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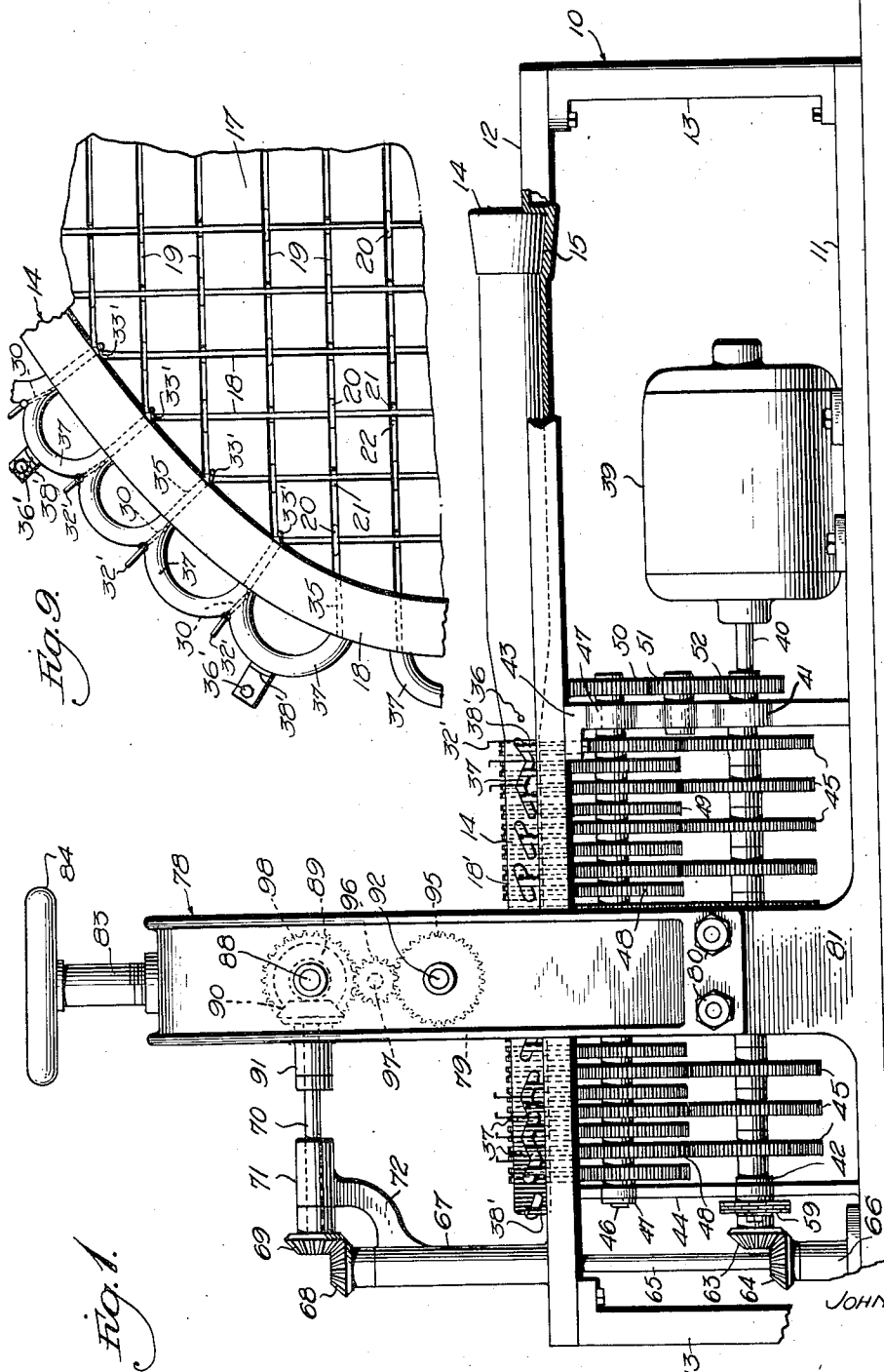
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2,028,663

APPARATUS FOR STRINGING TENNIS RACKETS

Filed Jan. 3, 1935

4 Sheets-Sheet 1



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APPARATUS FOR STRINGING TENNIS RACKETS

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4 Sheets-Sheet 2

Fig. 2.

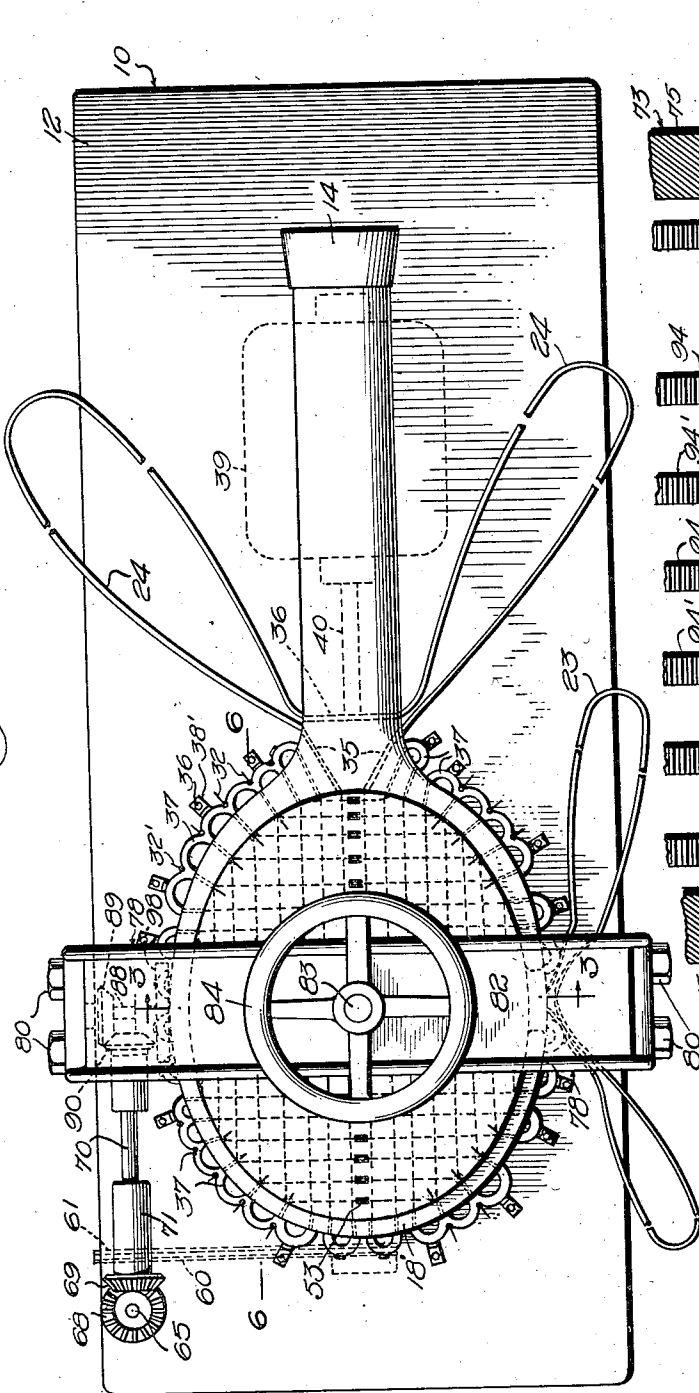
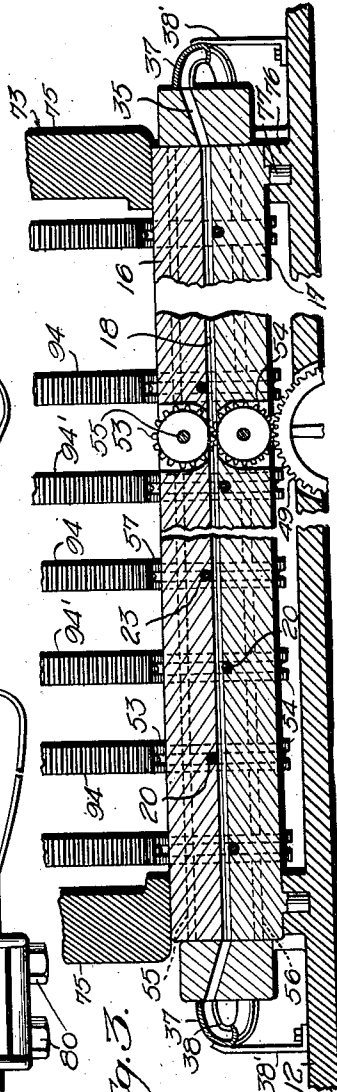


Fig. 3.



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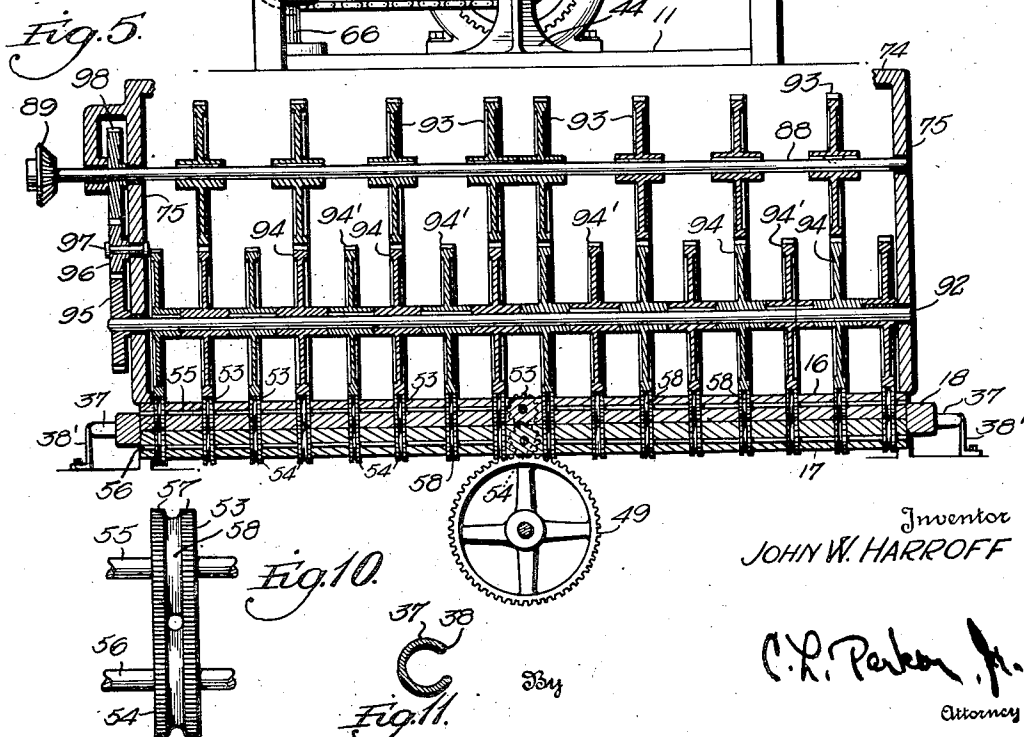
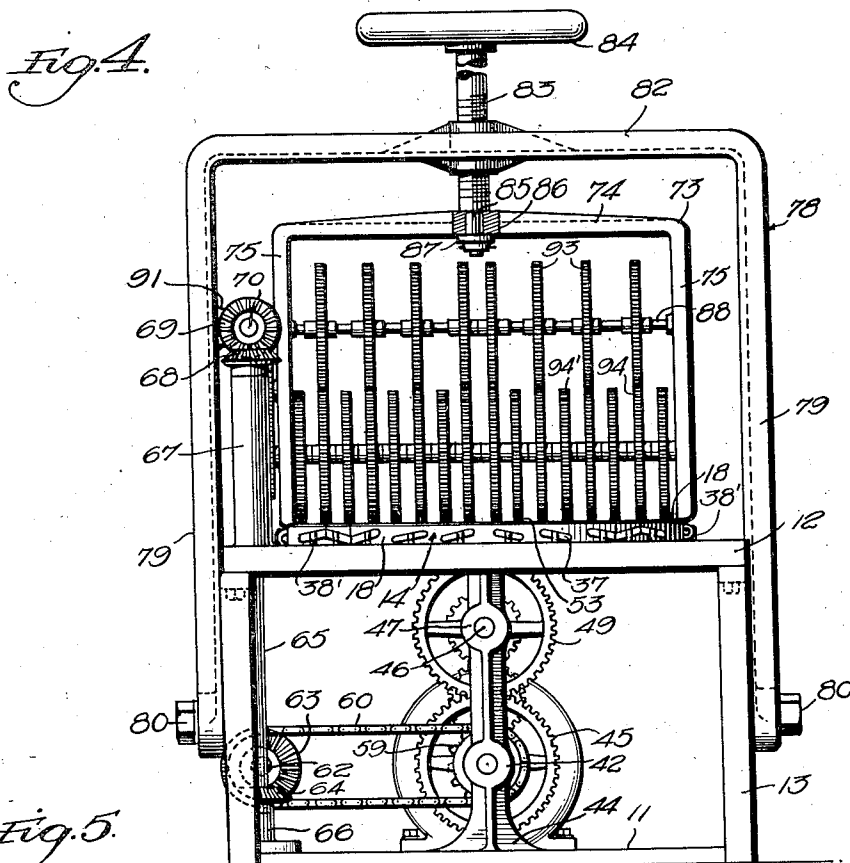
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4 Sheets-Sheet 3



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4 Sheets-Sheet 4

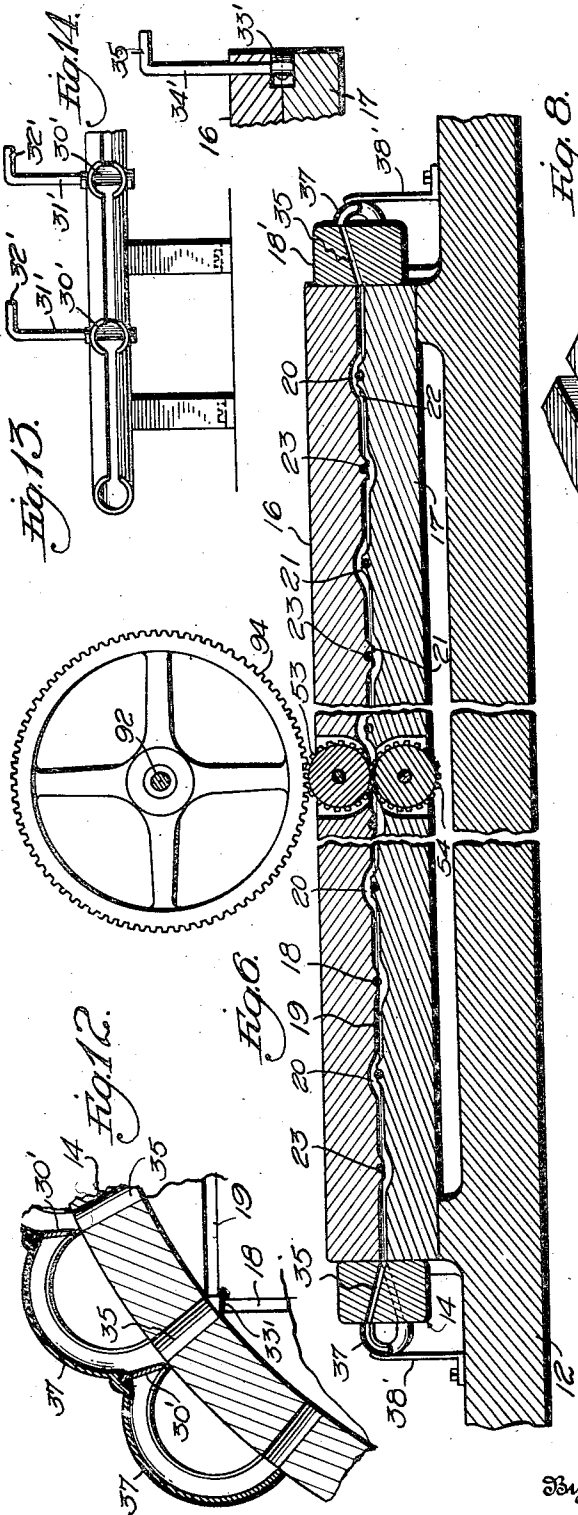


Fig. 8.

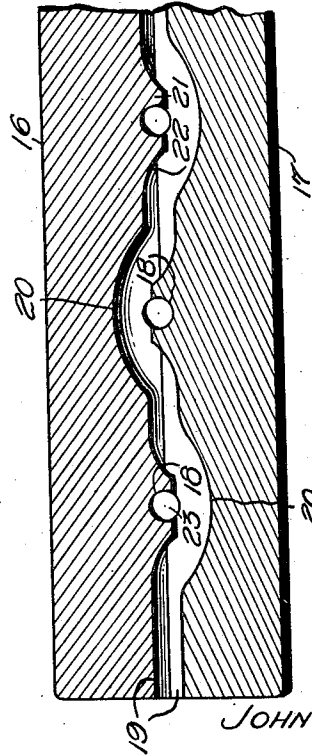
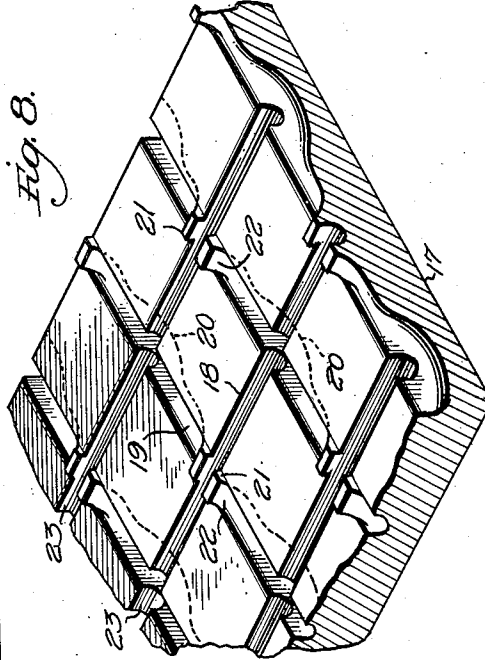


Fig. 7.

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UNITED STATES PATENT OFFICE

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APPARATUS FOR STRINGING TENNIS RACKETS

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Application January 3, 1935, Serial No. 297

20 Claims. (Cl. 273—73)

This invention relates to an apparatus for stringing tennis rackets.

As is well known, tennis rackets are strung in the factories and restrung after use solely by hand, it being necessary for the operator to thread through each individual string, and then to tighten it and tie it. The hand operations involved in stringing a tennis racket require substantial length of time, and a great amount of skill is required in order that the strings may be properly tensioned. Several efforts have been made to provide apparatus by means of which the stringing operations may be performed mechanically, but all machines of this type of which I am aware are only semi-automatic in operation, and the number of hand operations which must be performed are such that there is very little saving in the time required for stringing a racket.

An important object of the present invention is to provide an apparatus for stringing tennis rackets wherein practically all of the operations are performed automatically, thus permitting a substantial number of rackets to be strung in a relatively short time.

A further object is to provide an apparatus of the character referred to wherein the only hand operations necessary in the stringing of a racket are the initial feeding of the cross and longitudinal strings and the tying of the ends of the strings.

A further object is to provide novel means for picking up a manually inserted string end and automatically threading it back and forth through the openings in the racket frame to complete the threading operation without the further intervention of hand work.

A further object is to provide an apparatus of the character indicated wherein the strings, after being completely threaded back and forth through all of the openings in the racket frame, are automatically and uniformly tensioned.

A further object is to provide a tennis racket stringing apparatus having novel means for weaving one set of strings with respect to the other set.

A further object is to provide novel feeding and guiding means for the strings of a tennis racket wherein one set of strings is fed back and forth through the suitable openings provided in the racket frame, and to provide novel means for thereafter feeding the other set of strings through the openings in the racket frame and for weaving the latter set of strings back and forth with respect to the set of strings first inserted.

A further object is to provide an apparatus of the character referred to having novel driving means for feeding the strings back and forth across and longitudinally of the racket.

A further object is to provide novel supporting means for the racket and the string guiding

means, whereby a racket may be quickly inserted in position in the apparatus and quickly removed therefrom.

Other objects and advantages of the invention will become apparent during the course of the following description.

In the drawings I have shown one embodiment of the invention. In this showing—

Figure 1 is a side elevation of the apparatus,

Figure 2 is a plan view of the same,

Figure 3 is an enlarged fragmentary sectional view taken transversely of the apparatus substantially on line 3—3 of Figure 2 and indicating the frame of the racket, the guiding means for the strings, and associated elements, parts being broken away,

Figure 4 is an end view of the apparatus,

Figure 5 is a view taken substantially on the same plane as Figure 3 showing the upper portion of the apparatus on a somewhat smaller scale than Figure 3,

Figure 6 is a longitudinal sectional view taken substantially on line 6—6 of Figure 2, illustrating a portion of the frame of the racket, the string guiding means, and associated parts, portions of the device being broken away,

Figure 7 is an enlarged fragmentary vertical sectional view through a portion of the string guiding plates,

Figure 8 is a fragmentary perspective view of a portion of one of the guiding plates,

Figure 9 is an enlarged fragmentary plan view of a portion of a tennis racket in position on the apparatus showing a portion of the guiding tubes arranged outwardly of the racket,

Figure 10 is an edge view of a pair of the string feeding gear members,

Figure 11 is an enlarged detail sectional view taken transversely through one of the string guiding tubes,

Figure 12 is a detail sectional view of a portion of the guiding tubes and associated elements,

Figure 13 is an elevation of the same, and,

Figure 14 is a fragmentary detail sectional view of a portion of the guide plates showing one of the guide vanes associated therewith.

Referring to Figures 1, 2, and 4, the numeral 10 designates the main frame of the apparatus including a base plate 11, a working bed 12 arranged thereabove, and supporting legs 13 connecting the working bed 12 with respect to the base plate 11. All of the working operations of the apparatus are performed with a tennis racket supported on the working bed 12, and a racket 14 has been shown in position on the bed 12 in Figures 1 and 2. The bed 12 is recessed in its upper face as at 15 to receive a portion of the handle of the racket, as will be apparent.

Referring to Figures 3 to 8 inclusive the numer-

als 16 and 17 designate upper and lower guide plates respectively shaped in plan to correspond to the shape of the frame 18' of the racket and adapted to be placed therein as indicated in Figures 3 and 6. These plates have their adjacent faces transversely grooved as at 18 and longitudinally grooved as at 19. The grooves 18 are continuous except where they cross the grooves 19, as shown in Figure 8. Each groove 19, at alternate junction points with the grooves 18 is provided with a depressed groove portion 20, as shown in Figures 7 and 8. The grooves 19 adjacent the remaining junctions with the grooves 18 are provided with lugs 21 having curved guide faces 22. Transverse and longitudinal strings 23 and 24 are fed through the respective grooves 18 and 19, as will become apparent. The strings 23 are fed straight through the grooves 18, these grooves being straight and uninterrupted from end to end. The strings 24 are fed through the grooves 19 and are guided around the paths of the strings 23 by the curved lug faces 22 and the depressed groove portions 20. The means referred to permits both sets of strings to be fed automatically through the racket since the second set of strings introduced into the apparatus is not interfered with by the other set during its passage through the apparatus. The grooves 18 and 19 obviously may be reversed with the straight grooves 18 extending longitudinally of the racket and the grooves 19 extending transversely of the racket together with their associated guide lugs 21 and depressed groove portions 20.

The strings are initially fed into the frame in the manner suggested in Figure 2, and in this connection it will be noted that the racket frame 18' is provided with the usual string receiving openings 35 spaced around the frame 18'. In addition, the racket is provided adjacent the inner end of the handle thereof with a transverse opening 36 extending therethrough. The length of string to form the longitudinal strings is passed through the openings 35 and the ends of the string are then fed into the next adjacent pair of openings 35. The ends of the string to form the transverse string are fed into the adjacent pair of openings 35 adjacent the center of one side of the racket. Means to be described are provided for positively feeding the two sets of strings through the racket, and it will be apparent that as the advancing end of each string passes through successive openings in the racket frame, it must be turned back for insertion in the next adjacent opening. For this reason, what may be termed guide tubes 37 are arranged around the frame with the ends of the tubes coinciding with the adjacent pairs of openings 35 to receive the end of a string from one opening and guide it into the next adjacent opening. Each tube 37 is shaped in cross-section as shown to an enlarged degree in Figure 11, the tube being open in its inner face as indicated at 38 to permit the string to be drawn inwardly from the tube to be tightened against the frame of the racket. The tubes 37 may be supported in any suitable manner, and in the present instance, they have been illustrated as being supported on brackets 38' carried by the bed plate 12.

It will be noted that certain of the guide tubes are connected to each other, and this obviously is necessary because some of the guide grooves 18 and 19 coincide at the extremities of the guide plates 16 and 17, at the points where the cross strings and longitudinal strings pass through the

same openings in the racket frame. The junctions of such guide tubes are provided with guide vanes 30' carried by vertically extending shafts 31' having their upper ends turned at right angles as at 32' to form handles. Moreover, the guide plates 16 and 17 are provided with similar guide vanes 33' at the points where the grooves 18 and 19 intersect at the edges of the plates 16 and 17. Each vane 33' is likewise mounted on an upstanding shaft 34' extending through the top plate 16 and provided at its upper end with a handle portion 35'. For a purpose to be described, it is necessary to remove the multiple guide tubes 37 when the stringing operation is completed, and for this purpose, these tubes are secured to the bed plate 12 by screws or the like 36' which are adapted to be loosened or removed to permit the removal of the multiple tubes whereby the ends of the strings may be secured in the usual manner before the racket is removed from the apparatus.

As previously stated, means are provided for positively feeding the strings through the racket, and the source of power for such means is preferably in the form of an electric motor 39 arranged on the base plate 11 and provided with a drive shaft 40. The shaft 40 is journaled in bearings 41 and 42 formed in vertical frame members 43 and 44 connected between the plates 11 and 12.

The shaft 40, between the members 43 and 44, carries a plurality of parallel gears 45 keyed or otherwise secured thereto. A counter shaft 46 is arranged above and parallel to the shaft 40 and is also supported in bearings 47 carried by the members 43 and 44. The shaft 46 carries a plurality of gears 48 freely rotatable on the shaft 46 and meshing with the gears 45. A second set of gears 49 is carried by the shaft 46, between the gears 48. The set of gears 49 is fixed to the shaft 46 and is driven thereby through the medium of a gear 50 secured to the shaft 46. The gear 50 meshes with a similar gear 51, rotatably supported by the vertical member 43, and the gear 51, in turn, meshes with a gear 52 secured to the shaft 40.

It will be apparent that when the shaft 40 is driven in one direction, the gears 48 will rotate in the opposite direction since they mesh with the gears 45. On the other hand, the gears 49 rotate in the opposite direction to the gears 48, since shaft 46 is driven from the shaft 40 through the intermediate gear 51. The reverse rotation of the gears 48 and 49 is utilized for feeding the transverse strings of the racket back and forth therethrough. Upper and lower feed gears 53 and 54 are arranged in pairs corresponding to the grooves 18, one pair of these gears being illustrated in Figure 3. Each gear 54 meshes with one of the gears 48 or 49, to be driven thereby, and each gear 53 meshes with its associated gear 54 to be positively rotated by such gear and at the same speed.

A pair of the gears 53 and 54 is illustrated in Figure 10. As shown, these gears are mounted and freely rotatable on shafts 55 and 56 respectively, and these shafts extend through the respective guide plates 16 and 17. Each gear 53 and 54 is formed of integral spaced gear rings 57 connected by a curved intermediate portion 58, which may be the metal of the gear, or such intermediate section of the gear may be covered with a rubber friction surface to tightly engage the strings. The intermediate space between a pair of gears, as shown in Figure 10, forms a sub-

stantially circular opening through which a string is adapted to pass, and such string is gripped by the curved surfaces 58 to be positively fed through the racket.

Means are also provided for feeding the longitudinal strings through the racket. Referring to Figures 1 and 4, it will be noted that a sprocket 59 is mounted on the shaft 40, and a chain 60 passes around this sprocket and around a similar sprocket 61, mounted on a shaft 62 parallel to the shaft 40. The shaft 62 carries a bevel gear 63 (see Figures 1 and 4) meshing with a bevel gear 64 secured to a vertical shaft 65. The lower end of the shaft 65 is journaled in a bearing 66 supported by the bed plate 11, and the upper end of the shaft 65 is journaled in a bearing 67 supported by and projecting upwardly from the bed 12. The upper end of the shaft 65 carries a bevel gear 68 meshing with a similar gear 69 secured to a horizontal shaft 70. One end of this shaft is supported in a bearing 71 secured to an arm 72 carried by the bearing 67.

A substantially U-shaped frame 73 is arranged above the bed plate 12. This frame includes a central horizontal portion 74 and depending leg portions 75 which extend downwardly into engagement with the upper guide plate 16 when the apparatus is in operation. The frame 73 constitutes means for clamping the adjacent faces of the plates 16 and 17 into engagement with each other and for holding such plates against the bed plate 12. For the purpose of properly positioning the parts, the plate 12 is provided with means engageable with the guide plate 17 to fix these elements in proper position with respect to each other. For example, the plate 12 may be provided with a plurality of upstanding recessed lugs 76 to receive depending integral lugs 77 carried by the plate 17. In assembling the device, the pins 77 are arranged in the lugs 76, whereupon the frame 73 is adapted to hold the guide frames 16 and 17 rigidly in position during the operation of the apparatus.

A yoke indicated as a whole by the numeral 78 is provided with depending arms 79, bolted as at 80 to vertical webs 81 connected between the plates 11 and 12. The yoke 78 includes an upper horizontal portion 82 through which is threaded a clamping screw 83 having an operating handle 84. The lower end of this screw is reduced as at 85 to extend through a circular collar 86 formed integral with the arm 74, and a washer 87 is secured on the lower end of the stem 85 by a cotter pin or other suitable means. At the point where the screw 83 is reduced in the manner described, a shoulder is formed for engagement with the collar 86, whereby rotation of the screw 83 moves the yoke 73 downwardly to clamp the legs 75 against the upper guide plate 16.

A transverse shaft 88 is journaled in its ends in the arms 75 and one end of this shaft carries a bevel gear 89 meshing with a bevel gear 90 mounted on the shaft 70. The latter shaft has been previously described as being supported at one end in a bearing 71, and the other end of the shaft may be supported in a bearing 91 carried by the supporting frame 78. It will be apparent that the shaft 88 will be constantly driven, while the apparatus is in operation, through gears 89 and 90, shaft 70, gears 69 and 68, shaft 65, gears 64 and 63, shaft 62, sprocket chain 60 and sprockets 59 and 61.

A second shaft 92 is journaled at its ends in the arms 75, and this shaft is arranged parallel to the shaft 88. A plurality of gears 93 are ar-

ranged on the shaft 88 and are keyed or otherwise secured thereto. These gears mesh with corresponding gears 94 mounted on and freely rotatable with respect to the shaft 92. A second set of gears 94' are arranged on the shaft 92 and are keyed or otherwise secured thereto. One end of the shaft 92 carries a driving pinion 95 meshing with an intermediate pinion 96, as shown in Figure 5. The pinion 96 is rotatably supported by a stub shaft 97, carried by one of the arms 75, and the pinion 96 meshes with a pinion 98 secured to the shaft 88. It will be apparent that the gears 94 rotate in a direction opposite to the direction of rotation of the shaft 88, while the gears 94' rotate in the same direction as the shaft 88 because of the use of the intermediate gear 96. Obviously, therefore, the gears 94 and 94' rotate in opposite directions, and this opposite rotation is utilized for feeding adjacent longitudinal strings in opposite directions through the racket.

Each of the gears 94 and 94' is associated with a pair of the gears 53 and 54 previously described, and such gears need not be again referred to in detail. As shown in Figures 3 and 5, each of the gears 94 and 94' meshes with one of the upper gear wheels 53 which, in turn, meshes with one of the lower gear wheels 54 to positively drive the latter and thus feed the longitudinal strings through the grooves 19.

The operation of the apparatus is as follows:

The present apparatus is particularly intended for use in tennis racket factories where substantial quantities of identical rackets are made. While the device is capable of use for restringing rackets, it will be apparent that separate types of apparatus will be required for rackets of different shapes and sizes. It will be apparent, however, that this is a matter of little consideration in factories where large quantities of rackets of identical shapes and sizes are made, as stated. When it is desired to string a racket, the guide plate 17 is placed in position on the bed plate 12 with the pins 77 in engagement with the openings in the lugs 76 to properly position the plate 17. The racket is then placed in position with the handle arranged in the recess 15, and any suitable means may be employed for supporting portions of the racket frame such as extensions on the lugs 76, as shown in Figure 3, or any other suitable means. The top plate 16 is then placed in position within the racket frame, as shown in Figures 3 and 6.

The U-shaped frame 73 will have been elevated from the position shown in Figures 4 and 5 by the previous turning of the screw 83 and thus it will be apparent that the racket and the plates 16 and 17 may be placed in position in a manner to be described. The screw 83 is then rotated to move the frame 73 downwardly until the arm portions 75 of the frame are clamped against the top plate 16, as shown in Figure 3, and this clamping action obviously holds both plates 16 and 17 rigidly in position. The downward movement of the frame 73 also lowers all of the gear elements carried by the frame, and accordingly the gears 94 and 94' will be brought into mesh with their respective gears 53. Moreover, the gear 89 will be brought into mesh with the gear 90, and the apparatus is then ready for operation.

The motor 39 is started, and its operation drives the shaft 40 and rotates the gears 45 thereon. These gears in turn mesh with the gears 48 to drive the latter, while the gears 49 will be driven by the shaft 46, through the gears 50, 51, and 52.

As previously stated, the gears 48 and 49 rotate in opposite directions and these gears mesh with the lower gears 54 of the transverse set of feed gears, and alternate sets of these gears will be rotated in opposite directions. It will be noted that the two gears 45 adjacent the center of the length of the racket are arranged a distance apart equal to the distance between two adjacent racket strings whereas the remaining gears 45 are spaced apart a distance equal to the distance between every other pair of the strings. Hence the two strings adjacent the center of the racket will be fed transversely thereof in the same direction, and this arrangement is provided to permit the two ends of the string which forms the cross strings of the racket to be inserted in two adjacent openings, as indicated in Figure 2.

The string 23 is cut to a length sufficient to form all of the cross strings, whereupon the two ends of the string are inserted in the two openings adjacent the center of the length of the racket, as stated, and the ends of the string are fed by hand through the openings 35 referred to and through the corresponding transverse guide grooves 18 until the ends of the string are engaged by the corresponding feed gears 53 and 54. No further attention is then required on the part of the operator to complete the insertion of the cross strings. The gears 53 and 54 referred to feed the string across the remaining half of the width of the racket, thence out through the corresponding openings to the other side of the racket and around the guide tubes 37 adjacent such openings. These tubes turn the ends of the string into the next adjacent openings 35 and through the corresponding grooves 18 until the next pair of gears 53 and 54 engage the ends of the string to continue the feeding action.

It will be apparent that the feeding action is continued back and forth across the racket with the ends of the string passing through successive openings 35 to form successive transverse strings toward the ends of the racket, the tubes 37 serving to turn back the ends of the string as they pass through the successive openings 35. In this connection it will be noted that during the passage of the cross strings through the apparatus, the vanes 33' will be turned to properly direct the ends of the string through the openings 35 through which the string passes outwardly through the racket frame, and to guide the ends of the strings into certain of the grooves 18 at the points where the ends of the string pass inwardly through the openings 35. Similarly, the vanes 30' in the multiple tubes 37 are turned to guide the strings in the proper directions as will be apparent.

The feed gears 53 and 54 act as pushers as they successively take up the ends of the strings until the operation is completed and the center of the length of the string 23 is drawn up tight against the racket frame. The first set of guide rollers can then draw no more string into the racket, but tightens the center of the length of the string to the proper tension by frictional engagement with the string. Each successive pair of the guide rollers operates in the same manner, and accordingly after the string has been completely inserted, the feed rollers operate as tensioning rollers to draw the transverse strings taut to the proper degree. In this connection it will be noted that the pushing action of the feed rollers operates to advance the string successively back and forth, the end of the string being pushed

around the successive guide tubes 37 until no more string can be drawn into the racket. From this point on, as previously stated, the feed rollers act to tension the strings, and initially this action draws the string out of all of the feed tubes 37 through the inner openings 38 thereof and into snug contact with the racket frame.

The operation of inserting the longitudinal strings is substantially identical with the operation just described and need not be referred to in detail. The longitudinal string is cut to an ample length and inserted through the transverse handle opening 36, whereupon the ends of the strings are inserted into the adjacent openings 35 by hand and fed through the grooves 19 until they are picked up by the first set of the rollers 53 and 54 which feed the longitudinal strings. The string is thus advanced completely throughout the length of the racket to form the innermost pair of longitudinal strings, whereupon the string leaves the racket frame to be guided by the corresponding guide tubes 37 back into the racket to form the next adjacent pair of strings. This operation is continued until the strings are fed back and forth to complete all of the longitudinal strings. It will be noted that during the insertion of the longitudinal strings, the vanes 30' and 33' are reversed with respect to the positions of these elements previously described in order that the strings may be properly guided through the respective openings 35 and into and out of the longitudinal grooves 19. After all of the longitudinal strings have been inserted, the feed rollers act as tensioning means to draw the strings out of the guide tubes 37 and stretch them taut. The ends of the string then may be tied in the usual manner.

As will be apparent from an examination of Figures 6, 7, and 8, all of the guide grooves 18 are straight throughout their length, and the transverse strings are thus fed straight back and forth across the racket. In order to prevent interference between the inserted transverse and longitudinal strings and to properly interlace the strings, the guide lugs 22 and the depressed groove portions 20 are provided in the plates 16 and 17. As an advancing end of the longitudinal string 24 approaches the intersection of one of the grooves 19 with one of the grooves 18, the end of the string will contact with one of the curved guide faces 22 to be guided thereby into the adjacent depression 20, and this depression will then turn the string and guide it downwardly into the next continuation of the groove 19, after which the operation is continued. Thus the advancing end of the string 24 will be fed alternately above and below the groove 18 to thus be interlaced with respect to the transverse strings 23.

Since the depressed groove portions 20 and guide lugs 21 operate to maintain the advancing ends of the string 24 out of the path of the transverse strings 23, it will be apparent that the first set of strings introduced into the apparatus will not interfere with the passage of the second set of strings therethrough. It also will be apparent that either set of strings may be introduced first. It has been found that ordinary tennis rackets readily may be strung completely in from 3 to 5 minutes, as distinguished from the slow tedious hand operations which have been previously practiced. While the grooves 19 have been defined as being provided with the means for interlacing the strings with respect to each other, it will be apparent that the ar-

arrangement may be reversed with the grooves 19 formed straight, and with the lugs 21 and depressed groove portions 20 formed in the grooves 18. The various operations will be identical in either case, as will be apparent.

After the racket has been completely strung, the motor 39 is stopped and the multiple guide tubes 37 are removed, whereby free access may be had to the ends of the strings. The openings 35 through which the transverse strings pass from the racket frame after all of the strings have been inserted are provided with tapered pins driven therein by hand. The purpose of these pins is to maintain the tension of the strings during the subsequent tying operations. After the pins have been driven into the openings in the manner stated, the screw 83 is turned upwardly to elevate the frame 73 and all of the gearing carried thereby. The racket and the two plates 16 and 17 then may be lifted from the apparatus and the plates removed from the racket frame. Each end of the cross string is then inserted through one of the next adjacent openings 35 and secured to the nearest longitudinal string by means of a half-hitch, whereupon the tapered pins are then removed. The ends of the longitudinal strings are inserted under the loops of the longitudinal strings which lie against the racket frame and have been drawn taut. The method of securing the ends of the strings is conventional and need not be illustrated or described in detail.

The apparatus is relatively inexpensive to build, particularly in view of the fact that there is a substantial duplication of parts throughout the apparatus, thus eliminating the necessity for the manufacture of a large number of different parts. For example, all of the gears 53 and 54 are identical with each other, and all of the gears 45, 48, 49, 93, 94, and 94' are likewise identical. The apparatus is of such a character as to permit the ready insertion of a racket and the positioning of the parts for the stringing operations, and the racket is readily removed from the apparatus after the stringing has been completed. The apparatus is particularly adapted for use in tennis racket factories where quantity production is of importance and wherein large numbers of identical rackets are manufactured. Since the amount of skilled hand work is substantially reduced in the making of rackets, the cost of production of the rackets is correspondingly reduced. The tension of the strings, moreover, is not left to the judgment of the operator, but all rackets will have their strings tensioned to the same extent because of the operation of the feed gears 53 and 54.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred example of the same and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

I claim:

1. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with corresponding grooves forming guide openings for the passage of the racket strings, said openings registering at their ends with the string openings of the racket frame.

2. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with corresponding grooves forming guide openings for the passage of the racket strings, said openings registering at their ends with the string openings of the racket frame, and means for feeding the racket strings through said guide openings.

3. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with corresponding grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings of the racket frame, and a plurality of pairs of wheels for feeding the racket strings through said guide openings, each pair of wheels being grooved in its periphery to define a circular opening between the wheels registering with one of said guide openings.

4. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with corresponding grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings of the racket frame, a plurality of pairs of wheels for feeding the racket strings through said guide openings, each pair of wheels being arranged in edge to edge relation in a common plane and grooved in their periphery to define a circular opening between the wheels registering with one of said guide openings, and means for driving said wheels.

5. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with corresponding grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings of the racket frame, a plurality of pairs of wheels for feeding the racket strings through said guide openings, each pair of wheels being arranged in edge to edge relation in a common plane and grooved in their periphery to define a circular opening between the wheels registering with one of said guide openings, each pair of wheels being provided with gear portions meshing with each other to effect simultaneous rotation of said wheels, and means for driving one wheel of each pair.

6. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with transverse parallel grooves and longitudinal parallel grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings in the racket frame, said plates being provided with means for guiding the strings passing through one set of

guide openings alternately above and below the lines of the strings passing through the other set of guide openings.

7. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with transverse parallel grooves and longitudinal parallel grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings in the racket frame, said plates being provided with means for guiding the strings passing through one set of guide openings alternately above and below the lines of the strings passing through the other set of guide openings, and means for feeding the racket strings through said guide openings.

8. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with transverse parallel grooves and longitudinal parallel grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings in the racket frame, said plates being provided with means for guiding the strings passing through one set of guide openings alternately above and below the lines of the strings passing through the outer set of guide openings, and a plurality of pairs of wheels for feeding the racket strings through said guide openings, each pair of wheels being arranged in edge to edge relation in a common plane and grooved in their periphery to define a circular opening between the wheels registering with one of said guide openings.

9. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with transverse parallel grooves and longitudinal parallel grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings in the racket frame, said plates being provided with means for guiding the strings passing through one set of guide openings alternately above and below the lines of the strings passing through the other set of guide openings, a plurality of pairs of wheels for feeding the racket strings through said guide openings, each pair of wheels being arranged in edge to edge relation in a common plane and grooved in their periphery to define a circular opening between the wheels registering with one of said guide openings and means for driving said wheels.

10. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with transverse parallel grooves and longitudinal parallel grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings in the racket frame, said plates being provided with means for guiding the strings passing through one set of guide openings alternately above and below the

lines of the strings passing through the other set of guide openings, a plurality of pairs of wheels for feeding the racket strings through said guide openings, each pair of wheels being arranged in edge to edge relation in a common plane and grooved in their periphery to define a circular opening between the wheels registering with one of said guide openings, each pair of wheels being provided with gear portions meshing with each other to effect simultaneous rotation of said wheels, and means for driving one wheel of each pair.

11. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with transverse parallel grooves and longitudinal parallel grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings in the racket frame, said plates being provided with means for guiding the strings passing through one set of guide openings alternately above and below the lines of the strings passing through the other set of guide openings, means for feeding racket strings through said transverse openings, means for feeding strings through said longitudinal openings, and means for simultaneously driving all of said feed means.

12. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with transverse parallel grooves and longitudinal parallel grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings in the racket frame, said plates being provided with means for guiding the strings passing through one set of guide openings alternately above and below the lines of the strings passing through the other set of guide openings, a pair of feed wheels for each transverse and longitudinal opening, each pair of feed wheels being arranged in edge to edge relation in a common plane and provided with peripheral grooves defining a circular opening between the wheels arranged in alignment with the corresponding guide opening, and means for driving said wheels.

13. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with transverse parallel grooves and longitudinal parallel grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings in the racket frame, said plates being provided with means for guiding the strings passing through one set of guide openings alternately above and below the lines of the strings passing through the other set of guide openings, a pair of feed wheels for each transverse and longitudinal opening, each pair of feed wheels being arranged in edge to edge relation in a common plane and provided with peripheral grooves defining a circular opening between the wheels arranged in alignment with the corresponding guide opening, the wheels of each pair being provided with gear portions meshing

with each other, and means for driving one wheel of each pair.

14. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with corresponding grooves forming guide openings for the passage of the racket strings, said openings registering at their ends with the string openings of the racket frame, means for feeding the racket strings through said guide openings, and a plurality of guide means arranged outwardly of the racket frame to receive the end of a string projecting through one opening in the racket frame and guide it into an adjacent opening in said frame.

15. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with corresponding grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings of the racket frame, a plurality of pairs of wheels for feeding the racket strings through said guide openings, each pair of wheels being arranged in edge to edge relation in a common plane and grooved in their periphery to define a circular opening between the wheels registering with one of said guide openings, means for driving said wheels, and a plurality of guide means arranged outwardly of the racket frame to receive the end of a string projected through one opening in the racket frame and guide it into an adjacent opening in said frame.

16. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with transverse parallel grooves and longitudinal parallel grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings in the racket frame, said plates being provided with means for guiding the strings passing through one set of guide openings alternately above and below the lines of the strings passing through the other set of guide openings, means for feeding the racket strings through said guide openings, and a plurality of guide means arranged outwardly of the racket frame to receive the end of a string projected through one opening in the racket frame and guide it into an adjacent opening in said frame.

17. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged therein in face to face relation, said plates being provided in their adjacent faces with transverse parallel grooves and longitudinal parallel grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings in the racket frame, said plates being provided with means for guiding the strings passing through one set of guide openings alternately above and below the lines of the strings passing through the other set of guide openings, a plurality of

pairs of wheels for feeding the racket strings through said guide openings, each pair of wheels being arranged in edge to edge relation in a common plane and grooved in their periphery to define a circular opening between the wheels registering with one of said guide openings, means for driving said wheels, and a plurality of guide means arranged outwardly of the racket frame to receive the ends of a string projected through one opening in the racket frame and guide it into an adjacent opening in said frame.

18. Apparatus of the character described comprising a pair of complementary guide plates corresponding in shape and size to the inside of a tennis racket frame and adapted to be arranged in horizontal position in face to face relation within the racket frame, said plates being provided in their adjacent faces with transverse parallel grooves and longitudinal parallel grooves forming guide openings for the passage of the racket strings, said guide openings registering at their ends with the string openings in the racket frame, said plates being provided with means for guiding the strings passing through one set of guide openings alternately above and below the lines of the strings passing through the other set of guide openings, a plurality of pairs of feed wheels for said transverse openings, a plurality of pairs of feed wheels for said longitudinal openings, the wheels of each pair being arranged in edge to edge relation in a common plane and having peripheral grooves defining a circular opening between the wheels in alignment with one of said guide openings, the wheels of each pair having gear portions meshing with each other, guide tubes arranged outwardly of the racket frame to receive an advancing end of a racket string projected through openings in the racket frame and to guide the string into adjacent frame openings, a source of power, and transmission means connecting said source of power to each set of feed wheels to oppositely drive adjacent pairs of wheels of each set.

19. Apparatus constructed in accordance with claim 18 provided with a bed plate for supporting and positioning the lower guide plate, and a clamping frame for holding the upper guide plate in position against the lower guide plate, said transmission means comprising gearing arranged beneath said bed plate for driving one set of feed wheels, and gearing supported by said clamping frame for driving the other set of feed wheels.

20. Apparatus constructed in accordance with claim 18 provided with a bed plate for supporting the lower guide plate, a clamping frame for holding the upper guide plate in engagement with the lower guide plate, a shaft arranged beneath said bed plate, driving gears on said shaft meshing with the gear portions of the lower feed wheels of one set, means for driving two of the gears adjacent the center of the length of said shaft in one direction and the remaining of such gears alternately in opposite directions, a shaft carried by said clamping frame, a plurality of gears mounted on said last named shaft and meshing with the gear portions of the upper feed wheels of the other set, and means for driving the two gears adjacent the center of the length of said last named shaft in one direction and for driving the remaining gears of said last named shaft alternately in opposite directions.