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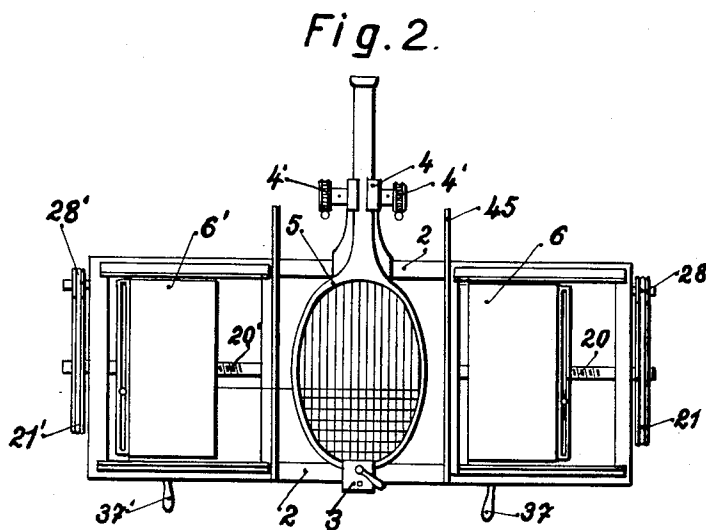
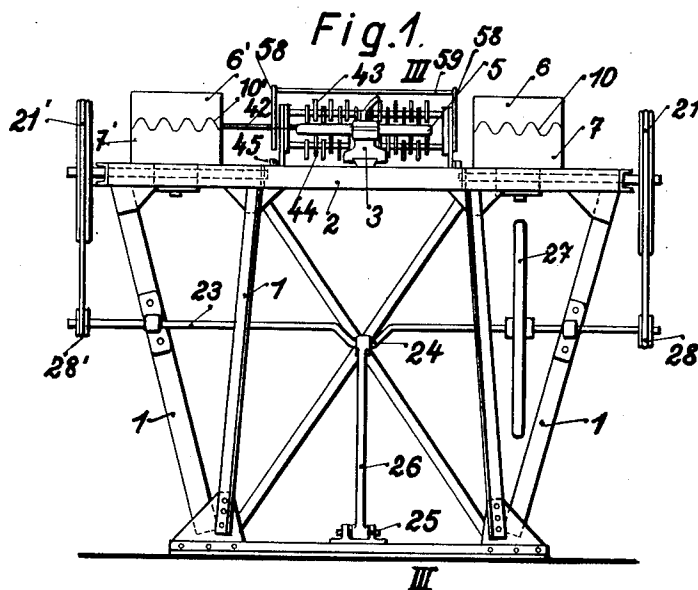
S. TAUBER ET AL

1,943,400

MEANS FOR STRINGING TENNIS RACKETS WITH STRINGS

Filed March 19, 1929

11 Sheets-Sheet 1



Siegfried Tauber  
Ladislau Fischmann  
INVENTORS.

BY *Otto Hunk*

their ATTORNEY.

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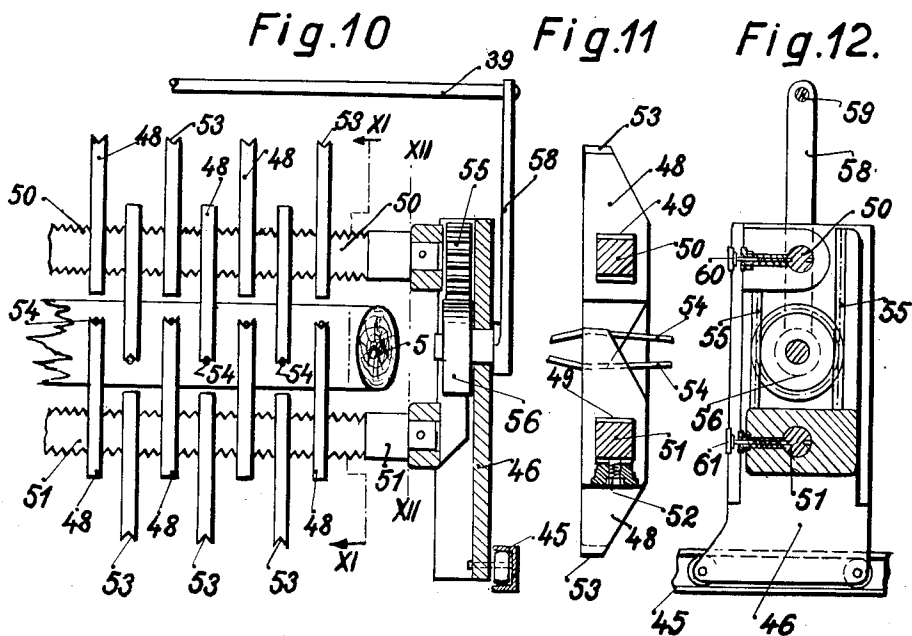
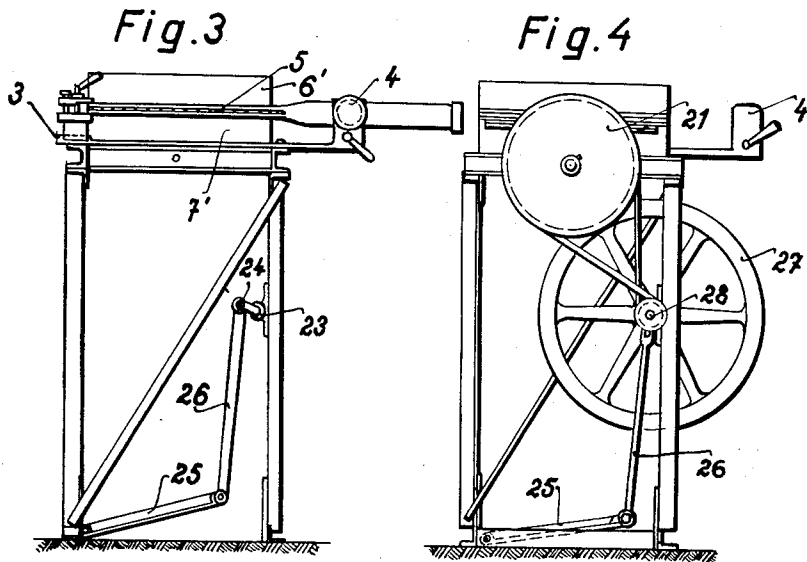
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MEANS FOR STRINGING TENNIS RACKETS WITH STRINGS

Filed March 19, 1929

11 Sheets-Sheet 2



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Jan. 16, 1934.

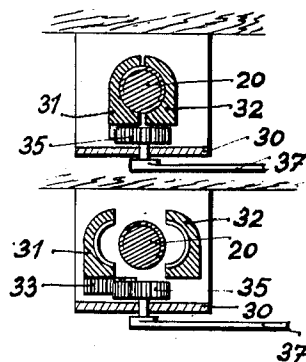
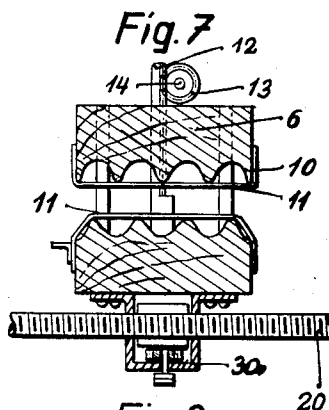
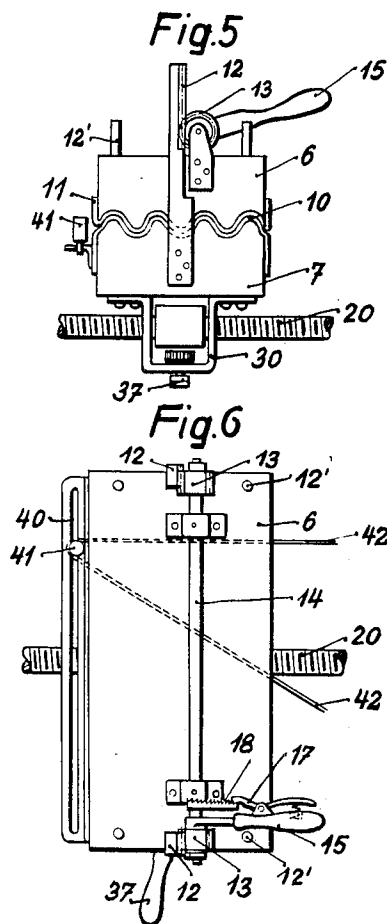
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MEANS FOR STRINGING TENNIS RACKETS WITH STRINGS

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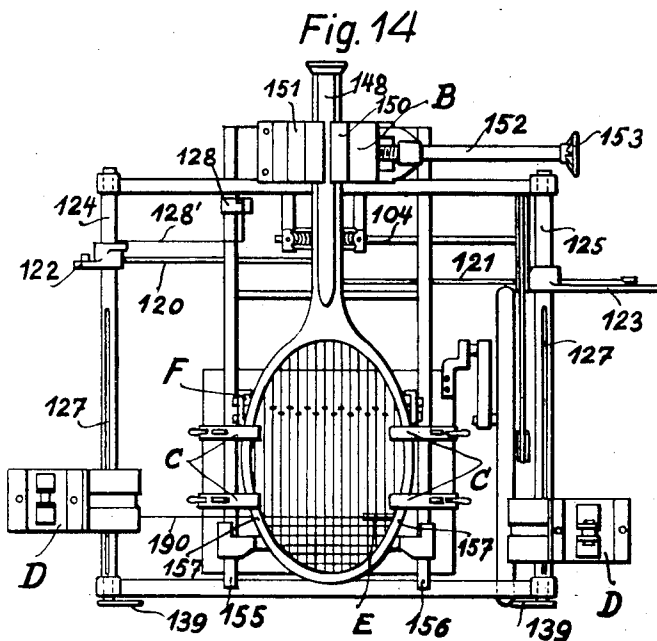
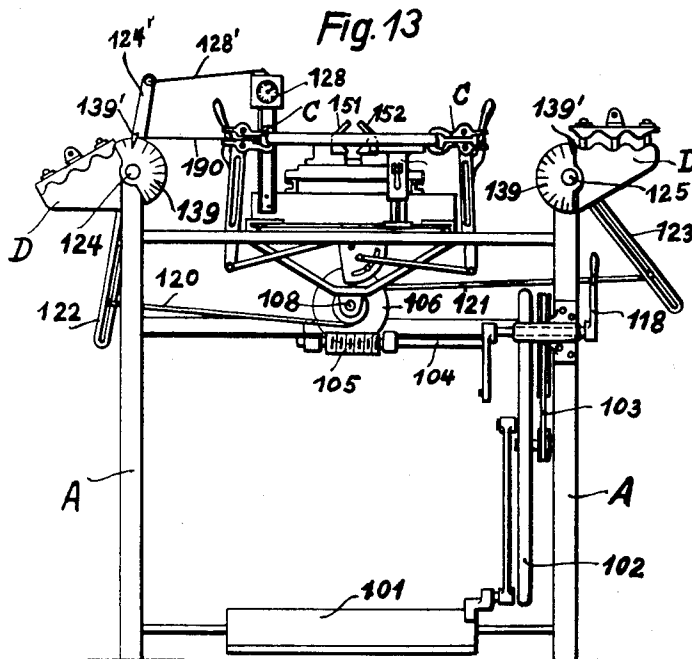
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MEANS FOR STRINGING TENNIS RACKETS WITH STRINGS

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11 Sheets-Sheet 4



Siegfried Tauber  
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Jan. 16, 1934.

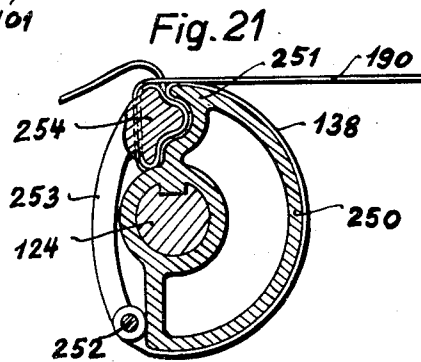
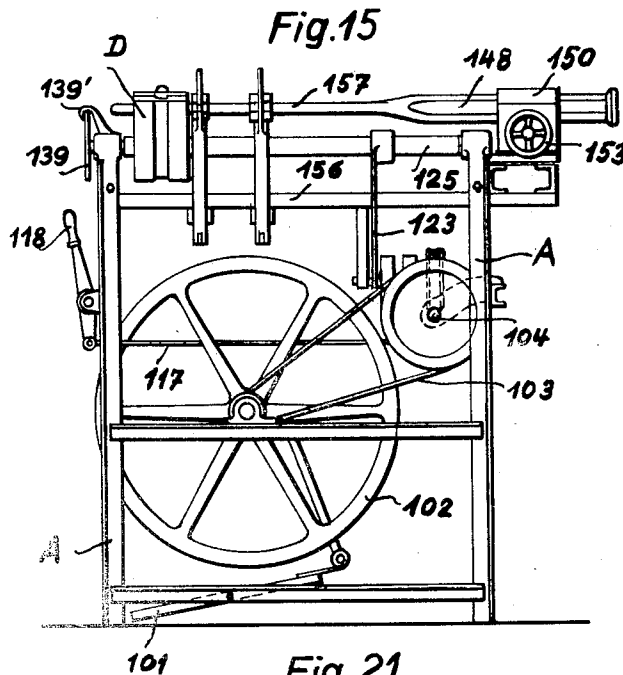
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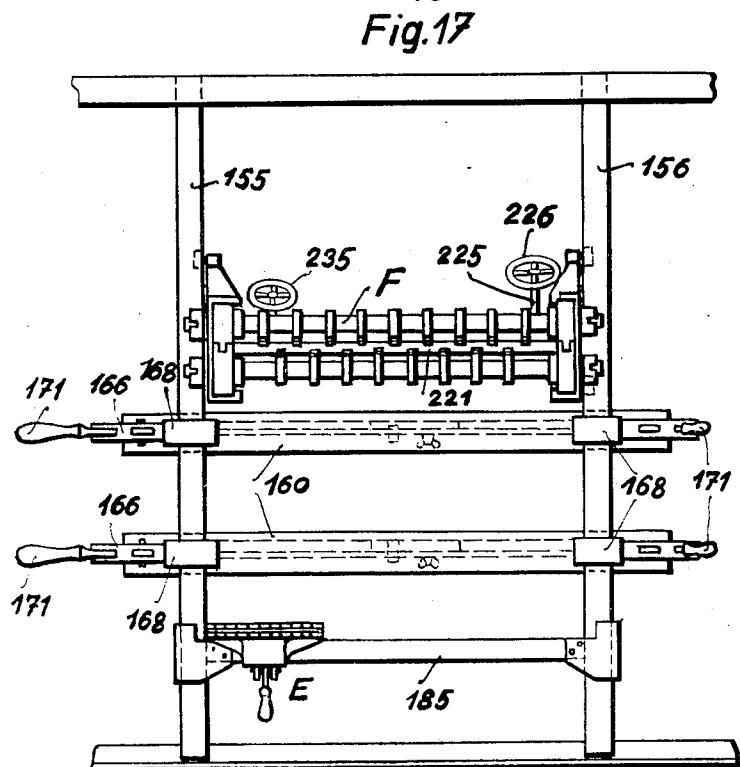
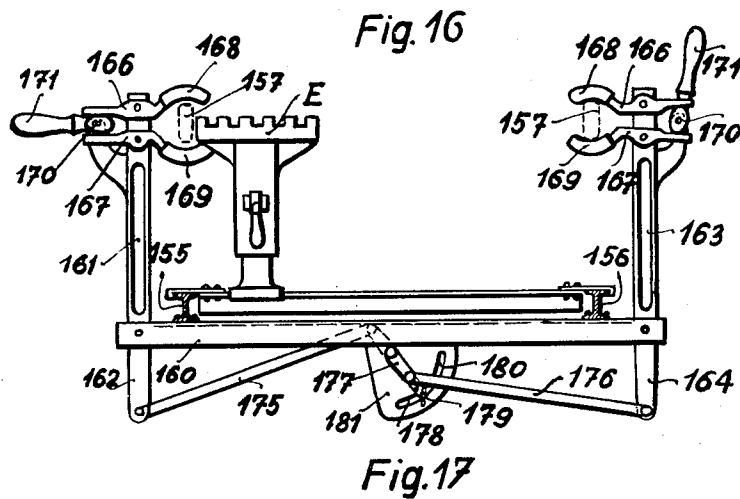
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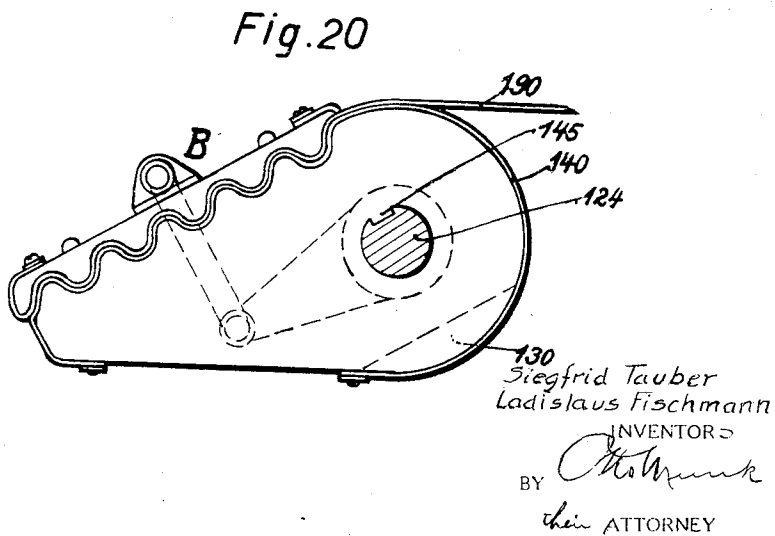
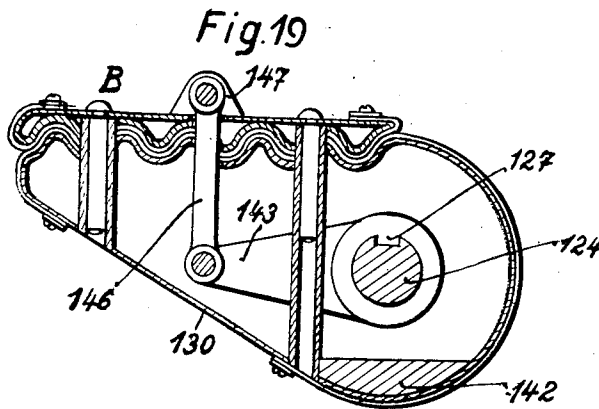
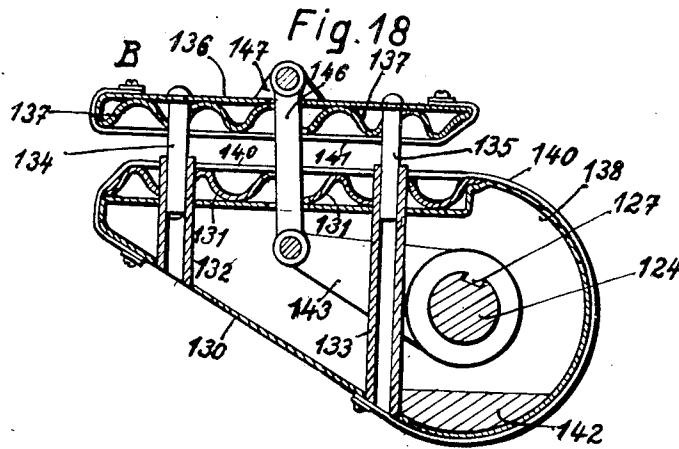
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MEANS FOR STRINGING TENNIS RACKETS WITH STRINGS

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MEANS FOR STRINGING TENNIS RACKETS WITH STRINGS

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Fig. 22

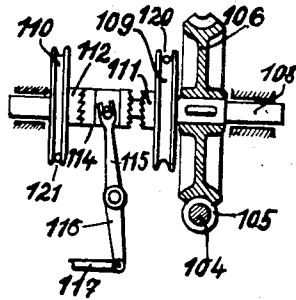


Fig. 23

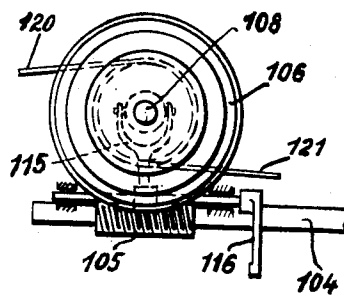


Fig. 24

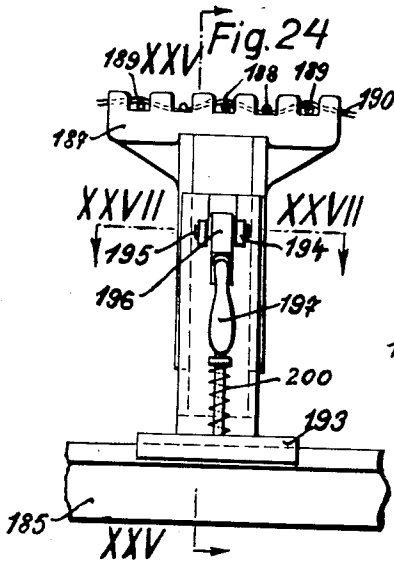


Fig. 25

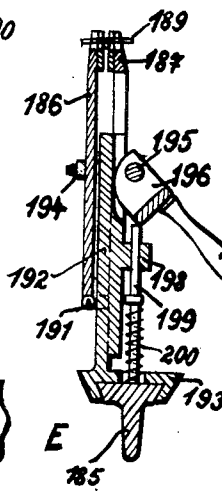


Fig. 26

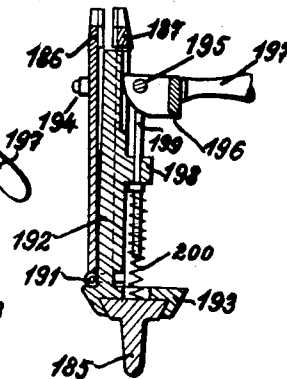
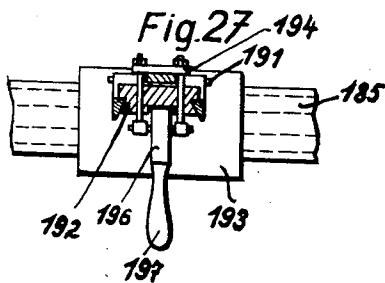


Fig. 27



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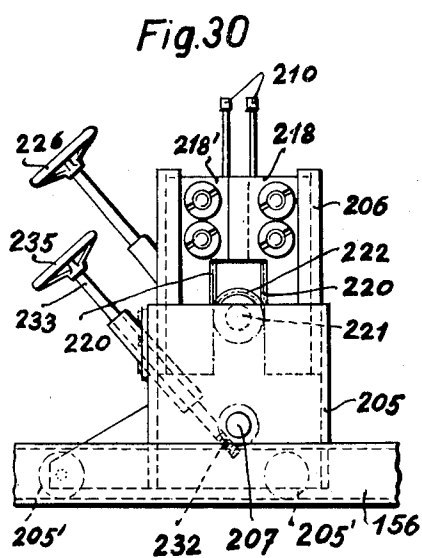
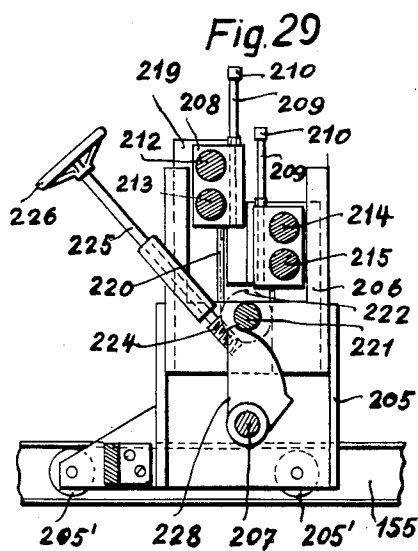
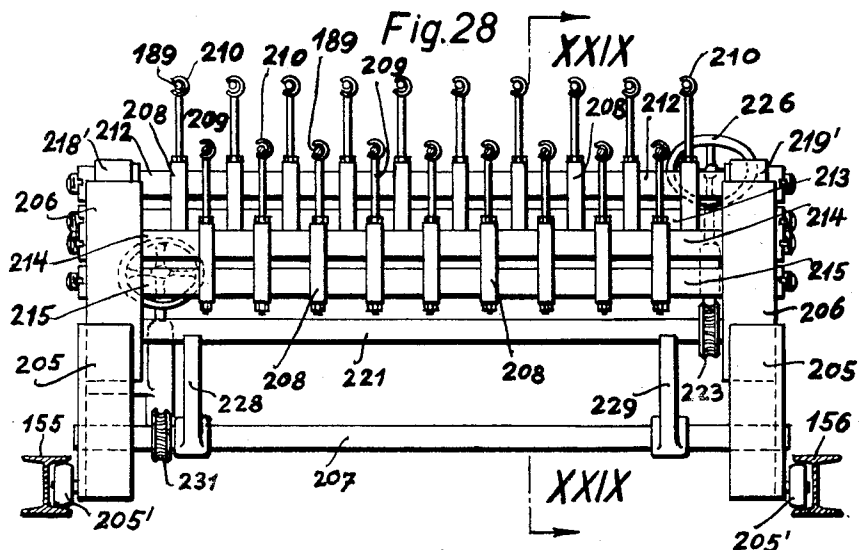
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MEANS FOR STRINGING TENNIS RACKETS WITH STRINGS

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11 Sheets-Sheet 9



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MEANS FOR STRINGING TENNIS RACKETS WITH STRINGS

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Fig.31

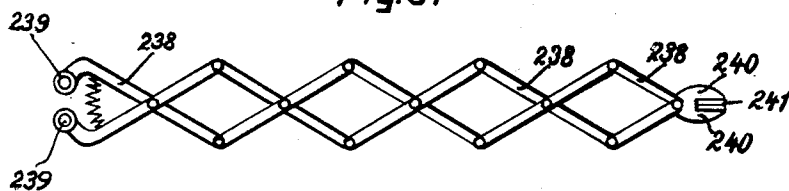


Fig.32

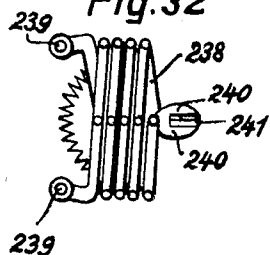


Fig.33.

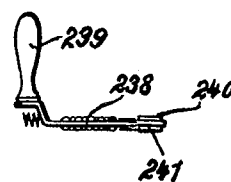
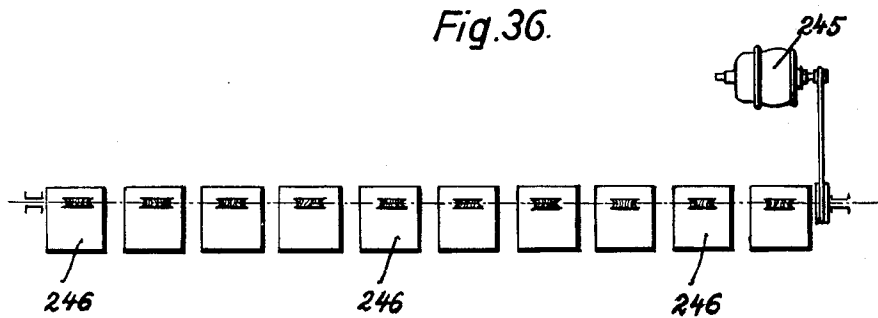


Fig.36.



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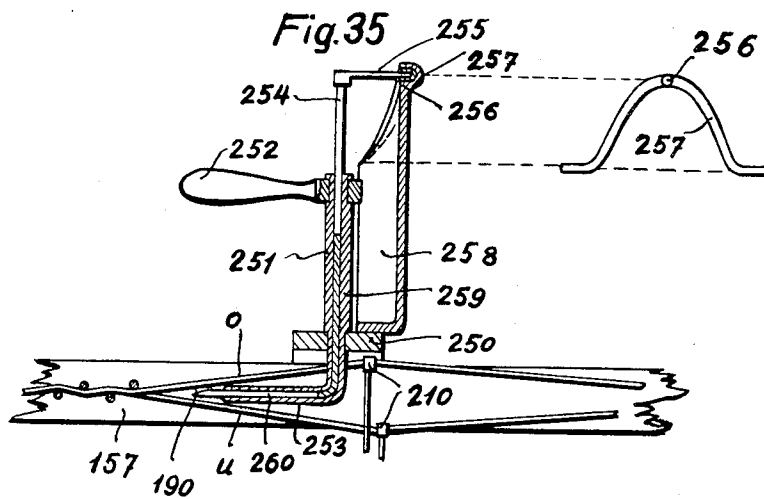
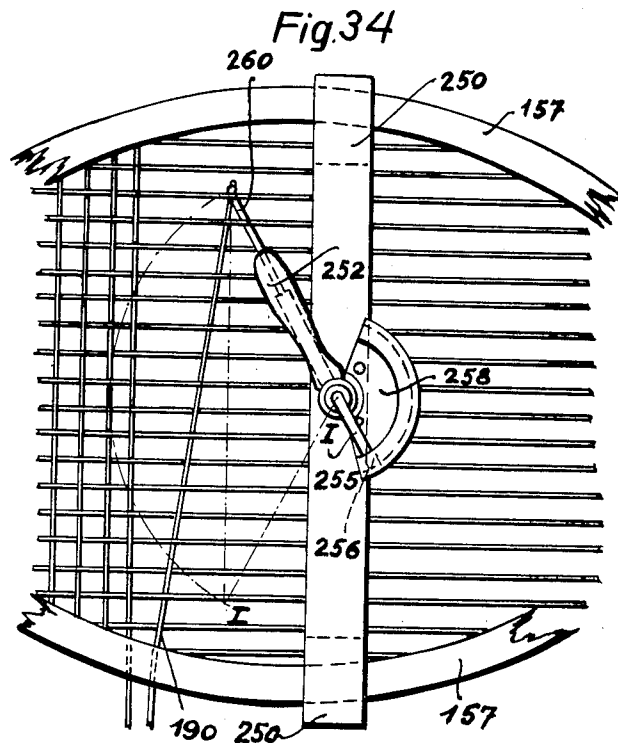
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MEANS FOR STRINGING TENNIS RACKETS WITH STRINGS

Filed March 19, 1929

11 Sheets-Sheet 11



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## UNITED STATES PATENT OFFICE

1,943,400

MEANS FOR STRINGING TENNIS RACKETS  
WITH STRINGS

Siegfrid Tauber and Ladislaus Fischmann,  
Vienna, Austria, assignors, by mesne assign-  
ments, to Dunlop Rubber Company Limited,  
London, England

Application March 19, 1929, Serial No. 348,328,  
and in Austria July 17, 1928

5 Claims. (Cl. 273—73)

The stringing of tennis rackets with strings has hitherto been carried out by hand or with primitive aids. As the tension of the strings is not an inconsiderable one, the carrying out of this work involves considerable expenditure of muscular effort on the part of the workman and consequently rapid fatigue is caused thereby. Notwithstanding all possible care and the expenditure of much time over the work uniform stringing cannot be achieved by the means hitherto known.

The problem to the solution of which the invention is directed is the provision of means which avoid the above mentioned disadvantages and whereby a more convenient, a more exact and a more rapid manipulation and control of the tension on the strings and therefore a more rational mode of working are obtained.

A constructional example of the means employed is shown in the Figs. 1 to 12 of the drawings, another constructional example is shown in the Figs. 13 to 35.

Fig. 1 shows the means in front elevation,

Fig. 2 in plan,

Fig. 3 in section on the line III—III of Fig. 1, and

Fig. 4 in end elevation.

Fig. 5 is a front elevation of the clamping apparatus on a larger scale.

Fig. 6 is a plan of Fig. 5, and

Fig. 7 shows the clamping apparatus open and in section.

In Fig. 8 is shown the apparatus for throwing the clamping apparatus into and out of operation.

Fig. 9 is a view from beneath Fig. 8.

Fig. 10 shows the combs for the formation of the reticulation in front elevation.

Fig. 11 is a section on the line XI—XI of Fig. 10, and Fig. 12 is a section on the line XII—XII of Fig. 10.

Fig. 13 shows the second constructional example in front elevation.

Fig. 14 the same apparatus in plan and

Fig. 15 the same in side elevation.

Fig. 16 shows to a larger scale the clamping device for the side portions of the frame.

Fig. 17 is a plan of Fig. 16.

Figs. 18, 19 and 20 show in three characteristic positions a constructional example of the clamping device for the stretching of the strings.

Fig. 21 shows another constructional example of the clamping device in section.

Fig. 22 shows the mechanism for working this clamping device in elevation.

Fig. 23 shows the same in side elevation.

Fig. 24 is a view of the string holder,

Fig. 25 is a section on the line XXV—XXV of Fig. 24 with the string clamped,

Fig. 26 is a similar section with the clamp open,

Fig. 27 is a section on the line XXVII—XXVII of Fig. 24,

Fig. 28 shows the means employed for the formation of the shed in front elevation,

Fig. 29 is a section thereof on the line XXIX—XXIX of Fig. 28 and

Fig. 30 shows the same in side elevation.

Figs. 31, 32 and 33 show an auxiliary tool for drawing the transverse strings through the shed formed by the longitudinal strings and of these figures

Figs. 31 and 32 show the tool in plan in two characteristic positions, and

Fig. 33 shows the tool in side elevation.

Figs. 34 and 35 show a further auxiliary tool.

Fig. 36 shows diagrammatically the combination of a number of arrangements according to this invention to form a group with a common driving mechanism.

The apparatus conform the Figs. 1—12 is mounted on a frame composed of angle iron which carries on top a rectangular frame 2. In the centre of the long sides of this frame is provided a clamping device for the head of the tennis racket 5 and a clamping device for the handle 4 thereof, which clamping devices completely fix the racket and prevent it from being distorted during the work. On both sides of these clamping devices is arranged an apparatus for gripping the strings. Each of these apparatus consists of two superposed clamping jaws 6 and 7 and 6<sup>1</sup> and 7<sup>1</sup> respectively, which are adapted to move endways longitudinally of the frame 2. The clamping jaws are provided on their operative faces with flutes 10, which are of corrugated form and engage in each other. The two jaws of a clamping apparatus may be brought together or moved apart by means of racks 12, which are connected to the lower clamping jaw 7 and cooperate with the pinions 13 attached to the upper clamping jaw 6, the upper jaw being guided on pins 12<sup>1</sup>. Both the pinions 13 are carried on the shaft 14 which can be rotated by means of the lever 15. To enable the two clamping jaws to be fixed in any position, there is connected to the lever 15 a spring ratchet tooth 17, which engages in a ratchet wheel 18 (Fig. 6). To increase the friction of the string on the clamping jaws and avoid damage to the string when clamping it, the two clamping jaws are covered with rubber sheets 11

which enter the flutes when the clamping jaws are brought together and so securely hold the string when it is being strung.

In the frame 2 on both sides of the clamped racket 5 are mounted revolving screw spindles 20 and 20<sup>1</sup> respectively which carry on their ends projecting from the frame 2 grooved pulleys 21 and 21<sup>1</sup> respectively. In the frame 1 is mounted a shaft 23 which has a crank 24 at its centre. By means of the treadle 25 and the connecting rod 26 the shaft can be caused to revolve. 27 is a flywheel, and 28, 28<sup>1</sup> are grooved pulleys, which are keyed on the shaft 23. The pulley 28 is connected by a crossed cord to the pulley 21 and the pulley 28<sup>1</sup> by an uncrossed cord to the pulley 21<sup>1</sup>, so that when the treadle 25 is worked the two screw spindles 20 and 20<sup>1</sup> will be driven in opposite directions.

The lower clamping jaw 7 (7<sup>1</sup>) has a projection or lug 30, in which a bi-partite nut 31, 32 for the screw spindle 20 is mounted. Each of the two parts 31, 32 is carried by a rack 33, 34, in which the gear wheel 35 gears. The spindle of the gear wheel 35 carries on its outwardly extended end a lever 37, by the rocking motion of which the gear wheel 35 is rotated and by means of the racks 33, 34 the two parts 31, 32 can be brought into or out of engagement with the spindle 20. On the outside of each clamping apparatus is mounted a vertical pin 41 movable in a slot 40 and around which the string 42 to be clamped is laid as will be hereinafter described.

As the transverse strings of the stringing of the racket must be passed alternately over and under the longitudinal strings, similar to the manner in which the weft threads of a fabric are passed between the warp threads, the friction when passing them through, if the longitudinal strings were to remain in one plane, would be too great and the transverse string to be inserted would in consequence be subjected to an undue amount of strain. In order to avoid this an apparatus is provided, which alternately raises and lowers the longitudinal strings 5, so as to form a shed as in a loom, through which the transverse string can be drawn without friction. This apparatus consists of two combs 43, 44 of which the one is arranged above and the other below the clamped racket. The two combs are mounted on a common frame 46, which is adapted to move endways longitudinally of the clamped racket 5 in the bars 45 provided on the frame 2. The various teeth 48 of each comb have a rectangular opening 49, by means of which they are pushed onto square bolts 50, 51 fluted on their upper and lower sides and these teeth can by means of a clamping screw 52, be clamped on the bolt at different distances from each other according to the distance apart of the longitudinal strings of the racket. The openings 49 are so arranged in the teeth 48, that each tooth projects more to one side of the bolt 50 than to the other. The end of each tooth which projects further than the other one is provided with a notch 53, which serves for the reception of one of the longitudinal strings 54 of the racket. Each of the two bolts 50, 51 carries on its end a rack 55. In these racks 55 engages on either side of the frame 46 a gear wheel 56, the spindle of which is journaled in the frame 46. The two gear wheels 56 (one such gear wheel is provided on each side of the frame 46) are so connected to each other by the levers 58, 58<sup>1</sup> and a connecting rod 59, that they can only be rotated conjointly. By rotating the gear wheels 56 the two bolts 50, 51 will

be brought towards or moved away from each other by means of the racks 55, whereby the shed is formed. The two bolts can be rotated by hand, and when so rotated the spring pins 60, 61 enter corresponding recesses in the bolts in positions of the latter located at 180° to each other, so that the bolts are securely held in these positions.

The manner in which the apparatus works is as follows:

After the racket which has already been provided with the longitudinal strings has been clamped by its head and handle in the clamping devices 3 and 4, the longitudinal strings are stretched and then fixed by means of the arrangement such as a swivel 4<sup>1</sup>, provided on either side of the clamping apparatus 4. The string intended for the transverse stringing is then first drawn through the holes lying next the head of the racket and one end of the string is knotted. The frame 46 after the teeth 48 have been previously adjusted to correspond to the distance apart of the longitudinal strings, is then pushed up to the head of the racket and the shed for drawing through the transverse strings thus formed. The transverse string 42 is drawn through the shed and through the hole in the racket and, as shown in Fig. 6, through and between the clamping jaws 6 and 7 to be then laid around the bolt 41 and passed back again between the clamping jaws. In this way the width of the clamping jaws is utilized twice and a secure hold on the string obtained. The two clamping jaws 6 and 7 are now pressed firmly together by rocking the lever 15 and locked by the entrance of the pawl 17 into the ratchet wheel 18. By rocking the lever 37 the nuts 31, 32 will be brought into contact with the screw spindle 20 and on working the treadle 25 the clamping device will move endways in such a manner that the string clamped in the clamping device will be stretched. When the necessary tension has been obtained, the transverse string which has been drawn in is fixed in the hole in the racket, the nuts 31, 32 disconnected from the spindle 20 by rocking the lever 37, the clamping apparatus released by the rocking of the lever 15 and the end of the string removed from the clamping apparatus. In the meantime the connecting rod 59 has been grasped and by means of it the two levers 58, 58<sup>1</sup> are so rocked that the crossing of the longitudinal strings necessary for the next formation of the shed is produced. The free end of the transverse string is now drawn through the next hole in the racket 5, through the shed which has been formed and through the opposite hole in the racket and clamped in the clamping apparatus 6<sup>1</sup>, 7<sup>1</sup> in the same way as described above. The nut of this clamping apparatus is now caused to engage with the screw spindle 20<sup>1</sup> and the stretching of the transverse string effected by working the treadle 25. This operation is repeated until the transverse string has been passed through all the holes in the frame of the racket, after which the end is fixed.

Instead of the clamping apparatus 6, 7 and 6<sup>1</sup>, 7<sup>1</sup> it is also possible to do with only one such clamping apparatus, if the clamping devices 3 and 4 be so constructed that the racket can be turned through an angle of 180° about its longitudinal axis each time a transverse string is to be drawn through.

The working of the apparatus by means of a treadle or a motor driving mechanism has the advantage that the hands of the workman are

always left free to properly guide the string, to control the tension and to fix the string already stretched and so on.

The apparatus conforming with the Figs. 13 to 35 consists essentially of the frame of the machine A, the clamping device B for the handle of the racket, the clamping device C for the side portions of the frame, the clamping devices D for the string to be drawn in, a string holder for holding the stretched string securely and a device F for forming the shed from the longitudinal strings.

In the frame A is provided a pedal drive 101 with a fly-wheel 102 by which the shaft 104 is driven by a belt drive 103. On the shaft 104 is mounted a worm 105, which gears with the worm wheel 106 which is keyed on the shaft 108 mounted in bearings in the frame. On the shaft 108 are mounted two rollers 109 and 110 (Fig. 22) which rotate freely thereon but are prevented from moving endways on the shaft. These two rollers 109 and 110 may be coupled selectively to the shaft 108 by means of the jaw clutches 111, 112. The throwing into and out of operation of the clutches is effected by the sliding sleeve 114, the levers 115, 116, the connecting rod 117, and by the lever 118. The distance of the two rollers 109 and 110 from each other is so selected that only one of the two rollers 109 or 110 can be coupled at a time to the shaft 108. 120 and 121 are two tension cords, one end of each of which is attached to the periphery of the rollers 109, 110 respectively, while the other ends of these two tension cords are connected to arms 122, 123, which operate the clamping devices D.

The arms 122, 123 are each provided with a longitudinal slot, in which the end of the corresponding tension cord can be securely clamped and the arms are rigidly connected to the shafts 124, 125 mounted in bearings in the frame. Each of these two shafts has a longitudinal groove formed in it along which the clamping devices D for clamping the string can slide. The devices D each consist as shown in Figs. 18, 19 and 20 of a hollow sheet-metal body 130, which is mounted to rotate freely on the shaft 124. The hollow body 130 forms one of the clamping jaws for the string and is provided with flutes 131 in its operative surface. On the hollow body 130 are mounted two guide sleeves 132, 133 in which the second clamping jaw 136 is guided by means of the bolts 134, 135. This clamping jaw also is provided with flutes 137 on its operative surface, these flutes engaging in the flutes 131 on the lower clamping jaw. The hollow body 130 is provided with a cylindrical supporting surface 138 for the string to be stretched, which surface is concentric with the shaft 124. The radius of the cylindrical surface is so selected that the upper horizontal tangent lies in the working plane, that is to say in that plane through which the string is to be drawn. The two clamping jaws and the supporting surface 138 are covered with rubber sheets 140, 141 which when the jaws are moved together, are pressed into the flutes whereby the string though held securely is protected against injury. On the interior of the hollow body 130 and on the shaft 124 is mounted a lever 143, the hub of which engages through a projection 145 in a groove 127 in the shaft 124, so that this lever 143 is rotatably coupled with the shaft 124. To the end of the lever 143 is pivoted a connecting rod 146, which extends with clearance through openings in the clamping jaws and is connected

pivotally through a bearing bracket 147 to the upper clamping jaw 136.

The hollow body 130 is provided at 142 with a counterweight which causes it, when there is no tension on the cord 120 (121) to automatically set itself in the position of rest shown in Fig. 18. Coupled to rotate with the shaft 124 (125) is a disc 139 bearing a scale, over which a pointer 139<sup>1</sup> fixed to the frame travels. This device serves to read off the angle of rotation of the shaft and consequently the elongation or stretching of the string. The arm 122 is prolonged outwards beyond the shaft 124 and this extension 124<sup>1</sup> is connected by a tension cord 128<sup>1</sup> to a tension measurer 128 of any well known type, on which the tension put upon the string can be read off in kilogrammes.

In the constructional example of clamp shown in Fig. 21, 250 is a hollow body keyed on the shaft 124 and adapted to be moved endways thereon. At 251 is formed a fluted rubber covered clamping jaw. To this hollow body 250 is pivoted an arm 253 adapted to rock on the pin 252 and this arm forms the second clamping jaw 254. The string 190 coming from the racket frame is wrapped first round the clamping jaw 254 on its outer side and then passed through between the clamping jaws 254 and 251. If now the shaft 124 be rocked the string 190 presses the clamping jaws together. It is thereby gripped and on further rotation of the shaft 124 the string is stretched. The hollow body 250 has a cylindrical outer surface 133 the diameter of which is so chosen that the string lying at a tangent to the cylindrical surface runs in the working plane.

The clamping device B for the handle 148 of the racket is attached to the frame A and has two central clamping jaws 150, 151 which by means of the spindle 152 and the hand wheel 153 can be brought towards each other or drawn away from each other after the manner of the jaws of a vise. The jaws 150, 151 are shaped on their insides angularly to correspond to the ordinary octagonal handle of a racket, so that it is impossible for the handle to rotate. On the frame are also mounted two bars 155, 156 which carry the clamping devices C for the side portions 157 of the frame. For this purpose there is rivetted to the undersides of the bars 155, 156 a cross bar 160, to each of the ends of which two-armed levers 161, 162 and 163, 164 are respectively pivotally attached. On the end of the lever arm 161 (163) are pivotally mounted two tong-like levers 166, 167. The ends of these levers are formed into clamping jaws 163, 169 and covered with rubber for the protection of the frame of the racket. Between the other ends of the levers 166, 167 is arranged an eccentric 170 which can be rotated by means of the lever 171. To each of the lever arms 162, 164 is pivoted a connecting rod 175, 176 and these rods are pivotally connected to a two-armed lever 177 mounted to rock beneath the bar 160. This ensures that the two levers 161, 162 and 163, 164 can only move in unison and each to the same extent. The lever 177 has at one end an extension 178, which carries a screw-threaded bolt 179. This bolt is guided in a slot 180 in a plate 181 mounted beneath the bar 160 and can be secured in any position in said slot by means of a wing nut. As shown in Figs. 14, 15 and 17, there are provided on each side of the apparatus two such clamping devices for the side portions of the frame, and the clamping jaws engage on both sides of the weakest portions of the frame. The clamping

jaws 166—169 and the clamping jaws 150, 151 lie in a common horizontal plane which is the working plane.

The string holder is guided on a cross bar 185 and this latter is adapted to slide on the two longitudinal rails or bars 155, 156, so that the holder is movable in two directions at right angles to each other. The string holder has two clamping jaws 186, 187, which have at their upper ends recesses, the distance apart of which corresponds to the distance apart of the longitudinal strings. The two clamping jaws are connected to each other by a link 191 and are adapted to slide vertically on a guide member 192 which is shaped at the bottom to form a dovetail guide groove 193. On the guide member 192 is mounted a yoke or stirrup 194 in which a bolt 195 is carried. In this bolt is keyed a rotating eccentric 196 which is operable through the handle 197. In a projection 198 on the guide member 192 slides a bolt 199 surrounded by a compression spring 200. This coiled spring bears on the one hand against the bar 185 and on the other hand against a collar on the bolt 199, and forces this bolt into the position shown in Fig. 25 so that the end of the bolt always bears against the eccentric 196. When the eccentric 196 is rocked by means of the handle 197, the jaws 186, 187 will be pressed against each other, but at the same time the bolt 199 will be forced downwards, so that under the action of the spring 200 now compressed, the dovetail guide groove 193 will be pressed against the bar 185.

The device F for forming the shed from the longitudinal strings is adapted to slide along the bars 155, 156 on rollers 205<sup>1</sup>. These rollers 205<sup>1</sup> are mounted on frames 205, which carry a rock shaft 207. The elements which serve to form the shed consist of the prismatic metal members 208, in which bolts 209 are inserted. Each of these bolts carries at its upper end a hook 210, which hooks over a longitudinal string 189. These elements are provided in such a number as corresponds to the number of longitudinal strings in the racket. The prismatic metal members 208 have two borings by means of which they are mounted on guide rods 212, 213 and 214, 215 respectively. Two groups of such elements are provided, one group of which is mounted on the rods 212, 213 while the other group is mounted on the rods 214, 215, the arrangement being such that the elements of the one group are caused to lie between the elements of the other group. The guide bars 212, 213 and 214, 215 are clamped respectively in two carrier devices 218, 218<sup>1</sup> and 219, 219<sup>1</sup> arranged at their ends which devices are arranged to slide vertically in guides 206. The guides 206 are adapted in their turn to slide in the frames 205 vertically. The carrier devices 218, 218<sup>1</sup> and 219, 219<sup>1</sup> respectively are provided with racks 220, which engage with gear wheels 222 mounted on a shaft 221. This shaft 221 carries also a worm wheel 223, into which the worm 224 gears. The shaft 225 of the worm 224 is mounted in a guide 206 and carries at its upper end a hand wheel 226. By turning this hand wheel 226 the shaft 221 will be rotated and consequently through the medium of the gear wheels 222 and the racks 220 the hooks 210 of one group will be raised and those of the other group depressed. The shaft 221 rests with its ends on two eccentrics 228, 229 which are keyed on the shaft 207. The eccentrics 228 and 229 are shaped so that when the shaft 207 is rocked the shaft 221 can be raised or lowered, whereby the hooks

210 can be conjointly raised into the working plane or lowered below it. To rock the shaft 207 a worm wheel 231 is keyed on this shaft and gears with the worm 232. The shaft 233 of this worm is mounted in the frame 205 and carries a hand wheel 235.

In order to facilitate the drawing of the transverse strings into the shed formed by the longitudinal strings an auxiliary tool such as is shown in Figs. 31, 32 and 33 may with advantage be employed. This tool consists of a series of levers 238 which are pivotally connected to each other after the manner of a lazytongs. To one end of the tool are attached two handles 239, which serve to operate the device. At the other end are provided two clamping jaws 240 which are covered with rubber plates between which the end of the string to be drawn in can be clamped.

The drawing of the transverse strings may also be facilitated by an auxiliary tool as shown in Figs. 34 and 35. In these figures 190 is the transverse string to be drawn in and 157 is the frame of the racket. 250 is a cross bar extending across the width of the racket and which is supported on the wooden frame 157 of the racket. In the middle of this cross bar and rotatable thereon is mounted a sleeve 251. This sleeve can be rotated about its longitudinal axis by means of a handlever 252. In a continuation of the sleeve 251 a rotating knee piece 253 is mounted rigid with the sleeve 251 and rotatable in the cross piece 250. The two members 251 and 253 can also be made in one piece. In the upper part of the sleeve 251 there is arranged a small rod-like member 254 which is held against rotation and carries at its upper end an arm 255 the end 256 of which engages in a cam groove 257. This cam groove is arranged in a part 258 attached to the cross piece 250. Below the small bar 254 is mounted a flexible bar-like member 259 which slides in the interior of the sleeves 251, 253. In the horizontal bent end of the lower member 253 is guided a sliding rod-like member 260 the end of which holds the string 190. As already described, the formation of a shed takes place here, the upper group *o* of longitudinal strings being raised by means of certain of small hooks 210 and the lower group *u* being lowered by means of the remainder of the small hooks 210. The rows of small hooks 210 are moved into the immediate vicinity of the lower part of the auxiliary tool supported on the cross bar 250. The mode of operation of this apparatus is as follows:

Before drawing in the first transverse string the shed *o, u* is formed in the manner already described. The drawing apparatus with its cross bar 250 is then placed directly on the frame of the racket in such a way that the lower knee-shaped bent part of the apparatus passes between the two central longitudinal strings. The apparatus can also be clamped to the frame of the racket or to the guide bar of the fixer by suitable means. The distance apart of the small hooks 210 of the present apparatus must be as small as possible so that the shed can be fully utilized. The lever 252 is now rocked into the position I—I from which it is moved for the introduction of the transverse string into the shed. The transverse string 190 to be drawn in is clamped in a suitable manner to the end of the small bar 260. The lever 252 is now rocked into its second position. During this movement the end of the small bar 260 and therefore also the end of the spring 190 do not describe an arc of a circle but they are moved approxi-

mately transversely to the longitudinal strings in the shed. The string 190 is then removed from the clamp on the end of the small bar 260, and threaded through the hole in the frame 157 of the racket. The lever 252 is then set parallel with the longitudinal axis of the racket so that the shed can be changed, after which preparation is made for the introduction of the next transverse string.

10 The operation is as follows:

The frame of the racket is laid in the clamping device and by working the hand wheel 153 the handle of the racket is clamped by the jaws 150, 151 and by working the handle 171 the side portions of the frame of the racket will be firmly clamped by the clamping jaws 168, 169. The racket is now so clamped in the apparatus that the plane of the longitudinal strings coincides with the working plane, that is to say with that plane in which the transverse strings are to be stretched. The drawing in and stretching of the transverse strings now proceeds in such a way that the two clamping devices D are moved along the shafts 127 to those points where the transverse string is to be stretched. The hand wheel 235 of the device for forming the shed from the longitudinal strings is so rotated that the shaft 221 is brought into its lowered position. (Rotated through 90° compared with the position shown in Fig. 29). The frames 205 are then moved along the rollers 205<sup>1</sup> into a position corresponding to that in which the transverse string is to be stretched. By turning the hand wheel 226 the shaft 221 and with it all the hooks 210 are raised conjointly so that the longitudinal strings 189 can be hooked into the hooks. By working the hand wheel 226 the one group of hooks 210 will be pushed up above the working plane and the other group will be lowered and consequently the crossing of the longitudinal strings required to form the shed will be effected. The other end of the transverse string 190 is clamped by pressing it in between the two rubber plates 241 on the clamping jaws 240 of the auxiliary tool, which is introduced into the shed formed by the longitudinal strings in the position shown in Fig. 32. By working the two handles 239 the transverse string will be drawn through the shed and between the two rubber plates 140, 141 of the device D. If now the pedal drive 101 be operated and the lever 115, 116 for example rocked to couple the roller 109 to the shaft 103, this roller when it rotates will pull on the cord 120 and the shaft 124 and the lever 143 will be rocked by the lever 122. Through the medium of the connecting rod 146 the top clamping jaw 136 will first be pressed against the lower one and the string 190 held between the flutes 131 and 137 will be seized and rigidly held. On the further movement of the arms 142, the hollow body 139 will now be carried with it and so rotated that the string 190 will be stretched, applying itself to the cylindrical surface 140. In consequence of the bearing of the string on the cylindrical surface 140 the pull on the string 190 will always be exerted in the working plane. The extent of the elongation of or the tension on the string 190 can be read off from the scale 139. The pull put on the string in kilogrammes can be read off on the tensiometer 128. When the desired tension has been obtained the driving mechanism is stopped but the strained string must now be held fast before the clamping device is released. This is achieved by the help of the fixer E.

75 The fixer is brought under the string which

has just been strained by sliding it along the bars 155, 156 and then pushed along the bar 185 to a position inside the frame of the racket and on that side on which lies the tensioning device which has been used. The clamping jaws 186, 187 are pushed upwards such a distance that the string is caused to lie between the clamping surface and then by depressing the handle 197 the excentric 196 is rocked. In this way the fixer is clamped fast to the bar 185 and the string 190 is also gripped between jaws 186, 187. The roller 109 is disconnected by working the connecting rod 117 and the lever 115, 116, the pull on the cord 120 ceases and the hollow body 130 returns to the position shown in Fig. 18 under the influence of counterweight 142.

Only on the cessation of the pull on the cord 120 is the string released and not till then does the hollow body return to its position of rest. The end of the string 190 can now be removed from the clamping device and again drawn through a newly formed shed in the opposite direction and so on.

By the connection of the clamping devices 168, 169 through the connecting rods 175, 176 and the lever 177 any possibility of unsymmetrical distortion of the frame is obviated. In order to prevent any bending of the side portions of the frame when tightening up the longitudinal strings, the locking device 179 is provided in the slot 180 in the plate 181. Instead of the pedal drive it is obvious that a motor driven mechanism may be provided worked by an electric motor for example. The motor driving mechanism may be a single drive and a number of such machines may be driven by a common motor (group driving) as shown in Fig. 36, and the arrangement may conveniently be such that all the machines 246 connected to the one motor 245 work in the same time or beat. In this way all the workmen are constrained to work at the same rate.

We claim:

1. In an apparatus for stringing tennis racket frames, the combination of clamping means for gripping the racket frame, clamping means for gripping the strings, actuating means associated with said second clamping means to move the same and tension the strings clamped thereby, and shed forming means to open a passage-way to receive a transverse string therethrough.

2. An apparatus for use in assembling and tensioning the strings forming the flexible striking face of a tennis racket, as claimed in claim 1, in which said passage forming means comprises a plurality of elements to engage the longitudinal strings in the frame and spread them in alternate directions to form a shed, and means for adjusting said elements to correspond to the distance of the said longitudinal strings from one another.

3. An apparatus as claimed in claim 1, in which the frame contains longitudinal strings, and the means for forming the passage between them comprises a pair of combs, the teeth of which engage the alternate longitudinal strings in opposite directions, bolts upon which the combs are supported, adjusting mechanism to shift and lock the bolts to effect a crossing of the longitudinal strings and form a shed through which the string being threaded may be drawn.

4. In an apparatus for stringing tennis racket frames, a support, clamping elements for gripping the racket frame carried by the support, a pair of movable string tensioning devices disposed to lie on either side of the racket frame, actuating means attached to said support to move the said tensioning devices transversely with re-



spect to the longitudinal axis of the frame, each  
 tensioning device comprising a pair of blocks, one  
 surface of each thereof being corrugated so as to  
 fit into that of the other to grip the string, each  
 5 string tensioning device further comprising a two  
 part nut and each actuating means further com-  
 prising a worm cooperating with said nut, a wheel  
 connected to each worm, a common crank rod  
 10 carried by the said support, a pair of wheels at-  
 tached to said rod, each of said second wheels  
 being operatively connected with each of said first  
 mentioned wheels, a lever associated with each  
 two part nut for opening and closing the same to  
 15 engage and disengage the said worms, and a lock-  
 ing mechanism associated with each tensioning  
 device.

5. In an apparatus for stringing tennis racket

frames, a support, clamping elements for grip-  
 ping the racket frame carried by the support, a  
 pair of movable string tensioning devices dis-  
 posed to lie on either side of the racket frame,  
 80 actuating means attached to said support to move  
 the said tensioning devices transversely with re-  
 spect to the longitudinal axis of the frame,  
 each tensioning device comprising a pair of blocks,  
 one surface of each thereof being corrugated so  
 85 as to fit into that of the other to grip the string,  
 a rubber blanket stretched over the said corru-  
 gated surfaces to bridge the grooves thereof and  
 contact with the corrugations upon engagement  
 of the blocks, and a locking mechanism asso-  
 90 ciated with each tensioning device.

SIEGFRID TAUBER.  
 LADISLAUS FISCHMANN.

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