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This invention relates to methods of manufacturing racket frames, for rackets such as tennis, badminton or squash rackets which incorporate strung frames made of metal, for example steel.

In this Specification the term "frame" means the looped portion of a racket within which stringing is carried out and which is attached by means of a shaft to a handle.

It has been proposed to form a racket frame from a metal tube in which integral flanged apertures are provided through the tube for the stringing of the racket. By an "integral flange" is meant that metal of the tube surrounding a hole in said tube is used to form the flange, the inner edge of the surrounding metal having been turned through substantially 90° from its original position in the tube, at least in the longitudinal direction of said tube, so that said flange forms a smooth surface for the stringing, or for grommets for the strings.

The integral flanges are arranged to project towards the interior of the metal tube and such integral flanged apertures may be provided both in the inside and outside of a racket frame to enable stringing to be applied through the frame.

In order to form the integral flanged apertures, very small holes are first required to be made in the tube, and subsequently the integral flanges are formed, such as by a punching operation. In piercing the small holes extreme accuracy in their location, especially having regard to the subsequent punching operation, is required, and it has been found difficult to obtain the required accuracy of location of such small holes, especially in the case of a steel tube.

The holes are required to be extremely small, for example approximately .045 inch (1.143mm.) in diameter in the case of a badminton racket, and the use of drill bits of this order of diameter gives rise to wandering when the bits come into contact with the metal tube and to excessive breakages of the bits thus tending to lead to inaccuracy in the positioning of the holes and to lengthy delays in production.

It is an object of this invention to provide a method of manufacturing a racket frame with a view to alleviating the difficulties indicated above.

According to the invention there is provided a method of manufacturing a metal racket frame for stringing characterised in forming simultaneously a plurality of holes in a metal member for use as said frame, employing a spark erosion head having a plurality of spaced electrodes.

The holes may be made in a straight metal member which is subsequently formed into a racket frame, or the metal member may be formed into a loop for the racket frame, and the holes subsequently made in the formed member, in groups a plurality at a time. If the racket frame is formed from a metal tube each electrode of the spark erosion head may be employed to form pairs of holes in the metal tube, respectively in opposite wall portions of said tube, in one pass of the spark erosion head. When the holes are formed in a straight metal member which is subsequently to be formed into a racket frame all the holes required for the stringing of the frame may be made in one pass of the spark erosion apparatus, or, if desired, said holes may be made in groups, a plurality at a time. Preferably integral flanges are formed in the metal tube surrounding the holes

before or after said tube is formed into a loop for a racket frame.

In order that the invention may be clearly understood and readily carried into effect it will now be more fully described with reference to the accompanying drawings, in which:-

Figure 1 shows, partly out away, spark erosion apparatus for forming holes in a metal member for use as a racket frame by a method in accordance with one embodiment of the invention;

Figure 2 shows, on an enlarged scale, the spark erosion head and supporting means for a metal member of the apparatus of Figure 1, a front panel of the head and part of said supporting means having been cut away to show component parts of said head and supporting means;

Figure 3 is a section on III-III of Figure 2, on a more enlarged scale;

Figure 4 is a plan view of a part of the spark erosion head as indicated by the arrow IV on Figure 2, also on a more enlarged scale;

Figure 5 shows a steel member for use as a racket frame having a plurality of holes therethrough formed by the apparatus of Figures 1 to 4;

Figure 6 is a section, on an enlarged scale of a portion of the steel member of Figure 5 showing integral flanges surrounding the holes therein; and

Figure 7 shows a racket having a steel frame formed from the steel member of Figure 5, integral flanges having been formed around the holes in said metal member.

Referring to Figures 1 to 4 the invention will be described, by way of example, with reference to a method

of piercing holes in opposite wall portions of two steel tubes to be used as racket frames, all of the holes required for the stringing of the racket frame being pierced in one pass of a spark erosion head. In the spark erosion apparatus to be described, two steel tubes, for forming two racket frames, are pierced with their holes as will become apparent hereinafter.

The spark erosion apparatus shown in Figures 1 to 4 comprises a spark erosion head 1 mounted via a coupling 2 on a spindle 3. The coupling 2 permits adjustment of the position of the head 1 in the lateral direction, and the spindle 3 can be employed to displace the head 1 vertically as viewed in Figures 1 and 2 to enable a pass of the spark erosion head to be performed. The head 1 comprises a substantially rectangular framework having a base block 4, side panels 5 and upper panels 6, within which two parallel rows of spark erosion electrodes 7 are housed. The electrodes 7 are mounted in the base block 4 and project from the base block 4 as shown. The head 1 is supported on the coupling 2 by means of an upper block 8 which is coupled to the base block 4 via two pillars 9 which extend through the head 1 as can be seen in Figures 2 and 3, between the two rows of spark erosion electrodes 7.

In order accurately to position the electrodes 7 there are mounted in the base block 4 two sets of adjustable screws, one set for each row of electrodes 7. Each set of adjustable screws comprises upper screws 10 and lower screws 11 which can be seen most clearly in Figures 3 and 4. The upper screws 10 pass between the electrodes 7 of the respective row and form spacing members for determining the spacing between the spark erosion elect-

rodes 7 of said row. The electrodes 7 are disposed in channels 12 in the base block 4 and are adjustable laterally of the respective rows by means of the lower screws 11. For this purpose each screw 11 is arranged to engage a plate 13 which bears against two adjacent electrodes 7 in the respective row, urging said electrodes 7 into contact with a longitudinal wall of the respective channel 12, which wall is accurately machined so as to provide an accurate positioning of the electrodes 7.

The spark erosion apparatus also comprises supporting means for two metal members in which holes are required to be formed by the respective rows of electrodes 7. The supporting means is mounted in a container 14 (Figure 1) for a suitable dielectric 15, which may for example be paraffin oil (kerosene), in which the two metal tubes are immersed during the formation of holes therein. The container 14 is mounted on a support 16 which is adjustable in two mutually perpendicular directions transverse to the lengthwise direction of the electrodes 7 by means of manually adjustable devices 17 and 18 as shown in Figure 1. The supporting means is mounted in the container 14 on a base plate 19 which may be secured, such as by screws or bolts, to the base of the container 14. The supporting means comprises three substantially parallel longitudinally extending blocks 20, 21 and 22 shown in Figure 3. The three blocks 20, 21 and 22 are urged apart by two pairs of compression springs 23 and 24 which are partially housed in recesses in the blocks 20, 21 and 22, the springs 23 being provided between the blocks 20 and 21 and the springs 24 being provided between the block 21 and 22. The three blocks 20, 21 and 22 can be urged towards each other against

the pressure in the springs 23 and 24 by a clamping coupling 25 operable by a handle 26. The two metal tubes in which holes are to be formed by the spark erosion apparatus are indicated in Figure 3 by reference numerals 27 and 28 and, as can be seen in that figure, are respectively mounted in the straight channels between the blocks 20 and 21, and 21 and 22. For locating the tubes 27 and 28 the block 21 is provided with two opposite V-shaped recesses 29 as shown.

In operation of the spark erosion apparatus described above, the two rows of electrodes 7 are accurately positioned in the head 1 as described and the two metal tubes 27 and 28 are clamped in position in the supporting means. The head 1 and the container 14 are located accurately relatively to each other and a suitable electric potential is applied between the electrodes 7 and the base plate 19 whilst the head 1 is moved downwardly towards the supporting means to execute a pass of the apparatus. Holes are formmed in the two tubes 27 and 28 simultaneously, first in the uppermost wall portions thereof and then in the lowermost wall portions thereof as the head 1 is moved downwardly. By way of example each tube may have 72 holes formed in each opposite wall portion so that a total of 144 holes are formed in each tube in one pass of the apparatus.

After forming the holes in the tubes 27 and 28, the head 1 is raised and the tubes 27 and 28 removed from their supporting means. A metal tube having holes therethrough formed in this manner is shown partly in section, in Figure 5, the holes being indicated by reference 30. In one embodiment, in order to form the metal tube in Figure 5 into a racket frame for stringing, integral flanges 31 are formed

around the holes 30, as shown in Figure 6, the flanges 31 projecting towards the interior of the tube and being as hereinbefore defined. The integral flanges may be formed all together on each side of the tube, or in groups, employing a plurality of simultaneously operated punches aligned with the holes 30. The metal tube is also formed into a loop to form a racket frame 32 (Figure 7) for stringing and is coupled to, such as by brazing or welding, or integral with a shaft 33 at the end of which remote from said frame 32 is provided a suitable handle 34 to form a racket. In Figure 6 the racket shown is a badminton racket, but the method described may be employed to manufacture other types of strung rackets such as tennis or squash rackets.

Although the invention has been described with reference to one particular embodiment thereof, various modifications to that embodiment may be made without departing from the invention. By way of example, the racket frame may be formed from a metal member other than a metal tube, and the holes in only one metal member may be formed in one pass of the spark erosion apparatus. Moreover, the spark erosion head may be provided with fewer electrodes, and the holes in the metal member may be made in groups, a plurality at a time, instead of all being made in one pass of the apparatus. Furthermore, the metal member may be formed into a loop for a racket frame prior to the formation of holes therein for stringing. In this event, the supporting means for the metal member will be suitably adapted to support a looped member, and the holes in said looped member will conveniently be formed by the spark erosion head in groups, a plurality of holes in each group.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a method of making a metal racket frame for stringing having a series of stringing apertures, the improvement comprising bringing a metal tube adjacent a spark erosion head having a plurality of spaced electrodes whose spacing apart corresponds to the spacing apart of the intended stringing apertures, and energizing said electrodes to produce concurrently by spark erosion a series of holes in said metal tube corresponding to the disposition of the electrodes in the spark erosion head.

2. A method according to Claim 1, in which the metal tube is bent into the shape of a racket frame before production of the holes.

3. A method according to Claim 1, in which the metal tube is bent into the shape of a racket frame after the production of the holes.

4. A method according to Claim 1, in which all said holes are formed in one pass of the spark erosion head, and said metal tube is subsequently bent into the shape of a racket frame.

5. A method according to Claim 1, in which said metal tube is bent into the form of a loop for said racket frame and said holes are subsequently formed in the metal tube in groups, a plurality at a time.

6. A method according to Claim 1 in which said holes are formed in pairs in the tube, respectively in opposite wall portions of the tube, in one pass of the spark erosion head.

7. A method according to Claim 6 which further comprises providing said holes with integral flanges, the flanges projecting towards the interior of said tube.

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Fig. 1.

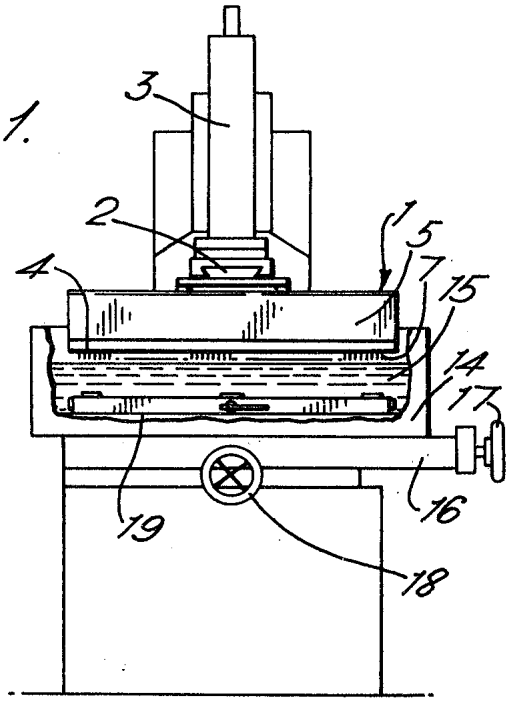


Fig. 3.

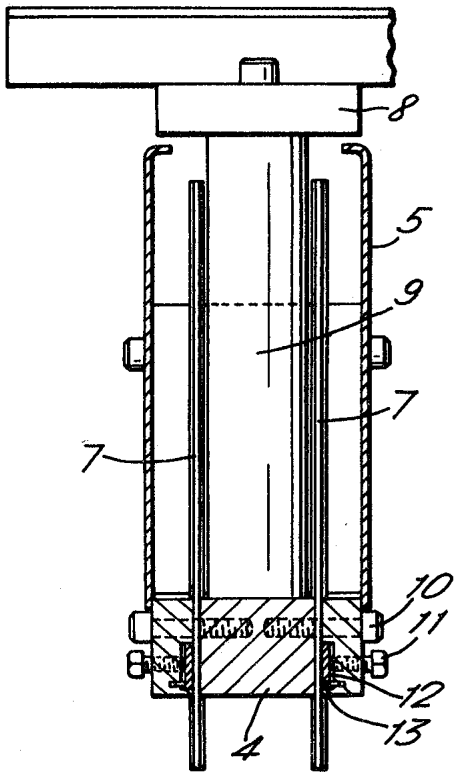
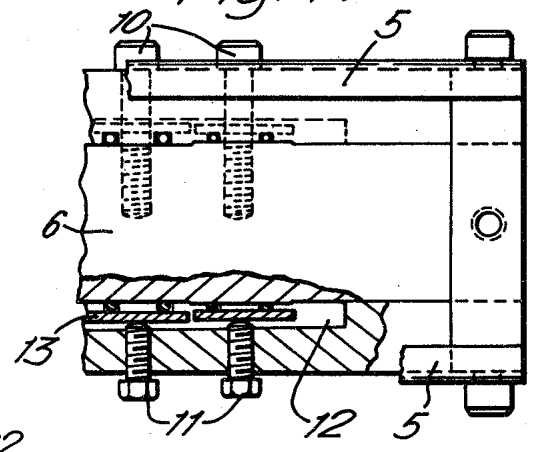
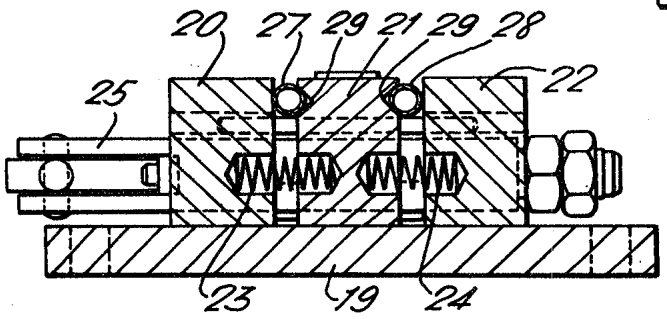


Fig. 4.





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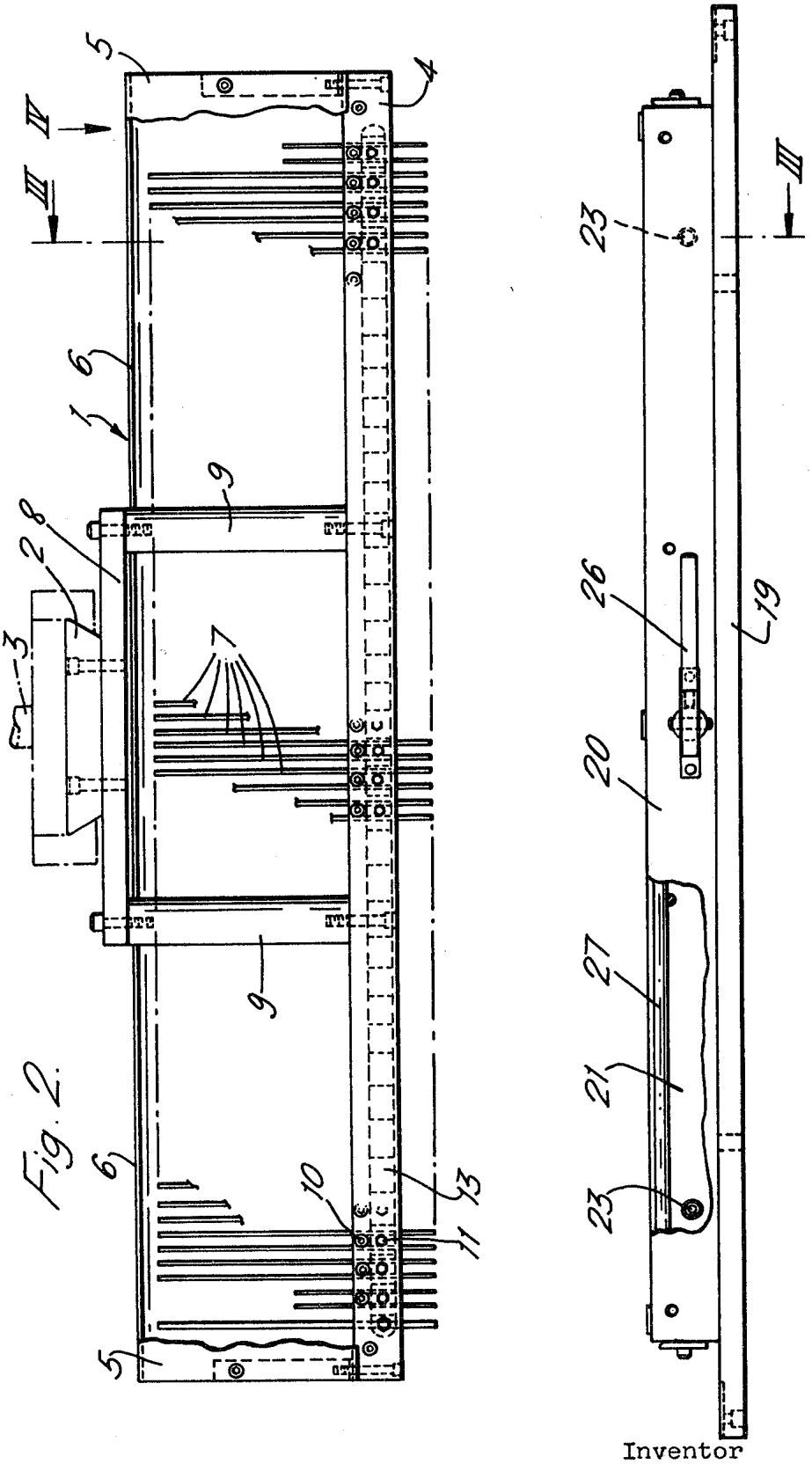

Fig. 2.

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Fig. 5.

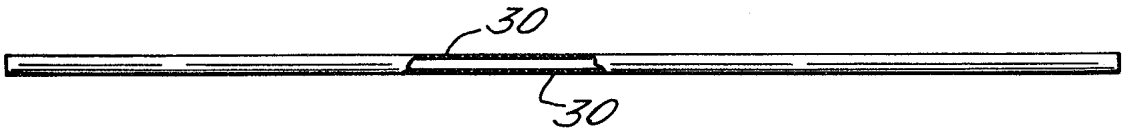
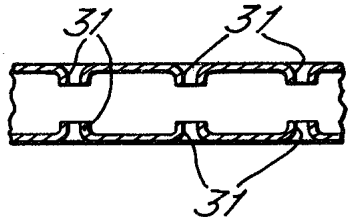


Fig. 6.



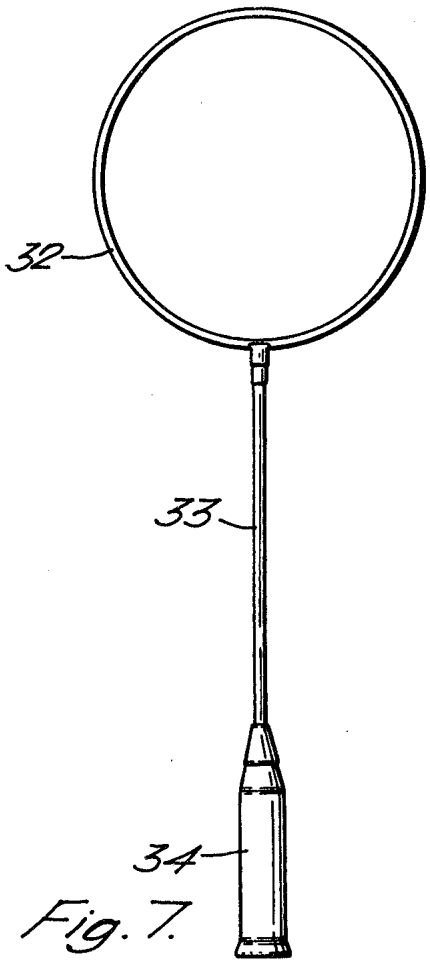


Fig. 7.

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