relations of which will be more thoroughly established in the following description particularly emphasizing and pointing out the same.

In the accompanying drawings:—

Fig. 1 is a plan view of a racket constructed in accordance with the invention.

Fig. 1^a is a sectional view taken on the line 1^a—1^a of Figure 1.

Fig. 1^b is a similar sectional view showing a modified form of frame construction for the head of the racket.

Fig. 2 is a sectional elevation showing the handle construction and means for contracting and expanding the head.

Figs. 3, 4, 5, and 6 are sectional views taken on the section lines 3—3, 4—4, 5—5 and 6—6 of Figure 2.

Fig. 7 is a view similar to Figure 2 on a smaller scale showing a modified form of handle and frame construction.

Figs. 8, 9, and 10 are sectional views taken on the section lines 8—8, 9—9 and 10—10 of Figure 7.

Fig. 11 is a fragmentary sectional elevation of another handle construction.

Fig. 11^a is a sectional view taken on the section line 11^a—11^a of Figure 11.

5 Fig. 12 is a view similar to Figure 11 of a modified handle and shank construction.

Fig. 12^a is a sectional view taken on the section line 12^a—12^a of Figure 12.

10 Figs. 13, 14, and 15 are views similar to Figures 11 and 12—that is, sectional elevations of further modified constructions.

Fig. 16 is a fragmentary elevation of another handle and shank construction.

15 Fig. 17 is a sectional view taken on the section line 17—17 of Figure 16.

Fig. 18 is a view similar to Fig. 16 of a modified construction.

Fig. 19 is a sectional view taken on the section line 19—19 of Figure 18.

20 Fig. 20 is a sectional elevation showing another form of frame, shank and handle construction and means for expanding the frame.

25 Figs. 21 to 27 inclusive are fragmentary elevation and sectional views respectively of further modified shank and handle constructions.

Fig. 28 is an elevation of another form of frame and handle construction.

Figs. 29 and 30 are sectional views taken on the section lines 29—29 and 30—30 of Figure 28.

30 Fig. 31 is a view similar to Figure 28 of another modification.

Fig. 32 is a sectional view taken on the section line 32—32 of Figure 31.

35 Fig. 33 is a view similar to Figs. 28 and 31 of another modification.

Fig. 34 is a sectional view taken on the section line 34—34 of Figure 33.

Figs. 35 to 39 inclusive are sectional views showing modified forms of frame construction.

40 Figs. 40 to 51 inclusive are fragmentary elevations and sectional views respectively of modified forms of frame construction particularly with reference to means for rendering the frame resilient or elastic and adding spring action thereto, Figures 41, 43, 45, 47 and 51 being sectional views taken on the section lines 41—41, 43—43, 45—45, 47—47, and 51—51 of Figures 40, 42, 44, 46 and 50 respectively.

50 Figs. 52 to 64 inclusive are sectional perspective views showing modified forms of frame construction, the same being taken transversely of the frame to show the manner of stringing the frame or head, and

55 Figs. 65 to 72 inclusive are transverse and longitudinal sectional views showing further modified forms of frame construction and stringing arrangements, Figures 65, 67, 69, 71 being taken on the section lines 65—65, 67—67 and 69—69 of Figures 66, 68 and 70 respectively, and Figures 66, 68 and 70 being taken on the section lines 66—66, 68—68 and 70—70 of Figures 65, 67 and 69 respectively.

60 Referring to the drawings in detail and more particularly to Figures 1 to 6 inclusive and Figure 1^a, the racket comprises a frame 1, handle 2 and stringing 3. The frame or head 1 in the present embodiment comprises a tube which preferably is not bent to the conventional oval shapes found in present day rackets but instead has the 70 oval distinctly flattened at the ends as indicated at 4. The throat end is preferably broader across than the other flattened end of the head of the racket and by virtue of a pronounced reverse or ogee curve turns in sharply to form the shank of the throat portion.

The ends of the frame or racket head are blunt or flattened with respect to an arc of a circle. That is, the customary ellipse or oval shape of racket heads is departed from in having the ends sharply flattened so as to approximate the flattened arc of a circle. The sides of the head are so curved as to form pronounced strongly self-supporting arches, and while not limiting myself to the form shown, I prefer to have the inner or throat end of the head broader than the tip or outer end and somewhat of the shape of an acorn with a flattened tip. One of the functions of this shape of head is to give better control of the racket in service or in play, because of reduced air resistance at the tip or outer end of the racket and reduced leverage in striking the ball, tending to turn the racket to one side. As a result of this, either side of the frame forms a strong arch supported at either end by a sharp turn in towards the longitudinal axis of the frame, which intumed portions may be said to form the flattened ends and stiff supporting legs for these arches, which prevents or lessens the customary elongation of the frame in stringing and greatly strengthens the frame, when strung, to resist the tendency of the head to unduly elongated and of the sides of the frame to collapse inward, particularly toward the throat.

This permits extra tight stringing without undue distortion or elongation of the frame, keeps the stringing tight afterwards, gives greater resistance to the ball impact thereby increasing the speed of the ball's return, permits of a broader more effective playing area at both ends of the racket and consequently allows a smaller head area for stringing and shortens the lengths of the stringing spans, thereby increasing and maintaining the tightness of the strings in play. Of still greater importance is the fact that this shape by producing two strongly shaped rigid lever arms from the top in combination with the spreader at the throat, I have devised for tightening the stringing permits expanding the frame most effectively with the sides moving as rigid units or lever arms hinging at the tip of the racket with strong effective resistance to collapse at intermediate points, particularly at the throat end, assuring the most effective tightening of the strings thereby and avoidance of collapse of the frame in expanding the same.

65 The frame 1, as illustrated in Figures 1 and 1^a, preferably comprises a tube of metal or other tubular material of comparatively high tensile strength and may be some non-metal substance such as celeron-condensite or fiber of proper tensile and compressive strength. For instance, a plastic molded mass such as vulcanized fiber thoroughly impregnated with a combination of phenol and formaldehyde and then hardened by heating and, if desired, may have incorporated therein some textile or fabric material or other reinforcing to render the same non-breakable and resilient to the proper degree. If of metal, it may be a tube of nickel, steel, or similar ferrous alloy or even some non-ferrous metal or alloy or 70 may be a composition of nickel or Monel metal bent into a racket head of substantially oval form with flattened ends but specifically in the shape described to provide a frame or head having the advantages pointed out. In the form illustrated, the tube is provided with a filler 5 of a non-metal substance which may completely or partially fill the tube or shell and which serves as a shock absorbing and vibration deadening member to prevent transmission of shocks to the 75

hand of the player and insure a relatively non-vibratory and substantially solid structure, and particularly to protect the stringing and hold the strings in proper place while at the same time allowing a proper "give" to save the more delicate gut stringing from undesirable strain.

The filler is inserted in the tube and embodies any suitable cushioning, shock absorbing and sound deadening material and, as illustrated, preferably comprises two outer layers or strips of softer material such as leather on either side and fastened to a central harder layer or strip such as fiber, the fiber holding the strings in position and the leather forming a protecting edge and allowing the proper "give" under stressing. All of these strips or plies are secured together to form a relatively integral composite member or laminated form, although other materials may be substituted for those described. This filler preferably engages the opposite sides of the tube—that is, the inner and outer sides as distinguished from the lateral sides and may be of any number of a variety of substances or materials of a compressible comparatively resilient and light-weight cushioning, sound deadening and shock absorbing material, and may include fiber, leather, raw hide, rattan, cork, reed, soft wood, or the like, or combinations thereof so as to give to the stringing as distinguished from metal, in order to cushion the stringing, hold the same in proper position, and prevent breaking and cutting thereof, as will be further described.

The stringing 3 extends through a small opening 8 in the filler and the tubing has inner and outer openings 9 which are larger than the openings in the filler and may be suitably formed therein by punching or turning in the metal after drilling the holes so that the edges of the metal at the openings approach contact, or preferably embed into the material of the filler, as indicated at 10, although primarily the idea is to cause the edges to contact with the filler so as to cover them and leave no exposed edges which would abrade and cut the strings. The rounding formation of the metal at the openings serves as an easy bearing face for the strings when bent thereon and the strings are kept out of contact with the metal except at such easy bearing surfaces, thereby permitting the use of silk or gut in stringing the racket, something which has heretofore been impossible or impractical with metal racket frames or heads except as outlined in my prior patents and applications above alluded to.

The ends of the tubing are turned outwardly as indicated at 11. These ends are extended into the handle 2 as indicated at 12 to provide a shank of the necessary strength and terminating at the point 13. In Figure 1 the handle is shown of wood and the shank ends are extended through a ferrule 14, the latter preferably being fitted thereon and brazed or welded to the frame with the brazing tapered on the ferrule upon the shanks toward the head, so as to practically merge with the tubing owing to its tapering formation, and, as noted, may be brazed, spot welded or otherwise molecularly joined with the tube at its small end toward the head or frame of the racket and in such a manner as to bridge or connect with the tubing at the juncture or contacting points thereof, forming the shank. This ferrule, preferably of thin sheet steel or of copper, brass, or other desired metal, is distinct from the customary ferrules on present metal rackets in being tapered, preferably on all sides, and of substantial length so that after the same is rigidly joined to the tub-

ing as described, the handle of wood or other suitable material can be very firmly driven up with glue into same with sufficient wood between the tubing and the ferrule walls on all sides to insure a very strong and rigid handle as well as one of fine lines merging into the tubing as though formed of one piece and distributing the whip of the racket shank gradually into the handle with less abrupt change. At any desired point above the ferrule but preferably close to their juncture with same, the shanks 12 diverge to form the head and curve outwardly with the abrupt or reverse ogee curve, already mentioned, thus providing an open and unbridged throat or head frame where the shank portions branch therefrom, particularly in the plane of the frame and stringing. This distinguishes from the old type of frame except as disclosed in my prior Patent No. 1,470,878 of October 16, 1923, and my application Serial No. 170,777. In the old type of racket, the frame was provided at the throat of the racket with an immovable strut or spreader commonly referred to as a bridge piece and understood to be necessary to give the desired strength or rigidity to the frame and to which the stringing was anchored. This reinforcing bridge piece in metal rackets was usually brazed or welded in position and entailed additional expense in manufacture, but I found in practice that such bridge piece is unnecessary and can be entirely eliminated with decreased cost of manufacture and at the same time provide a racket which possesses more than ample strength.

The construction of the handle is more particular disclosed in Figures 2 to 6 inclusive in which the shank portions 12 are seated in co-acting concave or semi-circular recesses 15. The handle sections 16 are fitted together and glued or otherwise connected and the shanks terminate at some point along the length or between the ends of the handle where they may be pinned to the wood or other material of the handle in any suitable way by a transverse pin 17 extended through registering openings in the parts and also through corresponding openings in metal strips 18 disposed crosswise in the manner of mortises and tenons embedded in the wood or grooves prepared in the latter at their co-acting faces for this purpose. Beyond the ends of the shanks, the handle presents a solid section at some point for effectively taking the customary vise for holding the racket in stringing to prevent cracking of the wood of the handle as happens where the shanks or bores for same extend throughout the length of the handle and close to the outer sides thereof.

In stringing the racket, the head or frame is adapted to be reduced in area by contracting the frame by suitable means such as an independent clamp or vise applied to the shank portions at or near the throat or at other desired point or by a turnbuckle 25 connecting said shank portions with a wheel or sleeve centrally located between same and provided with reverse threads at either end, the threaded stems 26 engaging threaded portions in bushings or sleeves 27 fitted transversely in openings in the tubing of the shank portions or otherwise suitably anchored to the frame members.

The holes for the longitudinal stringing of the frame are preferably so disposed at the throat end, in relation to their respective mates at the outer end, as to bring the longitudinal strings in lines which instead of being parallel with the central longitudinal axis of the racket, slightly diverge

from same towards the throat end on either side of the central vertical axis as indicated by the solid line positions shown at 28, while the throat shanks are spread apart, but when the shanks or sides of the racket head are pressed towards each other prior to stringing, the longitudinal stringing holes approach a vertical alignment parallel with the central longitudinal axis, as indicated by the dotted line position in Figure 1.

It will be readily seen that when the clamping of the frame sides together is released and the frame allowed to expand after stringing, the longitudinal strings, so far as they are allowed to swing outward from the center axis of the racket head at its base on either side, are drawn to a longer line and thus so tightened, in addition to the tightening due to lengthening of the racket head by the simultaneous tightening of the cross stringing.

In this tendency of the shanks to spread apart, it will be thus seen that both the cross strings and longitudinal strings are automatically tightened. It will also be appreciated that when a swift ball impacts upon these strings, the frame with a tendency and a means to contract gives a very brief relief to the strings by a very slight contraction of the frame and then gives added resiliency and speed to the return ball by shooting the ball off the racket after the manner of a bow string as the frame and strings whip back into their expanded positions.

This relief from too abrupt action on the string is also enhanced by the fact that the stringing is only in contact with the metal of the tubing at easy bearing surfaces and is properly relieved by the cushioning or protective material with which the strings are in contact.

It will also be seen that as the frame and stringing are in automatic equilibrium, the frame will tend to take up any slacking of the strings with play and age so that the exceptional tightness and resiliency of this racket is preserved.

The ends of the strips may be secured to the tubing 12 adjacent the pin 17 and the ends of the pin may terminate short of the sides of the handle to provide recesses for receiving wood or other finishing plugs 19 glued or otherwise secured in position and precluding the pin from view or displacement and adding to the effectiveness and finish of the handle. The strips 18 also have registering openings receiving another pin 20 which is secured in position in the same manner as the pin 17. This pin extends through a corresponding registering opening in an optional wood tongue, tenon or strip 21 centrally located and secured in position as a mortise and tenon as by gluing in position in opposed grooves in the handle sections. The wood strip serves as an important adjunct in insuring permanent connection of the handle sections and with the metal strips 18, effectively strengthens the handle as well as giving the desired balance to the racket. The wood strip 21 terminates at the shanks or shank ends of the point 13 but extends beyond the pin 20 to a counterbore 22 in the free or outer end of the handle provided to reduce the weight and which may be closed by a wood or other plug 23 or designed to receive any other suitable formation or studding with a surrounding ferrule or ring 24 at the tip of the handle.

It is also possible with this construction to relieve the tension on the racket stringing when not in play or in bad climatic conditions by clamping the throat slightly together when not

in use. It will also be appreciated that in stringing the degree of clamping can be regulated so as to produce varying degrees of subsequent tightness in the stringing as may be desired for any particular player or purpose.

The expansion of the frame may be left to the inherent resilient expansive property of the frame material proper or this may be and preferably is augmented by joining therewith additional reinforcing and resilient members on the frame at desired points and particularly on both sides of the frame members at the throat and lower portion of the head or entirely around the latter, as desired. As a means of accomplishing this latter object, a springy metal strip or wire member 29 may be mounted on the frame, preferably at the open throat portion or otherwise, as will be hereinafter more fully described.

The wire reinforcement on the frame and shanks, and the spreader expanding the throat may be omitted when so desired. Of course, it is to be understood that the metal of the frame is of such a resilient nature that the sides of the frame at the throat can still be clamped together any desired degree and, in this instance, preferably in contact, before stringing and even without any spreader or reinforcement on the shanks at or near the throat or other place on the frame, will still tend to expand the frame to separate said sides for enlarging the area of the head and tighten the stringing after the racket is strung and the clamp removed.

In the form shown in Figures 1 and 2, the spreader is shown comprising a strip or wire metal reinforcement 29 preferably rebent as at 29' and extending from adjacent or beneath the ferrule 14 up along the shanks and branching outwardly or following the frame curvature to points part way up on the racket head, preferably around the ogee bends, or as far as desired to properly reinforce the lower portion of the head where the greatest strains develop. The ends of the wire or metal reinforcements are preferably tapered off to gradually absorb the impact and distribute the same down the head. A connected piece or spreader 31 is provided on either side of the plane of the stringing between the members 29 to provide the proper expansion element to yield under impact or in stringing and on release to spread the frame, and is preferably of heavier cross-section than the frame wires 29 which can be relatively light. As applied to one or both sides of the frame, the strip or wire is bent at two points in acute angled relation, as indicated at 30 to form an intermediate portion 31 therebetween pressed outwardly in conformation with the curvature of the frame on either side of the throat beginning at the points 11—that is, to bulge toward the handle, and the ends beyond the bent portions 30 are curved substantially in conformation with the shank portions 12 so as to branch outwardly but preferably run along the inner portions of the peripheries of the tubing of the shanks, as indicated at 32, and brazed or welded to the tubing at the points of contact so as to give sufficiently to permit contraction but adapted to add a strong expanding force to the frame when released of its clamping means applied thereto prior to the stringing operation with the frame contracted. However, if desired to otherwise distribute the expanding force created by first contracting and then expanding the frame, the contracting force may be reduced at one or more intervals during the stringing, thus allowing a different distribution

of the expansive forces at different points on the frame to insure more even distribution and tightness at the center.

The manner of mounting the spring metal or wire member 29 on one or both sides of the frame at the open throat portion and shanks and upon opposite sides of the plane of the stringing, is shown more particularly in Figures 2 and 3 of the drawings. As to the metals of the frame and springs, they can be of different physical and tensile properties not inherent to one member. The tube can be given a variety of resilient properties. Thus the wiring or spring metal reinforcing serves to act as a spreader for the frame, the spaced portions or shanks at the open throat forming a tension throat which gives great resiliency along with added strength and rigidity to resist impact or tendency of the frame to bend or collapse under hard blows as well as to give a snap or kick to the ball with added speed and spin due to the springy character of the frame or head and tautness of the stringing maintained thereby. This automatically expanding construction takes up slack as the stringing stretches or loosens with play and age and likewise provides a saving or relieving yield to the strings at the moment of abrupt ball impact or when the strings are unduly stressed by climatic conditions.

It will be noted that the handle 2 tapers, as well as the tapering of the ferrule 14, so as to merge with one another and the shank of the racket. Also, instead of the ferrule being relatively short as is found in other metal rackets now being manufactured, the present racket and handle have a relatively long ferrule which length, together with the tapering, permits of a wooden handle in one or two pieces or laminated, being firmly driven into the ferrule together with some cementitious material and strongly held in the ferrule. This tapered ferrule together with the tapered brazing or welding at 14' also gives graduated whip to the racket, the strain of impact on the head being gradually distributed into the handle. The taper of the handle preferably begins about at the point of termination of the shank portions 12 and at the juncture thereof with the strips 18 and 21 and the dowel pin 17 which connects the sections of the handle.

I have also devised a new method of stringing in connection with this racket, which serves to keep the stringing taut, this being especially desirable for resiliency. When the frame is produced, proper curvature and spacing are allowed between the sides where they turn out at the open throat and between the shanks so that the frame may be contracted by pressure at these points by a temporary or permanently attached clamp below the strings before stringing, and after the head is strung, it is allowed to expand to separate or tending to separate the sides of the frame due to its normal resilient action or tendency to spread particularly when this is facilitated by the spreader when used and the release of the clamping means which is used to compress the frame or by additionally forcing the frame to an expanded position by the contracting means shown in Figure 2, although ordinarily it has sufficient spring action to expand when the clamping means is released or the thumb wheel 27 is turned to unscrew the oppositely threaded stems from their respective sleeves in the shank portions 12. That is, the racket frame is contracted before stringing and automatically expands after stringing on the release of the pressure tending to compress or to con-

tract the frame sufficiently to tighten the stringing. At the time of impact with the ball, there is a tendency to contract the frame to which the frame instantly reacts by expanding, tightening and whipping the strings, thereby shooting the ball.

In the form of the invention shown in Figures 7 to 10 inclusive, the frame is of the same construction as already described except that the spring metal member or spreader designated at 33, instead of being mounted on one or both lateral sides of the tubing of the frame, is mounted on the inner face thereof and is bent more abruptly at the points 34 or ends of the outwardly curved intermediate portion 35 which tends to expand the frame and separate the legs of the arches produced by the curved sides from the legs at the throat to the central point of the legs of the tip and of the head, and the ends 36 are brazed or otherwise similarly anchored between the shank portions 12 at the crotch of the open throat. From this point a metal strip 37 may be arranged between the shank portions to extend down into the handle and to serve as a reinforcement and connecting means between the sections thereof in the same manner as the strips 18 and 21, as well as to prevent said sections from shifting on one another. This strip 37 is preferably brazed or welded to the shank portions of the tube of the frame as at 38 and also to the ends 36 of the spring member forming the spreader if desired, so as to produce a practically continuous member with the shanks extending into the handle and anchoring the latter to the frame. This handle is also tapered to a point midway of its length merging with the tapered ferrule 39 and the shank in the same manner pointed out in connection with Figures 1 and 2. Pins 17 and 20 are also provided transversely through the sections of the handle in the same manner as shown in Figure 2, the pin 17 extending through the shank portions 12 and strip 37 while the pin 20 simply extends through the handle sections and strip 37 owing to the fact that the shanks 12 terminate a little past the pin 17 as shown and described in connection with Figure 2. In Figures 7, 8, and 9 the spreader members are shown mounted at opposite sides of the frame and brazed or otherwise molecularly joined thereto to produce a substantially integral structure. These two spreader members may be connected by a plurality of, preferably three, transverse connections or pins 40 to prevent buckling or displacement and cause them to act together with uniformity on both sides of the frame. In both forms shown in Figures 1 and 2 and in Figures 7, 8, and 9, the strings 3 extend between the spreaders and the transverse connections or pins 40 so located as to pass between the strings.

In the form of the invention shown in Figure 1^a, the frame is constructed of a metal tube of the same type employed in connection with the structure shown in Figures 1 and 1^a, except that in this form one side of the tube is pressed in as shown at 41—that is, indented in the outer face to form a longitudinally extending channel within which is fitted a cushioning strip or member 42 of leather, fiber, or other suitable material of a non-metal character as described in connection with Figures 1 and 1^a. The pressed-in portion or channel 41 is disposed in contact with the opposite side 43 of the tube, said latter side being somewhat flattened in the curvature while the curvature of the channel is narrowed toward the point of contact with the side 43 but may be

straight and parallel as shown in Figures 67 and 71 or enlarged inwardly or dovetailed as shown in Figures 69 and 72, to grip or hold the cushioning strip or filler in position, and has its sides diverging outwardly on reverse or ogee curves, is rounded, as indicated at 44, outwardly, downwardly and inwardly to meet the curvature of the portion 43 and providing what may be termed wing portions at each side of the channel in the cross-section of the frame, thus providing hollow spaces or voids 45 at each side of the channel. This produces a frame possessing sufficient strength radially to resist the strains of stringing and impact in the use of the racket and thrusts incident thereto, it of course being understood that with the shape of the racket as described, the pressures are balanced upon opposite sides of lines bisecting the frame longitudinally and transversely. This together with the fact that the shape of the frame has the flattened curves at the ends, results in creating a leverage from the center of the outer or tip end of the frame or head of the racket and the sides or arches thereof are supported by the legs at each end and the stresses transmitted longitudinally or axially of the legs through the legs and haunches produced by the abrupt or flattened curvatures of the inner and outer ends of the frame, thus giving the maximum of strength possible in a frame of this sort as more particularly shown in Figure 1.

In stringing this kind of a racket, the filler 42 has a number of small openings 46 radially there-through and centrally between the sides of the channel 41. The portions 41 and 43 at the base of the channel are provided with large openings 47 and 48 in alignment where these portions contact so as to receive the stringing therethrough in such a manner that the stringing will only contact with the cushion filler or not with any cutting edges of the metal at the openings 47 and 48. Furthermore, the edges of the metal at the openings 48 are sufficiently margined and the edge of the metal sufficiently thin, as indicated at 49, to avoid any metal edge contacting with the strings even where it comes at abrupt angles as the string leaves the filler at different points of the stringing, particularly in connection with the longitudinal strings so as to prevent the strings contacting with sharp edges and being cut or readily broken thereby. However, the strings ordinarily will not touch the metal owing to the openings 47 and 48 being much larger than the openings in the filler or cushioning member and also because of the relative thickness of the metal or other material composing the tube from which the frame is produced. The filler may be fastened in the channel in any suitable way.

Another construction of handle is shown in Figures 11 and 11^a of the drawings in which the handle sections 50 (preferably wood) receive the shank ends 51 with a surrounding ferrule 52 pinned thereto as indicated at 53 and the ends of the shanks are pressed from the inside in opposite relation, forming semi-circular portions 54 between which a tube 55 is inserted and brazed between the crushed parts, after which said parts are pinned to the tube as indicated at 56 with plugs 57 inserted in the same manner as the plugs 19. The tube 55 may extend the full length of the wood handle or less, so long as it provides sufficient anchorage.

In the form shown in Figures 12 and 12^a the construction is the same as shown in Figure 11

except that the shank ends are slit or saw cut, as indicated at 58, to receive the wall of the tube 55, which is shoved into the slits and the parts are brazed or pinned together as desired. Of course, the tube 55 may be brazed at the slits 58 and also pinned together if desired as shown, the pin at each end anchoring in the wood.

In Figure 13 of the drawings, another form of spreader and handle construction is illustrated corresponding to that shown in Figure 2. In this form a spring metal strip 59 is bent on itself intermediately and formed with a loop 60 which fits between the outturned shank portions at the crotch of the open throat while the ends of the strip extend between and are brazed to the shank portions, together with an intermediate metal strip 61, one end of which terminates short of the loop 60 and the other end of which extends into the handle. This produces a spring tongue or loop between the shanks where they turn outwardly to spread them and expand the frame, thereby keeping the strings taut but permits the necessary contraction or compression when the frame is being strung.

In Figure 14 of the drawings the handle construction corresponding to that shown in Figures 2 and 13 is shown but a modified form of spreader is illustrated in which the end portions of the spring metal strip 62 are brazed to the shank portions 12 and extended into the handle beyond the ends of said shanks. The sides of the strip produced by bending it on itself are also brazed to each other. The spring loop or tongue 63 has an inserted spring ring 64 brazed therein to give additional spring action.

In the construction shown in Figure 15, a single spring metal strip 65 is inserted between the shank portions and brazed thereto as well as extended beyond the ends of the shank portions and into the handle, while the opposite end of said strip is coiled as indicated at 66 to serve as a spreader.

In the form shown in Figures 16 and 17, the shanks are anchored in the handle in any well-known manner such as described and a tapered spring metal ring 67 is inserted between the outturned portions at the crotch of the open throat and brazed thereto to serve as a spreader.

In Figures 18 and 19 another form of spreader is illustrated in the form of an elliptical or oval ring 68 which is brazed between the outturned portions of the tube ends where they branch off to form the shanks at the open throat portion. Of course, all of these spreaders are located beyond the strings where they are anchored to said outturned portions.

In Figure 20 of the drawings the intermediate strings 69 are crossed and twisted as indicated at 70 so that the ends 71 diverge outwardly for anchoring with the next adjacent strings of the stringing in the outturned portions of the tube forming the frame. The spreader in this form is a helical expansion spring 72 of suitable tension spring steel, the ends of which are welded, brazed or otherwise anchored in the openings in the outturned portions of the tube as indicated at 73 at the points where they extend through said outturned portions. The shanks are also brazed together at the crotch of the throat as indicated at 74 and preferably to the metal ferrule, as shown at 74^a.

In Figure 21 another method of attaching the handle is illustrated, the shanks 75 being disposed substantially in contact and may be brazed or welded together and may be also embraced by

a ring 76 which is brazed thereon and the walls of the tube at the inside of the ends of the shanks are crushed and pressed in to form a longitudinal socket as indicated at 77 to receive the forward end of a tube 78 forming the handle which is welded or brazed in position. The ends of the outpressed portion 77 are also circular and may be embraced by a ring 79 brazed in position to afford the proper connection between the shanks and the handle forming tube 78.

In Figure 22 the shanks 80 are compressed into semi-circular form of reduced size as indicated at 81 to receive the handle forming tube 82 thereover, after which the parts may be brazed, welded or simply pinned or otherwise anchored together as indicated at 83. Rivets may be employed for this purpose and the end of the tube is preferably beveled on the inside as indicated at 84 to conform to the tapered portion of the shanks resulting from reducing the size of the shanks and brazed.

In Figure 23 of the drawings, the handle employed in connection with the structures shown in Figures 21 and 22 is illustrated. In this form the tube 78 is threaded at its outer end as indicated at 85 on which is threaded a nut 86 which seats in a recess or counterbore 87 in the end of a handle, after which it is closed over by a plug 88. In this form the handle 89 may be of one piece bored to receive the tube 78. The ferrule 90 is brazed or welded to the tube and the tapered end of the handle driven into it.

In the construction shown in Figure 24 the parts are the same as shown in Figure 23 excepting that the tube 78 has a transverse opening 91 which receives a pin or rivet 92 extending through the handle. The tube terminates short of the end of the handle or bore through which the tube extends and the end is closed by a plug 93.

In Figure 25 the shanks 94 are continued down through the handle 95, being reduced in size, as indicated at 96, and the crushed portions 97 of semi-circular form may be brazed along their co-acting edges or faces and formed in their outer ends with a socket in which one end of a pin 98 is brazed or anchored and the outer end is threaded as at 99 to receive the nut 100, which is seated in the counterbore 101 and closed over by a plug 102. These connections provide for securely mounting the handle on the shank of the racket. In the forms shown in Figures 23 and 25, means are provided by reason of the threaded connections for drawing the handles up against the nut 86 and the screw or bolt head 100.

In the construction shown in Figure 26 the shanks 103 are extended into the forward end of a reduced tubular portion 104 and brazed. The tubular portion 104 may be of the required length as used in connection with a tennis racket or longer as used in the game of racket or squash and has an enlarged handle portion 105 forming the grip, which tapers down as indicated at 106 to form the reduced portion 104 or may be made separate therefrom and anchored to the tube 104, though it is preferably integral therewith. The metal also may be formed into the enlarged outwardly flaring end 107 which takes the place of the leather ring 24 for the purpose of preventing the device from slipping from the hand of the player.

In Figure 27, the handle 108 is shown of hollow tubular metal having a crimp or bead 109 formed therein at the forward end of the grip. The op-

posite end is enlarged to flare outwardly as indicated at 110 while the portion forwardly of the crimp or bead 109 tapers down to the required size as indicated at 111 for the attachment of the shank portions such as indicated in Figure 26. The gripping portion between the crimp 109 and the enlarged end 110 may have a leather or like covering 112 to obviate gripping the metal and to give a proper friction grip which will prevent displacement of the racket from the hand of the player.

In Figures 28, 29 and 30 another form of spreader is illustrated in which the spring metal or wire reinforcing members 113 on the frame 1 are disposed to extend entirely around the frame. One or more of these spring metal members are employed. In the form shown the two wires or spring metal strips are brazed on each side of the frame and extend down around the outturned portions and shanks 12 where they are anchored in the handle 2. These spring metal members or wires may terminate at the handle or beneath the ferrule 114 and are mounted on the end of the handle over the shanks and brazed thereto as indicated at 115. The cross section of this construction is shown in Figures 29 and 30. In addition, strips 116 may be brazed or otherwise similarly joined to the spring metal members or wires 113 upon opposite sides of the frame as indicated in Figures 28 and 29. These members are mounted upon the outturned portions of the frame where they diverge at the open throat, upon opposite sides of the plane of the stringing so that the strings will extend between them. The shanks may then be brought into contact at the points where they straighten out before entering the handle. The handle in Figures 28 and 30 may be laminated transversely of the plane of the racket for strength and esthetic effect and pinned through the tubes, as at 2', at suitable points on the length of the handle with the tubes extended to the proper points to attain the necessary anchorage and balance.

In the form shown in Figures 31 and 32, the shank portions 12 of the frame are spaced apart as indicated at 117. The ferrule 118 has two extensions 119 receiving the shanks therein individually and brazed to the shanks as well as fastened to the handle. The spreaders consisting of the spring metal members or wires 120 and 121 are substantially of the form shown in Figures 1, 2 and 7 but in this instance are both mounted upon the opposite lateral sides of the frame and have the intermediate spring portions 122 and 123 curving or bulging outwardly to give the required spring action, tending to expand the frame after the frame has been strung in a compressed or contracted condition and then released of the pressure so as to effectively tighten the strings. The strings also extend down into the shank portions where they turn outwardly and in each instance are extended beyond the spring metal members which connect the outwardly directed or curved portions of the racket frame where they extend to produce the shanks at opposite sides of the open throat. In addition, a reinforcing tube 124 may be anchored to the extended shank ends within the handle by any suitable means, as by brazing, and extended the length of, or substantially down, the handle to reinforce the latter.

In Figures 33 and 34, the spreaders consist of reinforced spring metal tubes or sleeves 125 which are fitted over the outwardly curved and shank portions of the tube forming the frame, the ex-

tensions of the tube over the outwardly turned portions extending to the legs or haunches of the arches formed by opposite sides of the frame as indicated at 126. These tubes also extend into the handle and may be brazed together as indicated at 127 and to the ferrule 128 as indicated at 129.

In the form shown in Figure 35, a spring metal spreader plate 130 is inserted between the outwardly turned portions of the tube forming the frame, the ends being concaved or recessed as indicated at 131 to fit the tube periphery, the plate having large holes 132 with rounded ridges through which the strings are extended without having to contact with the edges of the metal at the holes. A metal racket frame reinforced with such spring elements produces a reaction to the impact of the ball.

In Figure 36 a spring element 133 corresponding to that shown in Figure 1 is illustrated mounted on the sides of the frame and the portions 133 are connected at their outer ends across the frame preferably at the inside as indicated so as to be laid on the frame and retained in position during the brazing. The spreader 134 is also formed in one piece having the side portions connected at their ends across the inside of the frame as indicated at 135 and brazed to the parts 133. The brazings and wires are tapered and ground down so as not to make an abrupt change in the strength of the cross section of the frame, thereby preventing breaking at these points. These cross pins of the metal strips or wires keep the racket tube from splitting open.

In the form shown in Figure 37 the spring element or spreader consists of an elongated loop having end portions 136 looped around the tubes or side portions of the frame beyond the open throat and connecting portions 137 therebetween spaced apart, the portions being brazed or welded to the tubes as at 138. Since the portions 137 are springy or elastic and normally bowed longitudinally of the racket as in Figure 31, tending to expand the racket following the release of the stringing clamp and the impact of the ball in play, this element moves up and down in play and serves as a spreader to expand the frame and keep the stringing tight so as to give greater resistance to the ball impact, thereby increasing the speed of the ball's return as well as taking up slackness in the strings as the racket ages and acts as a brace to prevent distortion of the racket. Since the spreader or portions 137 are on opposite sides of the plane of the stringing, the strings will freely pass between the portions 137 without contacting with any sharp edges of the metal and the center strings will pass down into the sides of the frame at the throat portion—for instance, in the manner shown in Figures 28, 31 and 33.

In the form of the invention shown in Figure 38, the structure is identical with that shown in Figure 37 so far as the frame is concerned, except that the spring element or spreader consists of two outwardly bulged or curved arcuate springs 139 disposed upon opposite sides of the frame at the throat portion somewhat in the manner shown in Figure 28 in respect to the elements or strips 116 and the ends are tapered, as indicated at 140, and brazed or otherwise similarly secured to the opposite sides of the tube 1 of which the frame is made. This structure obviously gives the necessary expansive properties to keep the stringing tight.

In Figure 39 a modification of the structure shown in Figures 31 and 32 is illustrated, in which, instead of having the wires 120 and 121 brazed or similarly attached to the tubing 1 of the frame at the shank portions 12 and the reversely curved or ogee portions where they branch from the frame to form the shanks, the spreader members or wires 141 are in the form of ribs on the tube made integral instead of separate. This stiffening or reinforcing means, preferably placed at four equi-distantly spaced points or otherwise as desired in order to give uniform spreading action, will serve to expand the frame to keep the stringing tight and resist the tendency of the tubing to bend in such a manner as to become distorted. Of course, it is to be understood that these ribs are preferably rolled or pressed from the metal and may be located at suitably spaced points and may be of any desired number and at anywhere along the frame for the entire or only portions of the length.

In Figures 40 and 41 of the drawings, a construction for the tip or end of the racket frame remote from the throat portion is shown in which the shape of the racket corresponds to that shown in Figure 1 or otherwise and in which the wires extend at the tip only or entirely around the frame as illustrated in Figure 28, excepting that only one wire 142 is shown, corresponding to the outer wire 113 brazed to the tubing 1. This wire is contacted at spaced points by a chord or brace wire 143 disposed substantially tangentially to the inner face of the tube and brazed to the latter, as well as to the wire 142 at its ends. Intermediate parallel brace wires 144 extend between the wire 143 and the wire 142 forming a strong truss formation to give the resistance and resilient action described.

In Figures 42 and 43 of the drawings, another modification is shown in which a brace wire 145 extends around the inner portion of the periphery of the frame or tubing at the tip and then branches off as indicated at 146 in convergent relation to the wire 142 for connection with the latter at its ends by brazing or the like in the same manner as the wire 143. Whereas two brace wires 144 are shown in Figure 40 extending parallel to each other and to the longitudinal axis of the frame, the brace wires or brazing 147 of suitable and proper metal strutting between the wires 142 and 145, extend substantially radially or in outwardly divergent relation and brazed at their ends and to the tubing, as already described. It will also be seen that the reinforcing structures shown in Figures 40 and 42 will protect the tip of the frame in the use of the racket.

In Figures 44 and 45, the racket frame is reinforced by the wires 113, as shown in Figure 28. In addition, two elongated arcuate loops 148 with closed ends 149 are interposed upon opposite sides of the tip between the wires 113 and brazed to the latter as well as to the tubing. The shape of the racket, as described, keeps the racket from elongating and overstraining of the central longitudinal strings. When the ordinary shape is employed the features shown in Figures 40 to 50 inclusive prevent the racket from elongating and tend to give additional resilience to the racket on impact with the ball, the impact tending to elongate the racket and this tending to return the racket to normal shape.

In Figures 46 and 47 of the drawings, the tubing of the frame at the tip is shown reinforced by a supplementary length of tube 150, preferably

of aluminum or duraluminum, following the arc or curvature thereof.

In Figures 48 and 49, the tubing 1 is shown reinforced on its outer face at the tip portion with an elongated resilient metal member or wire loop 151 brazed thereto and having closed ends 152. This structure serves the same purpose as the structures shown in Figures 40 to 47 inclusive.

In Figures 50 and 51, the frame or tubing 1 is shown with the wires or resilient metal strips 113 and the tube is split longitudinally or lengthwise to avoid a joint in the tube, as indicated at 153 to provide opposite portions 154 convexly arcuate with their concave sides toward each other and the split portion producing a substantially oval opening. A turnbuckle connection 155 connects the opposite ends of the tubing to the split portion and accommodate the turnbuckle which includes oppositely threaded shank portions 156 anchored in the tubing at their outer ends and serving as means for contracting and expanding the frame in connection with the resilient split portions of the tubing and the resilient strips or wires mounted thereon which are adapted to bow or move in and out with the operation of the turnbuckle.

Of course, this structure normally expands the frame but permits contraction thereof, whereby the racket may be strung while the frame is contracted and then positively expanded by the adjustable connection or turnbuckle to maintain the stringing in a tight condition. In those structures in which tubing is used to reinforce the frame tubing 1, as shown in Figures 33 and 46, the spreaders may consist of spring metal tubing or sleeves over the ordinary steel tubing of the frame, or these reinforcing parts may be of duraluminum or other aluminum alloy, or the reinforcing parts may be of steel tubing located at the top and bottom of the frame—that is, at the tip and shank portions or either. The tubing of the frame may be of duraluminum or steel as well as the reinforcing sleeves or casings. They may also be of fiber or a fiber rod may be used for the frame. In either event, the required reinforcement and spreading action will be produced.

In Figure 52 a modification of the frame structure is shown with respect more particularly to those forms illustrated in Figures 1^a and 1^b, in which the tube 1 is flattened as shown in Figure 1^a except that the inner side of the tube is left flat as indicated at 157 and is provided with large holes or openings 158 in the same manner as the outer openings 9, except that the latter are punched in as shown in Figure 1^a. The filler is indicated as being of laminated form with a central or intermediate strip 159 of fiber or the like and strips 160 on either side of leather, felt, or the like, and projecting into the openings 158 and 9, or the portions of the metal around the holes 9 may be punched into contact or embedded in the outer strip or layer 160 of this laminated cushion filler. Small holes 8 are provided through the cushion filler for receiving the stringing 3 and to take the strains or stresses exerted thereon without permitting the stringing to contact with the edges of the metal or other material of the tubing forming the frame proper. This prevents the stringing from contacting with the metal or fiber tubing except at easy bearing points or faces and thereby avoids cutting or abrading the stringing, so that gut may be used to even greater advantage than in a wooden racket owing to the softer surface lay-

ers such as leather, thus saving the gut from abrupt strains and providing the proper "give" while the tougher fiber core prevents the strings from enlarging the opening or cutting sideways into the metal and consequent loosening of the strings, as well as to hold the awl and string without injury to the string in the customary method of racket stringing.

In Figure 53 of the drawings, the reverse of the construction shown in Figure 52 is illustrated and the filler 161 is shown in one piece of cushioning material such as fiber, leather, or the like, adapted to deaden the sound as well as absorb shock and vibration. This filler is extended through the holes 158 which in this instance are at the outside of the frame and the turned-in portions at the holes 9 are in contact with the inner face of the filler. Of course, the filler shown in Figure 52 may be employed.

In Figure 54 the frame is shown comprising a tube as in the form shown in Figure 52 for receiving the filler 161, the inner side having openings for receiving filler disks 158' when it is desired to fill these holes, and the outer side of the frame is pressed in or indented to produce a channel 162, the walls of which are preferably arranged to hold the filler in place. The bottom wall of this channel is disposed intermediately of the thickness of the tubing and has openings which may receive filler disks 163 and a cushioning or filler strip 164 is mounted in the channel 162 with small holes 8 much smaller than the holes in the tube or metal, receiving the stringing 3 in the same manner as previously described so as to prevent cutting of the stringing. In this form there is no contact between the stringing and the frame at the outer side of the racket.

In Figure 55 the frame is shown as composed of a metallic or like strip 165 of double ribbed or channel formation as indicated at 166 along the side edges and the spaced intermediate flat portion 167 with large holes 168 for receiving the stringing 3. The fiber cushioning member 169 is fastened to the channeled member or strip 165 as by means of spaced rows of rivets 170 passing through the cushioning strip and openings in the ribs or channels 166 upset at their ends as a retention means for connecting the two parts of the frame when laid together. In this form it is not necessary to insert the cushion member in the tubing as in the forms already described.

In Figure 56 the frame is shown comprising a channel member 171 with openings 172 in the connecting portion or web thereof for receiving the cushioning strip 173. This strip preferably terminates in spaced relation to the edges of the side flanges of the channel as indicated at 174 so that the stringing is depressed and protected from abrasion and being accommodated in small holes in the cushioning strip in the same manner as previously described, only contacts with the cushioning strip at the outside and primarily the cushioning strip at the inside. The cushioning or filler strip has disks formed integral or separate to fit in the holes 172. In this manner the stringing is protected at the outside by the projecting sides of the channel as it lies in contact with the outer face of the cushioning member and at the inside by the disks of the filler.

In Figure 57 the construction is the same as shown in Figure 56 except that the cushioning member extends to the outer edges of the channel member 171 and is of laminated material. For instance, it may comprise a central and inner and outer strips 175 of leather, rattan, or

lighter and softer material and two intermediate and relatively thin layers or laminations 176 of fiber placed between the central strip and the inner and outer strip and suitably glued or otherwise fastened together.

In Figure 58 this structure is the same as shown in Figures 56 and 57 except that the filler is shown comprising three laminations instead of one or five and consists of a central or intermediate layer or lamination 177 such as fiber and inner and outer layers or laminations 178 of leather or felt. Of course, cork may be used for the central layers 175 and 177 shown in Figures 57 and 58.

In Figure 59 the frame is shown comprising a double channel or I-shaped member in cross section as indicated at 179. The outer channel receives a cushioning member 180 corresponding to the cushioning member 173, as shown in Figure 56 and formed at one section terminating in spaced relation to the edges of the flanges at the outer side of the frame, as indicated at 181. This cushioning member extends through the opening 182 of the connecting member or web 183 and has small holes receiving the stringing 3.

In Figure 60 of the drawings the construction is the same as shown in Figure 59 except that the cushioning member 184 comprises two strips, one having disks extending into or through the openings 182 of the connecting member or web 183 and is positioned between the bottom flanges as well as the top flanges 181 and may terminate in spaced relation to the edges thereof at both the inner and outer sides of the frame.

In Figure 61 of the drawings the frame 185 is substantially the same as that shown in Figures 59 and 60, except that the side flanges thereof diverge toward the connecting portion or web 186 and the openings 187 in the web do not receive the filler or cushioning member—that is, the flanges converge toward their edges to provide dovetail channels or grooves 188 and the cushioning members or strips 189 are correspondingly shaped in cross section in the manner of a dovetail to retain them in position. Both have small openings receiving the stringing 3 therethrough, which stringing is held out of contact with the edges of the metal at the openings 186 owing to the latter being enlarged with respect to the openings or holes through the cushioning members. The outer face of the outer cushioning member also may be formed with a depression or groove 190 so that the stringing will be embedded or set below the edges of the flanges at the outer side of the frame so that the stringing is protected. In each instance the frame may be of suitable metal such as duraluminum, or of fiber steel alloy.

In Figure 62 the frame 191 corresponds in shape to the frame 185 shown in Figure 61 except that the flanges are shorter and the cushioning members or strips 192 project beyond the flanges or have ribs overlying the edges thereof as indicated at 193. The stringing is arranged in the same manner, although the outer portions thereof may not necessarily be depressed or embedded.

In Figure 63 the frame 191 is employed but the cushioning strips or members 194 have the projecting portions or ribs 195 rounded over the edges of the flanges and the latter may be tapered or recessed at their outer edges as indicated at 196 so as to conform to the ribs. In this form

both the inner face of the inner strip or cushioning member and the outer face of the outer strip may be recessed or grooved longitudinally as indicated at 190 to accommodate the stringing. In this form the inner cushioning member or strip may terminate short of the intermediate connecting web portion 186 to receive a steel or like strip or band 197 to serve as a reinforcement for the frame and having large holes through which the strings pass without contacting with the web or strip.

In Figure 64 the frame 198 receives the fillers 199 and has the outer edges of the flanges thereof rolled or turned over as indicated at 200 to retain the strips in position. In addition, a leather or like strip 201 may be inserted between the fiber or other cushioning member or strip 199 and the connecting member or web 186 to protect the stringing at the large holes in the web. These leather strips or bands can be forced down into the holes in the metal if desired.

In Figures 65 and 66 the frame is of a cross section very similar to those forms shown in Figures 1^b and 54 in that the frame 202 is indented or pressed in at the outer side of the tube to form a channel 203 and the inner wall of the frame as well as the outer wall or wall of the channel are provided with openings and punched in to provide enlarged flaring portions 204, the inner edges of which are turned outwardly as indicated at 205 to prevent the stringing from coming in contact with the sharp edges of the metal and providing easy bearing faces for the stringing at these points. The outside cushioning member or strip 206 is fitted in the channel 203, preferably after heat-treating of the metal composing the frame. It will be seen that the holes in the portions 204 are sufficiently large to prevent contact of the strings with the metal edges owing to the fact that the strings are restrained somewhat in the small openings 207 of the cushioning member, which openings form a wall bearing for the stringing and an awl in stringing. Since the stringing will not contact with the edges of the metal at the large holes, this will prevent the stringing from being cut.

In Figures 67 and 68 of the drawings, the frame is practically the same construction as shown in Figures 65 and 66, except that the depressed channel 208 is set in much deeper and wider instead of tapering in cross section inwardly and at the bottom has large holes 209 receiving the stringing out of contact with the edges thereof. The inner wall has the turned-in portions 204, the same as shown in Figures 65 and 66. The cushioning member is of laminated form and may consist of a hard fiber strip 210 with an outer softer strip of leather or the like 211, and may have an inner leather or softer strip 212, all having aligned small openings receiving the stringing and to take stresses thereon without cutting the stringing. Of course, in each form, the cushioning members serve to absorb shock and vibration as well as to act as a sound deadener.

Figures 69 and 70 of the drawings show a similar construction, except that the portions 215 are turned or punched in closely adjacent to or in contact with the inner wall of the channel, as indicated at 213, and the inner side is provided with enlarged holes 214. The metal around the holes is punched in as indicated at 215, in somewhat rounded formation at the longitudinal sides to provide easy bearing faces for the stringing.

The outer side is indented or pressed in to produce a channel 216, preferably of dovetail cross section having the inner wall 217 overlying the outer edges of the punched-in portions 215. The filler or cushion is preferably of laminated structure having a central cushion member 218, preferably of fiber, and strips 219 of leather or softer material at the inner and outer sides thereof. This filler has its laminations or strips forced into the channel after the racket frame is fabricated and heat treated, and since the outer cushion strip is set in from the outer face of the frame, the stringing will be embedded or set below the outer face of the frame and protected from injury or breakage.

In Figure 71 of the drawings, the frame construction is substantially the same as shown in Figures 69 and 70, except that the tube of the frame 220 has the channels 221 and 222 formed in the opposite sides of the tube. The channel 222 at the outer side and the inner wall 223 are adjacent to or in contact with the inner wall of the channel 221 which is provided with enlarged openings 224 to receive the stringing out of contact with the metal edges owing to the restraint of the stringing in the small holes of the cushioning member 225 which is mounted in the channel 222, and the thinness of the wall of the tube, the inner channel is left open.

In Figure 72, the frame 226 is provided with inner and outer channels 227, the inner walls 228 having enlarged openings and between which a steel reinforcing band or strip 229 may be inserted to reinforce and give additional resiliency to the frame as in connection with the steel band or strip 197 shown in Figure 63 to cause the frame to normally expand but permitting it to be contracted when the frame is strung and thereby retain the stringing in a tight condition when the contracting pressure is released at the open throat in addition to the spreader. Of course, the walls 228, as well as the strip 229, have large holes 230 through which the strings will extend in such a manner so as to clear the edges of the metal while passing through the small openings in the cushioning members 231 which are fitted in the channels 227. The inner cushioning member or strip 231 is preferably extended to the inner face of the frame while the outer member may be countersunk or depressed below the outer face of the frame to protect the stringing. If the bridging brace or element 31 is sufficiently rigid to fulcrum the sides of the frame on the ends thereof or pivoted at these points, it will be found that the clamping of the shanks together tends to expand the frame midway of the length of the head instead of narrowing it at this point. This fact can be taken advantage of in using a somewhat reverse method in stringing from that already described.

In such case, the shanks are forced apart from their normal position before stringing as by means of the turnbuckle 26—27 or by other suitable means, instead of being forced together as already described. This forces in the sides of the head midway of the racket and the racket head is strung, while the frame is in this condition and the force then removed. That is, the longitudinal stringing and half or more, or all of the cross stringing are strung up to the customary tightness and then the force removed at the throat or shanks to allow the sides of the shank to move together or contract toward their normal position, thereby correspondingly spreading the sides of the head above the bridging brace

which may be rigid or also act as a resilient spreader. However, when half or more only and not all of the cross strings are strung before removing the expanding force between the shanks, this force is then removed or omitted entirely previously to such degree of stringing. With the lower cross strings remaining to be strung, the shanks may then be clamped together as already described, and the remaining cross strings strung. This, it will be seen, causes additional expanding force to be exerted at the midway point of the head to produce greater resistance, tightness and tension on the cross strings.

While I have shown and described my invention in a preferred form, I am aware that various changes and modifications may be made therein without departing from the principles of the invention, the scope of which may be determined by reference to the appended claims.

I claim as my invention:

1. A method of stringing rackets in which the frame thereof is made of resilient material and the head is contracted prior to stringing and then released after stringing to permit the head automatically to expand and tighten the stringing.

2. A racket of the class described, comprising a frame having its ends curved but distinctly flattened as distinguished from the conventional oval-shaped frame, the throat end being broader than the other flattened end of the head or frame of the racket and by reason of said flattened ends providing relatively sharp reverse curves where the ends of the frame are turned to form the shank of the racket, the sides of the frame being also curved outwardly so as to resist inward collapse of said frame when being strung and in play.

3. A tennis racket frame of somewhat acorn shape having flattened ends and comprising a resilient member having an open throat adapted to permit contraction of the frame to reduce the area thereof in stringing and thereafter adapted to expand automatically to tighten the stringing, and a handle on the shank portions.

4. A tennis racket frame of somewhat acorn shape having flattened ends and shank portions, a resilient member spanning the sides of the frame adjacent the throat to permit contraction of the frame to reduce the area thereof and adapted to normally expand, whereby the stringing will be tightened, said frame adapted to be strung in a contracted condition and to expand for tightening the stringing, and additional means for expanding the frame.

5. A racket of the class described, comprising a frame adapted to receive stringing and a resilient member on the frame adapted to cause expansion thereof.

6. A racket comprising a resilient frame member with outturned ends forming shanks for attachment to a handle, and a spring member on the frame and joined thereto to supplement the resiliency of the frame to permit contraction thereof for stringing or when not in use, and to cause expansion of the frame and tightening of the stringing when released.

7. A tennis racket or the like comprising a frame with a cushioning element for the stringing, and a resilient member mounted on the frame to normally spread the same.

8. A racket comprising a metal frame and a resilient automatic spreader member for the frame, the sides of said frame forming pro-

nounced self-supporting arches with the ends abruptly flattened.

9. A tennis racket comprising a resilient frame with outturned ends forming shank portions and having a freely open and unobstructed throat in the plane of the stringing, a resilient spreader member disposed at the throat tending to normally expand the frame for tightening the stringing thereof, a handle on the shank portion having a ferrule tapered toward the same, a pin anchoring the shank portions transversely through the handle, and a reinforcing member joined to the shank portions and extending longitudinally of and embedded in the handle.

10. In a racket of the class described, a resilient frame having converging shanks, a handle joined to said shanks, and a resilient member secured adjacent the throat of said frame for restoring said frame to normal shape after the same has been distorted.

11. In a racket of the class described, a frame comprising a resilient tubular member having converging semi-circular shanks, a cylindrical reinforcing member embraced by said shanks, and a handle embracing said reinforcing member.

12. In a racket of the class described, a frame comprising a resilient tubular member having converging semi-circular shanks, a tubular reinforcing member embraced by said shanks, and a handle embracing said reinforcing member.

13. In a racket of the class described, a resilient frame having converging shanks, a handle secured to said shanks, and a resilient wire-like member secured to said frame at least a part of which extends parallel thereto for restoring said frame to its original shape after the same has been distorted.

14. In a racket of the class described, a resilient frame having converging shanks, and a resilient member secured to the tip portion of said frame for restoring said frame to normal shape after the same has been distorted.

15. In a racket of the class described, a resilient frame having converging shanks, a wire secured to said frame and extending along the tip portion thereof parallel to said frame, and a second wire bracing said first wire.

16. In a racket of the class described, a resilient frame having converging shanks, a wire secured to said frame and extending along the tip portion thereof parallel to said frame, and a truss-like member bracing said first wire.

17. In a racket of the class described, a resilient frame having converging shanks, a handle secured to said shanks, a pair of resilient members secured on opposite sides of said frame adjacent the throat portion thereof for restoring said frame to normal shape after the same has been distorted, and means connecting said resilient members and extending transversely of the plane of stringing of said racket.

18. In a racket of the class described, a resilient frame having converging shanks, a handle secured to said shanks, a pair of resilient members secured on opposite sides of said frame adjacent the throat portion thereof for restoring said frame to normal shape after the same has been distorted, each of said resilient members comprising oppositely extending arcuate portions substantially parallel with said frame and a portion joining said arcuate portions adjacent said handle, and means extending transversely of the stringing of said racket and connecting the outermost extremities of the arcuate portions of the respective resilient members.

19. A racket comprising a resilient string supporting framework, stringing anchored to said framework, and resilient means acting through the framework for enhancing the string movement at at least a portion of their anchorages in addition to the "give" permitted by the ordinary frame and acting to restore said strings to normal position after such movement produced by ball impact thereon, so as to produce an enhanced whip of the strings, said resilient means being secured to said framework and acting to spring the latter back to its normal position after distortion thereof caused by impact of a ball on the stringing.

20. A racket comprising a resilient string supporting framework, longitudinal stringing anchored to said framework, and resilient means moving away from the plane of stringing upon ball impact on said stringing so as to move at least a portion of the anchorages of said longitudinal stringing in addition to the "give" permitted by the ordinary frame and operative to restore the stringing to normal position and thus produce an enhanced whip of the strings.

21. A racket comprising a frame and a handle secured thereto and having a resilient member adjacent the throat tending to arch away from said handle upon ball impact on said stringing and thereby returning to normal position so as to increase the string resilience by moving the anchorages thereof.

22. A racket comprising a resilient frame, and a resilient tubular member encasing a portion of said frame normally subjected to strains in play.

23. A racket comprising a frame, and a resilient wire-like member secured to a portion of said frame for restoring said frame to its original shape after the same has been distorted.

24. A racket comprising a metallic tubular frame, the shanks of which converge into a metallic union, a metallic tubular member molecularly joined to said shanks substantially in continuation thereof, and a handle formed on one end of said tubular member, said frame and tubular member constituting, in effect, a continuous branching tube having an integral metallic structure.

25. A racket comprising a head portion formed of a hollow metallic shell terminating in a pair of shanks, a tubular member molecularly united to said shanks, said tube increasing in outside diameter toward its outer end, and a handle secured to said tubular member.

26. A racket frame formed of a hollow shell terminating in a pair of shanks, a tubular member embraced by the end portions of said shanks, an annular member gripping said shanks adjacent their ends so as to secure them to said tubular member, and a handle secured to said tubular member, said shanks, tubular member, and annular member being formed of metal and molecularly united.

27. A racket comprising a resilient frame having its ends converging to form a throat, and a resilient bridge member secured to said frame and spanning opposite sides of said frame adjacent said throat and having apertures therein and longitudinal stringing passing through said apertures.

28. A racket comprising a resilient frame having its ends converging to form a throat, and a pair of resilient wire-like members secured to said frame on opposite sides of the stringing thereof and spanning said throat.

29. A racket comprising a tubular frame having a channel formed in the periphery thereof, said tube having unflared stringing holes in the channelled wall and having aligned flared holes in the opposite wall thereof, all of said holes being of substantially greater diameter than the stringing, string-supporting material disposed in said channel, and stringing threaded through said material and through said holes, said stringing being maintained by the supporting material out of contact with cutting edges of said holes.

30. A racket comprising a frame formed of a plurality of metal parts, said parts being of different physical characteristics and one part serving to impart resiliency to the frame while also constituting a reinforcement therefor.

31. In a racket, a frame comprising a metallic shell with outturned ends forming shank portions, a handle recessed to receive said shank portions and tapered at its inner end, a ferrule tapered to tightly fit said inner end of the handle and having a single opening through which said shank portions pass into the handle, and means molecularly uniting said ferrule to said shank portions, said means being located at the inner end of the ferrule and tapered in continuation of the taper of the ferrule to the surfaces of said shanks so as to avoid abrupt changes in cross-sectional size between said shank portions and said handle, whereby the stresses transmitted from the head of the racket to the handle are gradually distributed to and absorbed by the handle so as to prevent breakage of said shank portions adjacent the inner end of the handle.

32. In a racket, a frame comprising a metallic shell with outturned ends forming shank portions, a handle recessed to receive said shank portions and tapered at its inner end, a ferrule tapered to tightly fit around the inner end of the handle and molecularly joined to said shank portions, the taper of said ferrule being such as to avoid materially abrupt changes in the cross-sectional sizes between said shank portions and the handle, whereby the stresses transmitted from the head of the racket to the handle are gradually distributed to be absorbed by the handle so as to prevent breakage of said shank portions adjacent the inner end of the handle.

33. A racket comprising a frame and a handle secured thereto and having a compression spring secured to the frame adjacent the throat for resiliently effecting spreading of said throat, said spring functioning, upon ball impact, to allow some of the string anchorages in said throat portion of the frame to shift so as to impart "give" to the stringing beyond that permitted by the ordinary frame, said spring also serving to resiliently restore the throat portion of the frame and the stringing to normal position, thereby producing an increasing whip in the stringing.

34. A racket comprising a frame formed of a hollow shell having pairs of stringing holes, the holes of each pair being respectively disposed in axially aligned relation in the opposite wall portions of the frame, one of the holes being larger than the other and provided with a smooth, inwardly flaring wall, whereby the opposite stringing may pass freely through such larger holes, and means associated with the smaller holes for positioning and guiding the stringing through said smaller holes.

35. A tennis racket having a head portion formed of a hollow shell providing a frame with a throat, and a flexing handle section

formed by a pair of long extended shanks continued from the head frame and meeting in a molecular union so as to work as a single unit and extending without a long enveloping and reinforcing handle throughout the portion customarily so provided and instead having only a relatively short handle at the outer extremity of the long extended shanks whereby the rigid stiffness of a long non-flexing handle portion is eliminated and the racket permitted to whip, flex, and graduate the shock absorption over a greater portion of the entire racket length while still providing strong torsional resistance.

36. A racket comprising a head formed of a hollow shell, said shell defining an inclosure with stringing woven therein and having a handle connected therewith at one end, said hollow shell having a varying wall thickness at a predetermined points and having a changing exterior cross-sectional perimeter approaching an end of the racket head and symmetrically disposed on both sides of the longitudinal axis of the racket.

37. A racket comprising a frame formed of a hollow shell, said shell defining an inclosing head with stringing woven therein and having a handle connected therewith, portions of said shell wall having a multiple ply thickness at predetermined points including points adjacent the throat portion of the racket head so as to increase resilience and resist fracture.

38. A racket comprising a frame formed of a tubular metal shell, said shell having a varying wall thickness at predetermined points and being metallically reinforced and of increased diameter adjacent the throat of the racket head.

39. A racket comprising a head formed of a hollow shell, said shell forming an inclosing head with stringing woven therein and having a handle connected therewith at one end, said shell at either end of the racket head being stepped to a changed exterior diameter at points symmetrically disposed on both sides of and equidistant from the longitudinal axis of the racket.

40. A striking implement for games comprising a resilient hollow shell, said shell having multiple reinforcing members increasing the wall thickness, spaced apart and extending longitudinally so as to reinforce said shell against strains at predetermined points and increase resiliency while maintaining lightness of weight.

41. A racket comprising a frame formed of a hollow metal shell having converging shanks extending into an enveloping handle and terminating in the upper portion thereof, a longitudinal metallic anchor member being metallically connected to said shanks and projecting therefrom longitudinally of the handle into the lower portion thereof so as to securely anchor and unite the metallic frame with the lower handle portion of the racket.

42. A racket comprising a frame formed of a hollow shell, having in combination therewith a composite member for positioning and protecting the stringing from cutting and abrasion by the hollow shell and for deadening vibration, said composite member having a relatively softer string supporting surface for bedding and cushioning the string, in combination with a harder under core for preventing the taut string from enlarging the hole and thereby slackening the stringing.

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