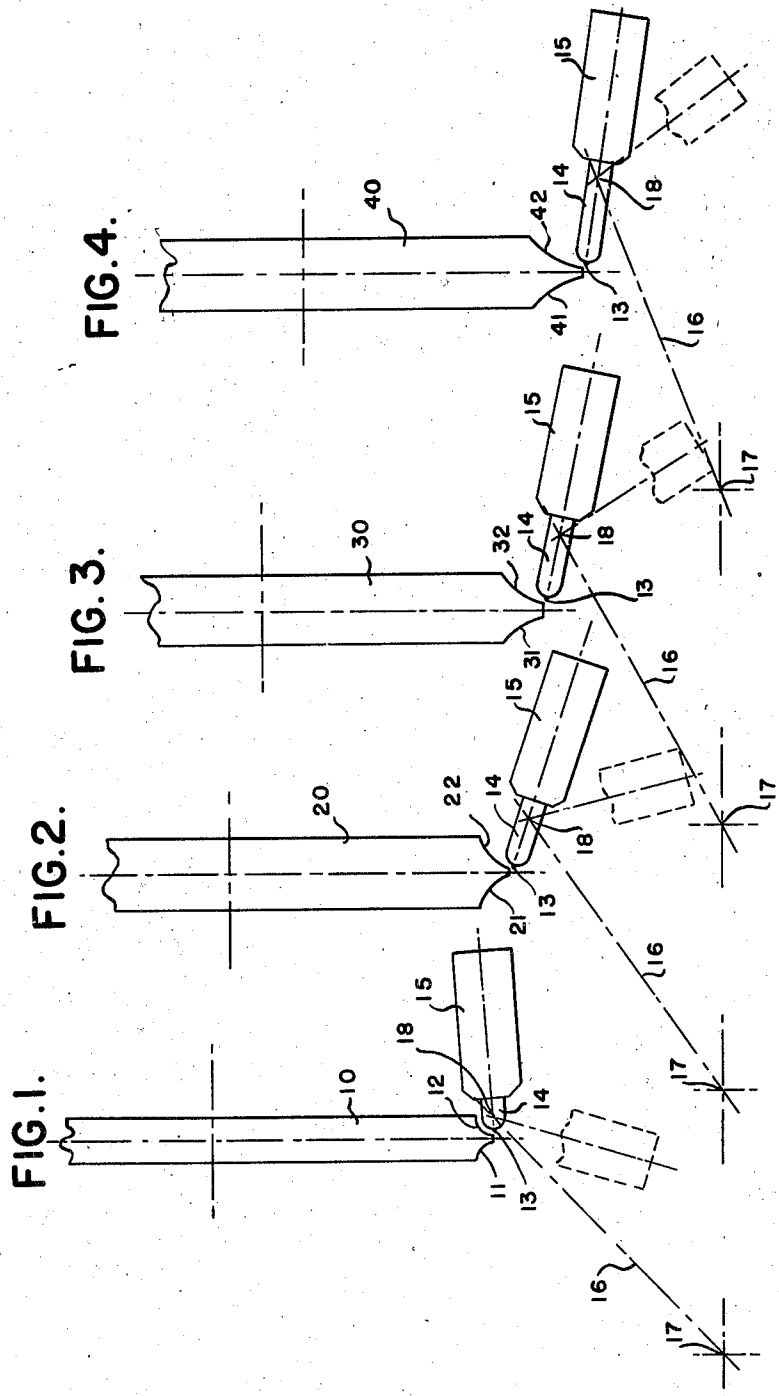
Feb. 24, 1942. F. PERNACK ET AL 2,274,561

TRIMMER

Filed Feb. 10, 1941 8 Sheets-Sheet 1



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TRIMMER

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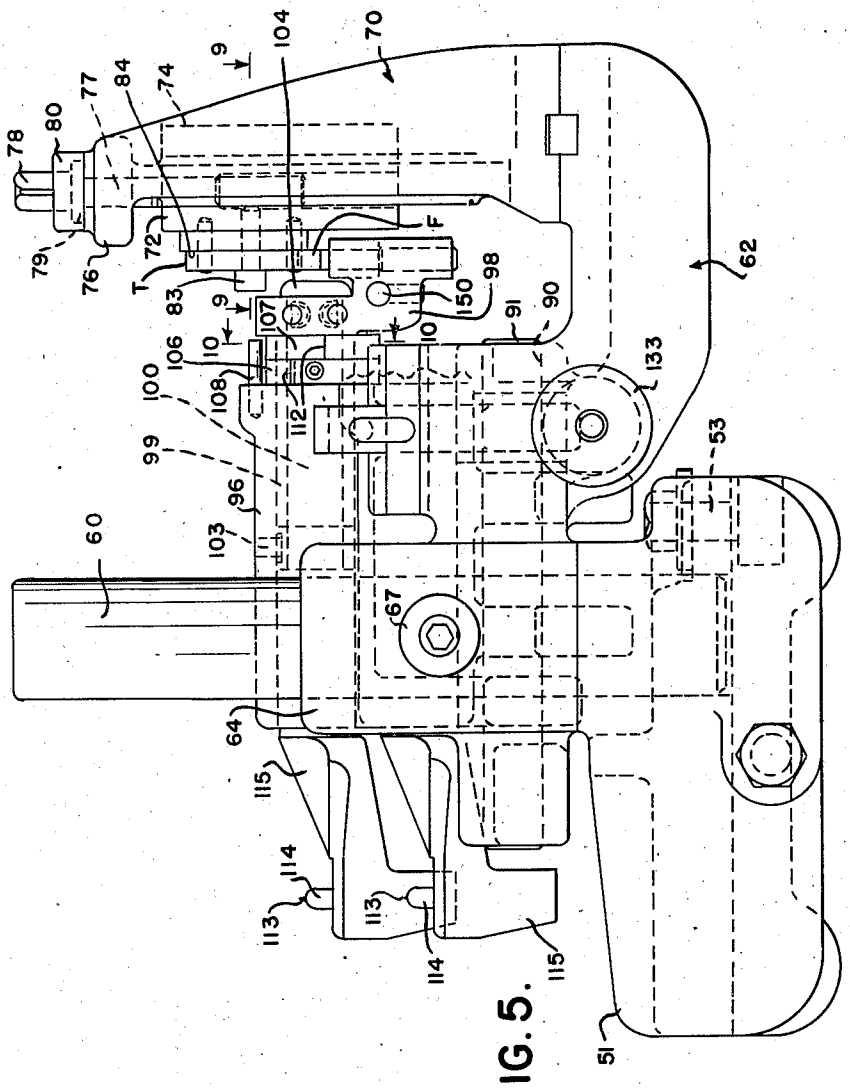


FIG. 5.

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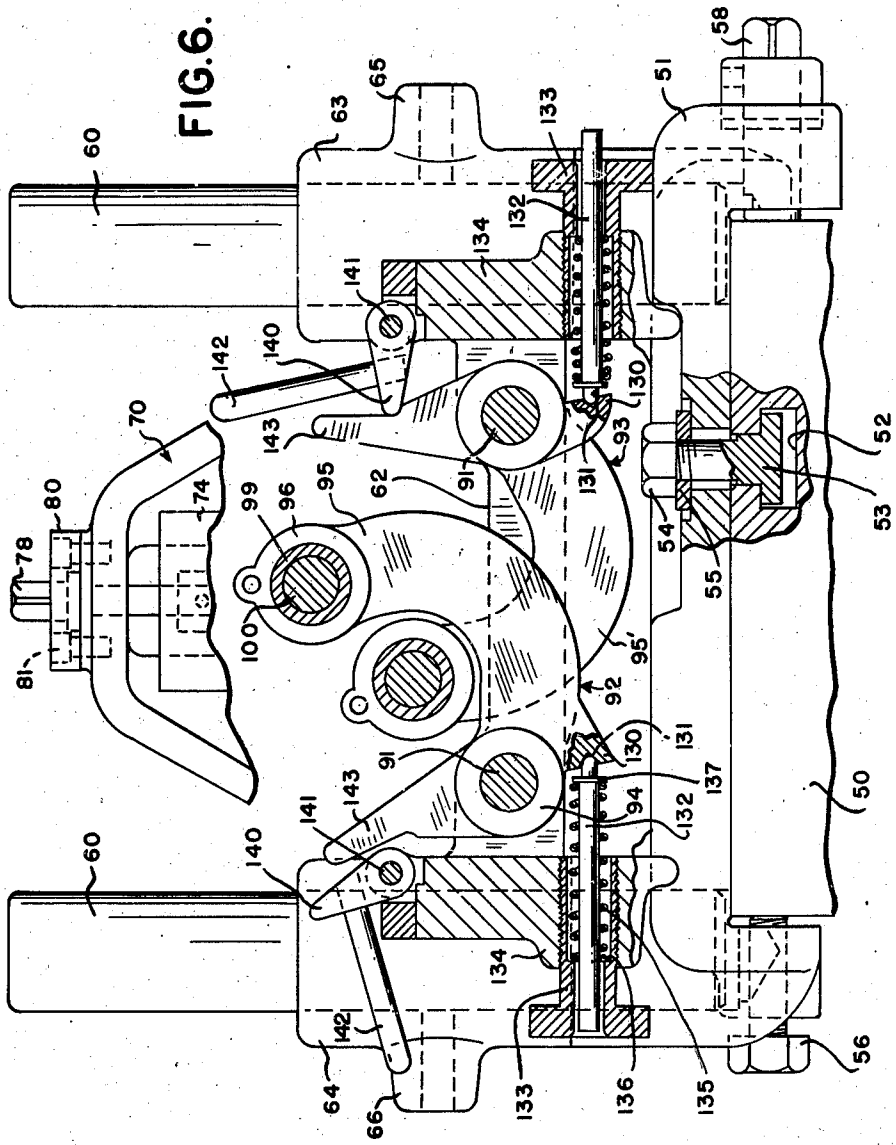
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FIG. 6.



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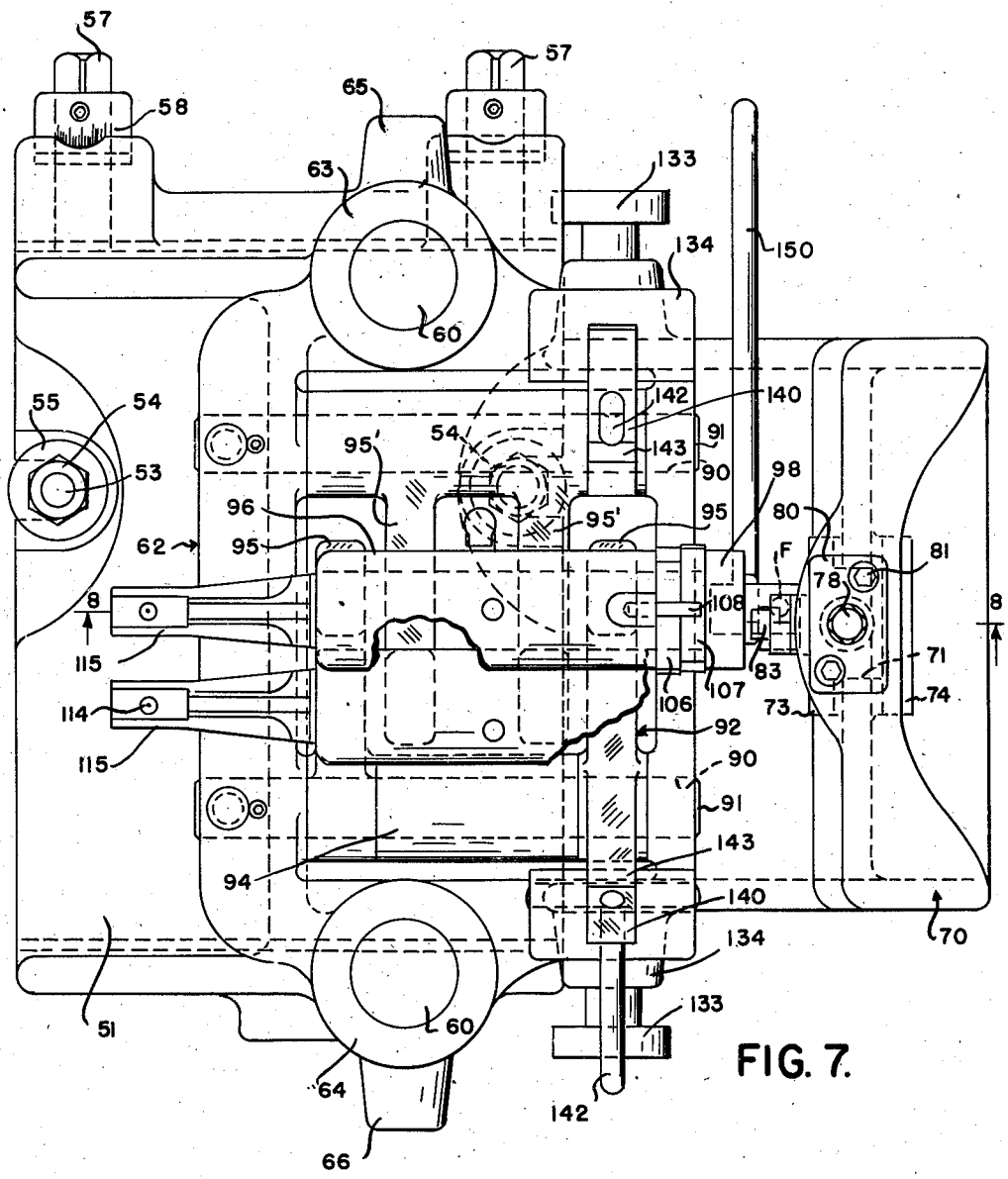


FIG. 7.

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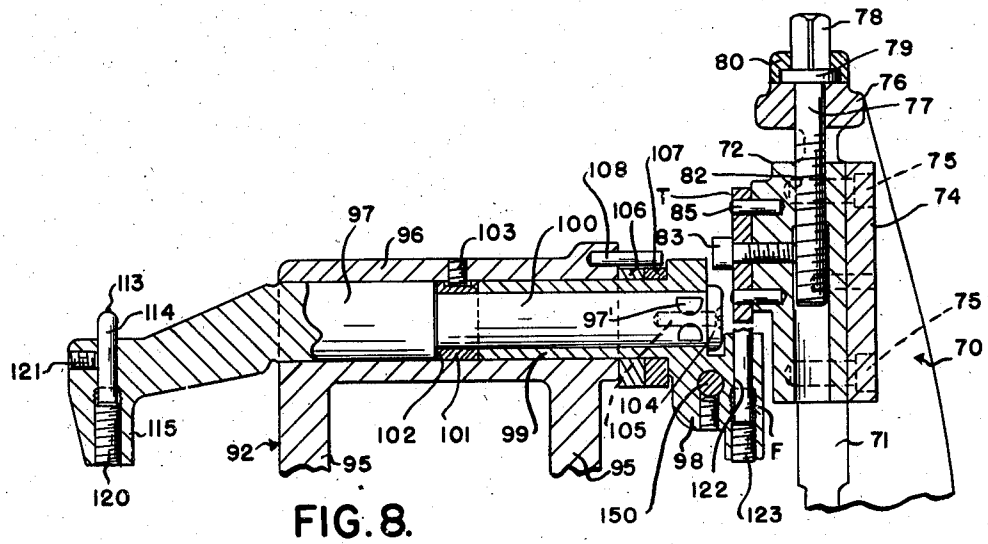


FIG. 8.

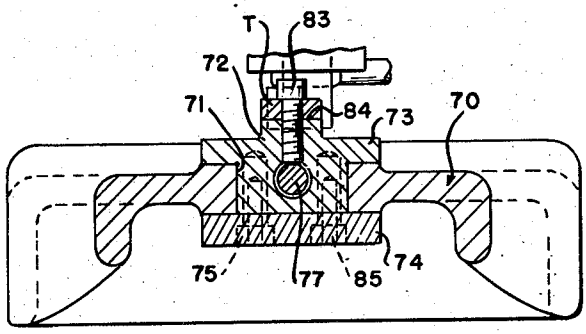


FIG. 9.

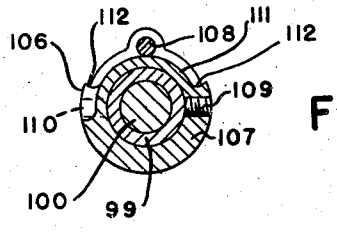


FIG. 10.

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FIG. 14.

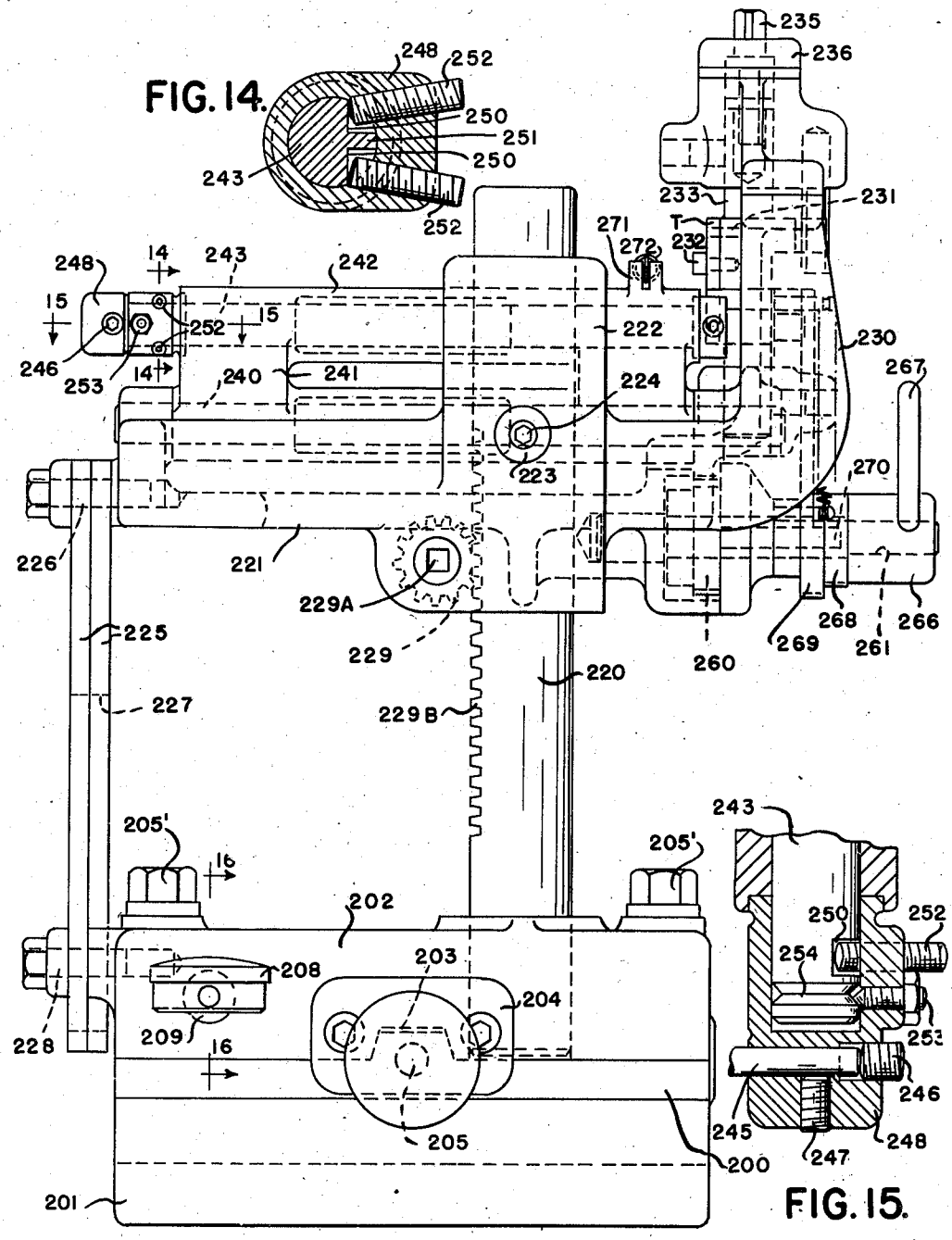


FIG. 11.

FIG. 15.

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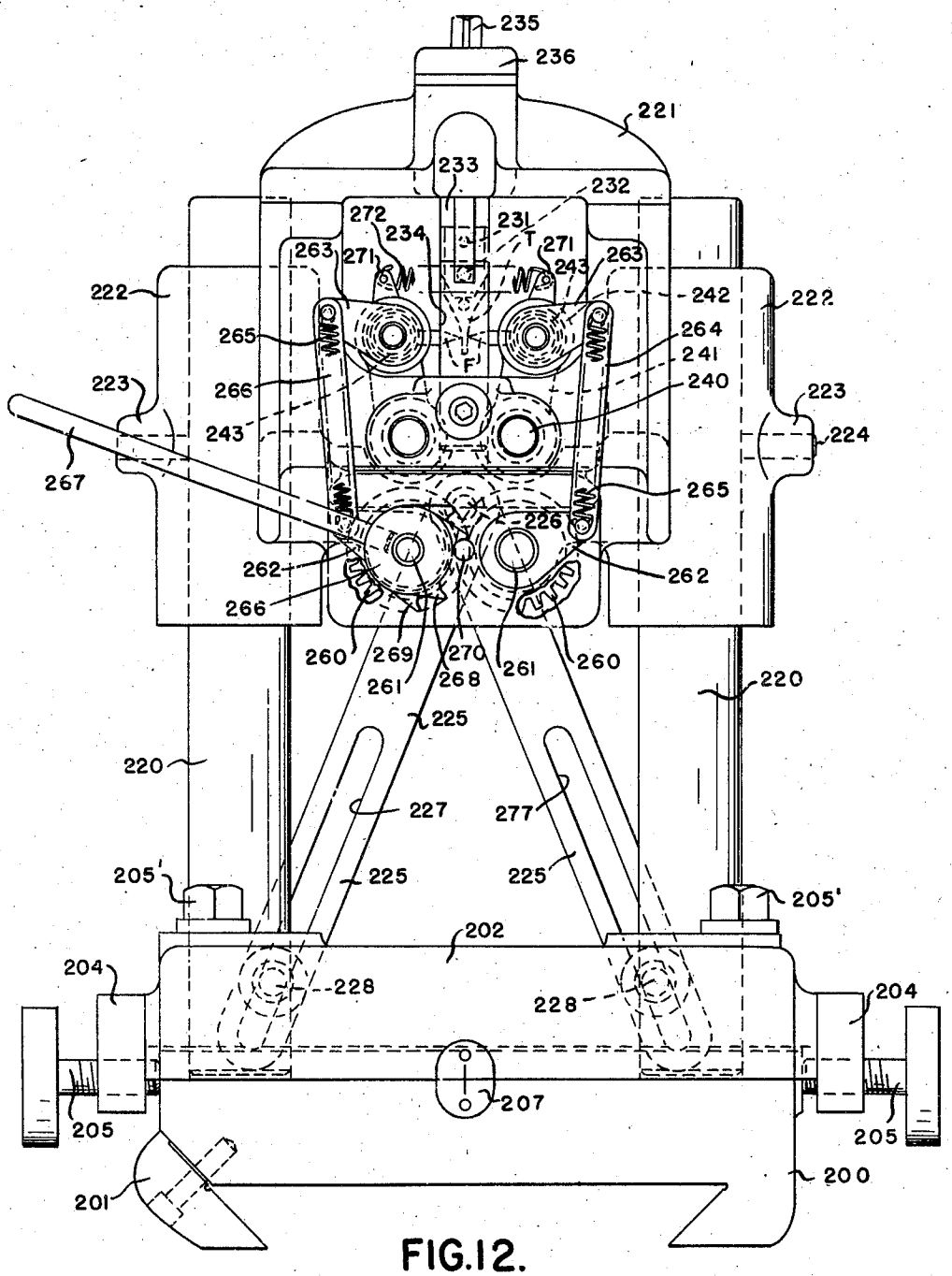


FIG.12.

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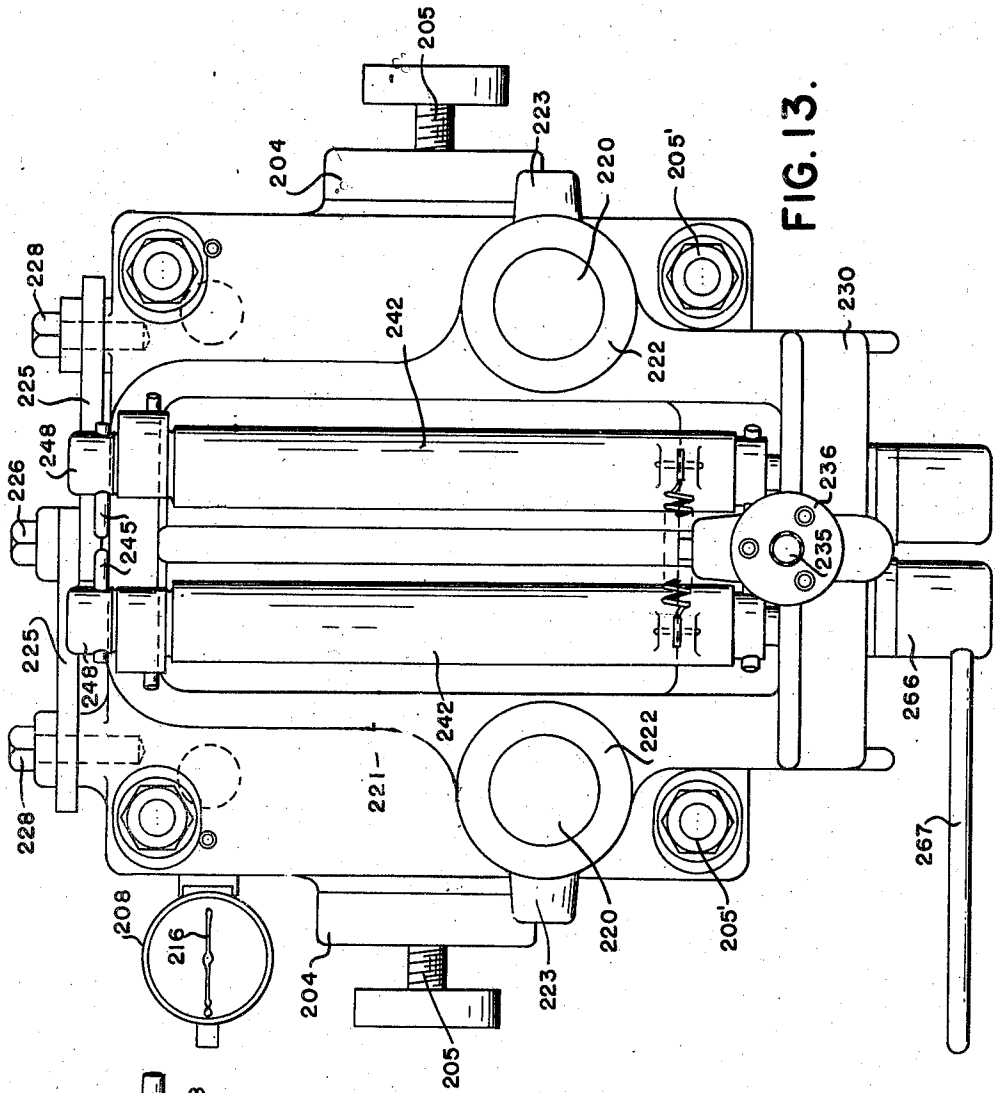


FIG. 13.

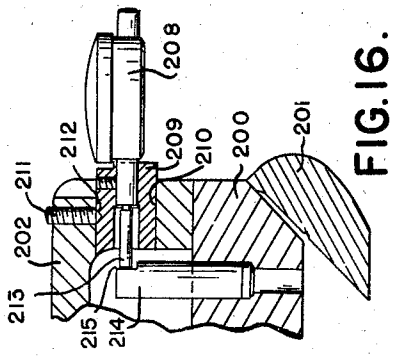


FIG. 16.

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Patented Feb. 24, 1942 2,274,561

UNITED STATES PATENT OFFICE

2,274,561

TRIMMER

Frank Pernack and William A. Schulte, Detroit, Mich., assignors to National Broach & Machine Company, Detroit, Mich., a corporation of Michigan

Application February 10, 1941, Serial No. 378,311

12 Claims. (Cl. 125—11)

The present invention relates to a trimming mechanism and more particularly to means for trimming grinding wheels used in grinding gears, broaches and the like, particularly having involute teeth.

The trimming mechanism is of the type which employs a template accurately formed in accordance with the profile which is to be ground on the teeth of the gear, broach or the like. Trimming mechanism for use with the type of grinding machine in which the grinding wheel has the desired profile of the teeth accurately formed thereon, which is reproduced on the teeth of the gear, broach or the like by passing the grinding wheel axially of the gear, broach or the like. In other words, the grinding machine is of the type in which a complementary profile is formed on the grinding wheel, rather than of the type in which the profile of the teeth on the work piece is generated.

Trimming mechanisms for trimming the desired curvature or shape onto a grinding wheel from a template form have long been employed. One of the serious difficulties of this type of trimming mechanism in the past has been that no provision has been made for adjusting the trimming mechanism in accordance with the curvature of the shape being ground on the wheel so that the arm which carries the trimming point may at all times be substantially perpendicular to the surface being trimmed at the point of engagement.

For the most part, work pieces which have given most trouble in the past have been those having an involute form that have a great degree of angular difference between extreme perpendiculars.

Past principles of construction made it very important that the point of follower contacting the very accurate surface of the template be exactly the same shape as that of the diamond trimmer point in order to duplicate within the required manufacturing tolerances. It may be readily seen that a slight amount of wear on the diamond point in this case produces error in the work piece and necessitates early replacement of diamonds.

In so arranging and shaping the principle parts herein described, in our invention, namely the form covered in Figures 5 to 10, it is possible to maintain a point or axis so located as to permit the diamond point to rotate freely about this point (or axis) and yet have provision for moving or "floating" this said point (or axis) sufficiently to compensate for difference between the involute shape and its nearest true radius likeness. This system allows the diamonds to be used until they no longer present a suitable cutting edge without causing interference in duplicating accurately and thus increasing the useful life of the diamonds many times and not disturbing the "set-up" for a much longer period.

According to the present invention, trimming mechanism is adjustable so that the lever arm which carries the diamond point may have its effective length adjusted to be approximately equal to the average radius of curvature of the surface being trimmed, and is further adjustable to position the pivot point of the lever substantially adjacent the average center of curvature of the surface. As a result of this, the lever arm which carries the diamond point is always substantially perpendicular to the surface being trimmed at its point of engagement. This results in substantially increased life of the diamond trimmer, and in practice we have observed that when the present invention is practiced the life of the trimmer is several times the life of trimmers employed in previous trimming mechanism.

With the foregoing general remarks in view, it is an object of the present invention to provide trimming mechanism having adjustments which result in maintaining the lever arm which carries the diamond point substantially perpendicular to the surface being trimmed at the point of engagement at all times.

It is a further object of the invention to provide trimming mechanism having means for adjusting the effective length of the lever arm carrying the diamond point so that said lever arm is substantially equal to the average radius of curvature of the surface being trimmed.

It is a further object of the invention to provide trimming mechanism having adjustments which result in locating the pivot point of the lever arm carrying the diamond point substantially adjacent the average center of curvature of the surface being trimmed.

It is a further object of the invention to provide trimming mechanism employing a template and a compound lever system in which the pivot points of the levers and their lengths are adjustable.

It is a further object of the present invention to provide a trimming mechanism employing a template in which a system of compound levers is employed, the pivot point of one of said levers being located at the opposite side of the template from the surface being trimmed.

It is a further object of the present invention to provide a trimming mechanism having a pair of trimming devices alternately shiftable to operative and inoperative position.

It is a further object of the invention to provide a trimming mechanism having a pair of simultaneously operable trimming devices.

Other objects of the invention will be apparent as the description proceeds, and when taken in conjunction with the accompanying drawings, wherein:

Figures 1 to 4 are diagrammatic views illustrating the relationship between the trimming arm and the trimming wheel;

Figure 5 is a side elevation of one form of trimming mechanism;

Figure 6 is an end view of the trimming mechanism shown in Figure 5 with parts broken away;

Figure 7 is a plan view of the trimming mechanism shown in Figure 5 with parts broken away;

Figure 8 is a section on the line 8—8, Figure 7;

Figure 9 is a section on the line 9—9, Figure 5;

Figure 10 is a section on the line 10—10, Figure 5;

Figure 11 is a side elevation of a modified form of trimming mechanism;

Figure 12 is an end view of the trimming mechanism shown in Figure 11 with parts broken away;

Figure 13 is a plan view of the trimming mechanism shown in Figure 11;

Figure 14 is a section on the line 14—14, Figure 11;

Figure 15 is a section on the line 15—15, Figure 11; and

Figure 16 is a section on the line 16—16, Figure 11.

Referring first to Figures 1 to 4, we have illustrated in Figure 1 a portion of a grinding wheel 10 having its periphery trimmed to provide involute surfaces 11 and 12. The diamond point 13 is mounted on an adjustable element 14 which is axially adjustable of a sleeve 15. The sleeve 15 is connected to a lever arm 16 indicated by the broken line which is pivoted to a pivot point 17, and the pivot connection between lever arm 16 and the sleeve 15 is indicated at 18. It will be observed in Figure 1 that the point 18 is located substantially adjacent the average center of curvature of the surface 12, and the diamond point 13 is spaced from the pivot point 18 a distance substantially equal to the average radius of curvature of the surface 12. As a result, the axis of the lever arm carrying the diamond point 13 (as determined by the line joining the diamond point 13 to the pivot point 18) will always be approximately perpendicular to the surface 12 at the point of contact. This will result in a uniform action on the diamond point and will substantially lengthen the life of the diamond. In addition, since in practice it is impossible to provide a diamond point 13 which is a theoretical point, this same construction provides for accurate reproduction of the curve. In other words, if the attitude of the diamond were changed relative to the surface which it is trimming, errors would be introduced into this surface by reason of irregularities in the diamond trimmer. By maintaining the lever arm carrying the diamond point 13 always in the same attitude, however, irregularities in the diamond point are not permitted to affect the profile of curvature being trimmed.

In Figure 2 we have indicated a grinding wheel 20 having involute curves 21 and 22 trimmed thereon by a diamond point 13 carried by the element 14 which is longitudinally adjustable in the sleeve 15. Since the average radius of curvature of the surfaces 21 and 22 is substantially longer in the wheel 20 than in the wheel 10, the element 14 will be adjusted outwardly in the sleeve 15 so as to locate the point 18 substantially adjacent the average center of curvature of the surface 22. At the same time it will be necessary to relatively adjust the wheel and the trimming mechanism so as to locate the pivot point 17 substantially closer to the axis of the wheel 20. In Figure 2 we have illustrated this condition as being taken care of by adjusting the trimming wheel downwardly. In practice, however, it is ordinarily preferable to adjust the pivot point 17 of the lever 16 upwardly relative to the axis of the wheel 20.

In Figure 3 we have indicated a trimming wheel 30 having curves 31 and 32 trimmed thereon by the diamond 13 of the element 14. In this case the element 14 is adjustable longitudinally of the sleeve 15 so as to locate the point 18 substantially further from the diamond point 13. The point 18 is located substantially adjacent the average center of curvature of the surface 32, and for this purpose a further adjustment of the pivot point 17 of the lever 16 relative to the wheel 30 is made.

In Figure 4 we have indicated a wheel 40 having surfaces 41 and 42 of substantially larger radius of curvature, as shown in Figures 1 to 3. In this case the diamond point 13 of the element 14 is adjusted further out of the sleeve 15 so as to locate the pivot point 18 substantially adjacent the center of curvature of the surface 42. A second adjustment is made which positions the pivot point 17 of the lever 16 substantially closer to the axis of the wheel 40, thus positioning the pivot point 18 at the desired location.

In these figures it will be noted that the pivot point 17 of the lever 16 is located at the opposite side of the wheel from the surface being trimmed. This is a desirable condition since it permits the lever formed between the sleeve 15 and diamond 14 to swing freely about the pivot point 18 in both extreme positions of movement. If on the other hand, the lever 16 has its pivot point 17 located at the same side of the wheel as the surface being trimmed, there will be a tendency to bind in some cases, where lever 16 and sleeve 15 approach a straight line. This is particularly true when a small radius of curvature is trimmed onto a wheel, as illustrated in Figure 1. In this figure it will be noted that in the two extreme positions shown by full and dotted lines, the axis of the lever arm 16 shown between sleeve 15 and element 14 make substantially equal angles with the axis of the lever arm 16. This is a very desirable condition and is one of the valuable features of the present invention.

Referring now to Figures 5 to 10, we have illustrated one form of our invention. The trimming mechanism is adapted to be mounted on the slide 50 that also supports the work piece which is acted upon by the grinding wheel. Grinding machines of this type are well-known and normally the slide is traversed in the line of the work axis between a working position in which the work piece is located at the grinding wheel, and a trimming position in which the trimming mechanism is located at the grinding wheel.

In the type of trimming device chosen to illustrate the present invention, the template has a shape identical with the shape to be trimmed

onto the periphery of the grinding wheel. In other words, the compound system of levers reproduces the curvature of the template at a one to one ratio. It is further a feature of the present invention that the follower point which engages the surface of the template is aligned with the diamond point which trims the surface of the grinding wheel. Accordingly, the template will be located exactly in line with the periphery of the grinding wheel and also in exact alignment with the work piece being ground, if desired. We have shown the trimming mechanism in Figures 6 to 10 as comprising a base 51 adjustably mounted on the slide 50. A T slot 52 is provided in the slide 50, and a headed bolt 53, nut 54 and washer 55 provide for clamping the base 51 in position on the slide 50. Lateral adjustment of the base 51 on the slide 50 by means of adjustable bolts 56 and 57, these being calibrated as indicated at 58 to provide for ease in positioning the base 51, is provided.

The base 51 is provided with a pair of vertical guide posts 60 which are rigidly supported in the base 51. A trimmer frame indicated generally at 62 is provided with a pair of apertured guides 63 and 64 which engage the posts 60 and provide for vertical adjustment of the trimmer frame 62 thereon. The guides 63 and 64 have internally threaded bosses 65 and 66 formed thereon for the reception of clamping means indicated in Figure 5 at 67. These clamping means lock the trimmer frame 62 in the desired position of vertical adjustment.

Secured to the trimmer frame 62 is a vertically extending arm 70 which carries the template T in vertically adjustable position thereon. The structure of the template supporting mechanism is best illustrated in Figures 8 and 9, in which the arm 70 is shown as provided with a vertically extending slot 71. Vertically adjustable in the slot 71 is a block 72 having flanges 73 engaging the surfaces of the arm 70 adjacent the slot 71 and having its main body portion received within the slot 71. A plate 74 is bolted or otherwise secured to the block 72 as indicated at 75, the plate 74 engaging surfaces of the arm 70 at opposite sides of the slot 71 from the surfaces engaged by the flanges 73. This locates the block 72 accurately in the slot 71 but permits vertical adjustment thereof by means which will now be described.

The arm 70 adjacent its top has an apertured boss 76 which receives an adjusting bolt 77. The bolt 77 is provided with a squared upper portion 78 to be engaged by a wrench or suitable tool, and is further provided with a flange 79 which rests upon the flat upper surface of the boss 76, thus limiting downward movement of the bolt 77. A retaining cap 80 engages over the flange 79 and is secured in place by bolts 81, as best seen in Figure 7. This arrangement permits rotation of the adjusting bolt 77 while retaining the same firmly against vertical displacement. The block 72 has a threaded opening 82 in which the bolt 77 engages and, accordingly, rotation of the bolt 77 results in vertical adjustment of the block 72 and its associated structure. A lock bolt 83 is adapted to engage the adjustable bolt 77 to lock the same in adjusted position.

The block 72 has an accurately formed flat surfaced boss 84 against which the template T is to be positioned. Positioning pins 85 are provided, and the template T is provided with accurately located openings for receiving the pins 85. The lock bolt 83 previously referred to passes through another opening in the template T and clamps the template in accurately located position against the flat surface of the boss 84.

As previously stated, it is essential in the present construction that the template T be located at a definite position aligned with the surface of the grinding wheel at the point of trimming, and aligned also with the corresponding surfaces of the work piece being ground. In order to position the template T in the proper position, it will be evident that it is necessary to adjust the trimmer frame 62 vertically and to make a corresponding vertical adjustment of the block 72 carrying the template T. By this arrangement it will be possible to position the template T in properly aligned position while the trimmer frame 62 is located in various positions of vertical adjustment.

The trimmer frame 62 is provided with a pair of aligned openings 90 for receiving pins 91. The pins 91 form the pivot supports for the system of levers which carry the diamond trimmers and, accordingly, their axes correspond to the pivot point 17 shown in the diagrammatic views of Figures 1 to 4. Lever structures 92 and 93, best seen in Figure 6, are pivoted to the pins 91. The lever structure 92 comprises a sleeve 94 embracing corresponding pin 91 and carrying a pair of arms 95 which, in turn, support a second sleeve 96. The sleeve 96 supports a diamond carrying supporting shaft 97 and a follower member 98 having a tubular portion 99 which are assembled together to form the second lever of the compound lever system, as best illustrated in Figure 8. The diamond supporting shaft 97 has a reduced portion 100 over which the member 98 fits. A positioning collar 101 is located within the sleeve 96 and abuts against the shoulder 102 of the shaft 97. A lock screw 103 retains the positioning collar 101 in the sleeve 96 and the end of the tubular portion 99 engages the collar 101 so that the lever formed by the members 97 and 98 is retained accurately against axial displacement in the sleeve 96.

The member 98 is retained in assembled position on the shaft 97 by means of a washer 104 which, in turn, is retained in position by means of a set screw 105.

As best seen in Figure 10, rotation of the shaft 97 and member 98 is limited by means of a pair of collars 106 and 107 which cooperate with a stop pin 108 let into a boss in the sleeve 96. The collars 106 and 107 are clamped in position on the tubular portion 99 by means of set screws 109 and 110. The collars have cutaway portions indicated at 111 providing shoulders 112 which are adapted to abut stop pin 108 to limit rotation of the parts. By adjusting the collars 106 and 107 it will be possible to limit the amplitude of rotation permitted the shaft 97 and the member 98 in either direction.

As previously stated, it is desirable to adjust the effective length of the lever arm terminating in the diamond point 13 and the corresponding point of the follower F. Accordingly, the shaft 97 is offset as indicated in Figure 8 so that its sleeve portion 115, in which the diamond element 114 carrying the diamond point 113, permits location of the point 113 very close to the axis of rotation of the shaft 97. An adjusting screw 120 is provided in the sleeve portion 115, and a lock screw 121 retains the diamond element 114 in adjusted position.

Correspondingly, at the opposite end of the

shaft 97 the element 98 is offset from the axis of the shaft 97 and tubular portion 99 so as to permit the point of the follower F to be located substantially adjacent the axis of the shaft 97. The follower is adjustable in an opening 122 in the member 98, and an adjusting screw 123 is provided for adjusting the follower F in the opening 122. A suitable lock screw (not shown) is also provided, similar to the screw 121 cooperating with the diamond element 114.

We have so far described in detail the construction of the compound lever structure 92 and its associated mechanism. The lever structure 93 is substantially similar, with the exception that its lever arms 95', as best seen in Figure 7, are located so as to be received between the lever arms 95. This is a structural arrangement to avoid interference between the two lever systems.

The trimming mechanism illustrated in Figures 5 to 10 is adapted to trim one side of a grinding wheel at a time and, accordingly, the lever structures 92 and 93 are alternately movable to operative and inoperative position. This is best illustrated in Figure 6 in which the lever structure 92 is shown in operative position and the lever structure 93 is shown in inoperative position. In order to retain the selected system in operative position, each of the systems has depending projections 130 having seats 131 for the reception of the end of a spring pressed plunger 132. The spring pressed plungers 132 are located in adjustable housings 133 threaded within bosses 134 of the trimmer frame 62. Compression springs 135 seat against shoulders 136 in the member 133 and at their opposite ends bear against collars 137 formed on the plunger 132. As will be evident from Figure 6, the plunger 132 tends to rotate the lever structures 92 and 93 into operative position.

In order to move either of the lever systems 92 or 93 into inoperative position, dogs 140 are provided which are pivoted to the trimmer frame 62 as indicated at 141. Each of the dogs 140 has an actuating lever 142 secured thereto for swinging the same. The lever structures 92 and 93 are each provided with upwardly extending projections 143 which are adapted to cooperate with the dogs 140. As shown in Figure 6, the lever structure 93 is retained in inoperative position by its dog 140 engaging the projection 143. The lever structure 92 is retained in operative position, its dog 140 being withdrawn from engagement with its projection 143 so as to permit the lever structure 92 to be swung counterclockwise about the axis of the pin 91 under the influence of the spring pressed plunger 132.

The trimming operation is carried out by means of an actuating lever 150, as shown in Figures 7 and 8. The actuating lever 150 is rigidly secured in a suitably formed opening in the member 98 and locked in placed by a set screw, as best shown in Figure 8.

When the trimming wheel is positioned so that its axis is aligned with the axis of the diamond carrying element 114, the trimming operation is carried out by swinging the lever 150 back and forth between the positions determined by the engagement of the shoulder 122 with the stop pin 108. The spring pressed plunger 132 urges the lever structures 92 or 93, as the case may be, in the direction to retain the point of the follower F in engagement with the surface of the template T. Since this surface is not an arc of circle, swinging of the lever 150 will result in rotation of the shaft 97 and member 98 about their axes and will also result in a slight rotation of the lever system 92 or 93 about the axis of the pin 91. The point of the diamond 113 being aligned with the point of the follower F, it will trace a curve identical with the curvature on the template F and will thus reproduce this curvature on the periphery of the grinding wheel in a well-known manner.

As stated at the outset, the structure is adjustable to position the pivot center of the diamond 113 substantially adjacent the average center of curvature of the surface being trimmed. Specifically, this adjustment is made by adjusting the diamond carrying element 114 radially of the shaft 97 and making a like adjustment of the follower F. This provides for making the length of the pivot arm of the diamond 113 substantially equal to the average radius of curvature of the surface being trimmed. The length of this pivot arm is, of course, the radial distance between the point 13 and the axis of the shaft 97. A further adjustment is necessary to position the axis of the shaft 97 substantially adjacent the average center of curvature of the surface being trimmed. This is taken care of by positioning the trimmer frame 62 vertically of the posts 60 to the desired position, and makes a corresponding adjustment of the template T so as to position the same in alignment with the periphery of the trimming wheel.

By employing the mechanism illustrated in Figures 5 to 10, it will be necessary to trim first one side of the wheel and then the other side, since the lever structures 92 and 93 are arranged for alternate use. It will be observed in Figure 6 that the pivot axis of the pins 91 are located on opposite sides of the template and grinding wheel from the surface being trimmed. However, in some cases, this desirable feature may not be necessary and the construction may be modified so as to provide for simultaneous trimming of opposite sides of the grinding wheel.

Such a construction is illustrated in Figures 11 to 16.

In this second modification we provide a sub-base 200 which is adapted to be mounted on the work-carrying slide of the grinding machine, a removable gib 201 being provided for this purpose. Adjustably secured on the sub-base 200 is a base 202 which is adjustable transversely of the sub-base so as to position the template in line with the work centers of the grinding machine. The base 202 and sub-base 200 have interfitting ways, as indicated at 203 in Figure 11, which permits transverse sliding of the base 202. At each side of the base 202, as best seen in Figure 12, are a pair of depending ears 204 having threaded openings for the reception of adjusting bolts 205 which bear against side surfaces of the sub-base 200. By loosening one of the bolts 205 and tightening the other a corresponding amount, the base 202 is adjusted transversely. Clamp bolts 205' are provided for clamping base 202 in adjusted position. At 207 we have indicated lines carried respectively by the sub-base and adapted to register with each other when the base is in the proper position of adjustment.

A more accurate indication of the accuracy of the adjustment of the base is provided by indicator 208, shown in Figure 13, assembled with the detailed construction best seen in Figure 16. The indicator 208 is mounted in sleeve 209 seated in recess 210 formed in base 202, and retained in definitely located position therein by a set

screw 211 engaging recess 212 in the sleeve 210. The indicator 208 is of conventional type and includes a projecting arm 213 adapted to actuate the indicator mechanism. Mounted on the sub-base 200 is a pin 214 having a gauge surface 215 adapted to engage the indicator actuator 213.

When the trimming mechanism is initially calibrated the dowel pins which support the template (later to be described) are accurately aligned with the work centers, and the sleeve 209 is positioned so that the indicator needle 216 has an intermediate reading. The recess 212 is then provided and the set screw 211 is seated therein. The calibrations 207 would only be used for an approximate setting.

The indicator is used in making minute corrections in relative radial positions of the template to the work piece, this being accomplished by moving the base transversely until the center line of the template intersects the work center. This adjustment should be very small and is only necessitated in misalignment resulting from wear on gauge points, etc.

Thus in the event that template T is for some reason slightly inclined from the vertical axis, it will be possible to shift the trimming mechanism transversely by loosening the clamping bolts 205' and providing the transverse adjustment by means of the bolts 205. In this case the indicator 208 will indicate the amount of the transverse shifting of the base 202. It will be appreciated that in the present type of machine accuracy is maintained within one or two ten-thousandths of an inch, and that after adjustment by means of the bolts 205 it is entirely possible that tightening of the clamping bolts 205' will throw the adjustment off by at least a fraction of ten-thousandths of an inch. The amount of wear thus introduced is shown on the indicator and it may be corrected. It will be seen from the foregoing that it is entirely possible, in the event that the template is inclined, that the grinding operation on the gear will be carried out away from a vertical center line. This, however, will introduce no errors since the grinding wheel will be trimmed for accurate grinding in this off center condition.

Rigidly secured on the sub-base 200 are a pair of vertically extending posts 220 on which the trimmer frame 221 is vertically slidable. The frame 221 includes elongated bosses 222 to provide for a firm support of the trimmer carriage 221 on the posts 220. Tapped bosses 223 are provided on the bosses 222 for the reception of locking bolts 224 which secure the trimmer support 221 in vertically adjusted position. Adjacent the opposite end of the trimmer support 221 we provide a pair of links 225 which are pivoted to a stud bolt 226. The lower end of the links 225 are slotted as indicated at 227 and the base 202 carries clamping bolts 228 which pass through slots 227. The bolts 228 may be loosened to permit vertical adjustment of the trimmer support 221 and may be tightened after such adjustment to assist in retaining the trimmer support rigidly in adjusted position.

Means for effecting vertical adjustment of the trimmer 221 may be provided in the form of a pinion 229 mounted on a shaft having a squared end 229a for cooperation with a suitable tool or wrench. The posts 220 may be provided with rack teeth 229b for cooperation with the pinion. When the locking bolts 224 and 228 are loosened, the trimmer carriage 221 may be vertically adjusted by rotating the shaft 229a carrying the pinion 229.

The trimmer support 221 includes a template supporting arm 230 which is in all important respects similar to the template supporting arm 70. In the modification illustrated in Figures 11 to 16, this template supporting arm includes a template T accurately located by means of a pair of centering pins 231, and clamped in place by means of a clamping screw 232. The template T is secured to a block 233 which is vertically adjustable in a slot 234 provided in the template support 230. The block 233 has a tapped opening in its upper portion which receives an adjusting screw 235 which is retained against axial displacement by a cap 236. Rotation of the adjusting screw 235 results in corresponding vertical adjustment of the template T.

As best seen in Figure 12, the trimmer frame 221 is provided with a pair of shafts 240 on which are mounted a pair of levers 241 terminating in sleeve portions 242 which are adapted to support the trimmer shafts 243. The trimmer shafts 240 carry radially adjustable diamond elements 245, as best indicated in Figure 15. These elements are mounted in carriers 248. An adjusting screw 246 is provided for effecting the radial adjustment of the diamond element 245 and after adjustment the element is clamped in adjusted position by a set screw 247.

In order to effect circumferential adjustment of the diamond element 245 relative to the shaft 243, the construction best illustrated in Figure 14 is employed. The shaft 243 is cut away to provide a pair of seats 250 separated by a radial flange portion 251. A pair of adjusting screws 252 are provided, threaded into tapped openings in the carrier 248 and adapted to engage the seats 250. As will be evident if one of the adjusting screws 252 is loosened while the other is tightened, a corresponding circumferential adjustment of the carrier 248 relative to the shaft 240 will be effected. This permits accurately aligning the diamond point on the diamond element 245 with the point of the follower F. As best seen in Figure 15, the carrier 248 is retained against axial movement of the shaft 243 by means of a lock bolt 253 which seats within an annular V-shaped groove 254 formed in the shaft 243.

The followers F are likewise radially adjustable of the shaft 243, and in practice the point of each follower F will be adjusted to have the same spacing from the axis of the shaft 243 as the point of the diamond element 245.

Means are provided for simultaneously actuating both of the trimmer elements, and the mechanism for effecting this comprises a pair of meshing gears 260 mounted on trimmer support 221. The gears are secured against rotation to their respective mounting shafts 261 and the shafts 261 carry levers 262. The shafts 243 are each provided with levers 263 which are secured thereto against rotation. Interconnecting the levers 263 and 262 are links 264 which transmit rotation from the shafts 261 to the shafts 243. Springs 265 are provided, paralleling the links 264 for the purpose of taking up lost motion.

An actuating sleeve 266 is rigidly secured to one of the shafts 261 and has projecting therefrom an operating lever 267.

Means are provided for limiting the amplitude of oscillation of the shafts 261, and these take the form of collars 268 and 269 having projecting ears adapted to engage a stop pin 270. Collars

268 and 269 are independently adjustable relative to the shafts 261 and have means (not shown) for rigidly clamping them in adjusted position on the shaft. As will be evident from Figure 12, this provides means for limiting the amplitude of oscillation of the shaft and also for definitely fixing the point at which said oscillation is terminated in each direction.

The sleeves 242 have extending ears 271 thereon which are adapted to be interconnected by a tension spring 272, the spring being effective to urge the follower F inwardly toward the template T.

Inasmuch as the form of the template is not a portion of the circular arc, oscillation of the shafts 243 as a result of the operation of the lever 267 will result in a slight oscillation of the levers 241 about the axes of the shafts 240.

In this embodiment of our invention as in the one previously described, the construction provides for adjustability of the parts so as to locate the center of oscillation of the arms carrying the follower F and the diamond element 245 substantially adjacent the average center of curvature of the template F and hence of the surface being trimmed onto the grinding wheel. This adjustment is accompanied by an adjustment of the length of the arm of the follower F and of the diamond element 245 so as to make these arms approximately equal to the average radius of curvature of the template and of the work being trimmed. As a result of this construction, the diamond element 245 will always be substantially perpendicular to the surface being trimmed at the point of engagement therewith, thus increasing the life of the diamond and increasing the accuracy of the surface being trimmed.

Adjustment of the axis of the shaft 243 to approximately the desired position relative to the template is accomplished by vertical adjustment of the trimmer support 221 as a whole, and a corresponding adjustment of the template T into alignment with the surface being trimmed. This has the effect of raising or lowering the axis of the shaft 243 relative to the template. The remaining adjustments necessary are the adjustment of the length of the diamond element 245 radially of its carrier 248 previously described and a similar adjustment of the follower F.

In the present embodiment the axis of the major link of the system of linkage is located on the same side of the template and of the work piece as the follower and diamond point. In most cases this is an entirely satisfactory arrangement, and the present construction which provides for simultaneous trimming of both surfaces of the wheel permits much more rapid work than the embodiment of our invention previously described.

While we have illustrated carrier 248 in detail only in conjunction with the embodiment of our invention illustrated in Figures 11 to 16, it will be understood that the same structure may, if desired, be employed in the modification illustrated in Figures 1 to 5. In the modification illustrated in Figures 1 to 5, we have indicated a somewhat different arrangement in which the follower carrying member 98 with its sleeve 99 is radially adjustable of the shaft 97, and seats 97' are shown on the shaft in Figure 8 for cooperation with adjusting screws, similar to those shown at 252 in Figure 14.

In like manner it will be understood that while we have not fully described the details of the means for adjusting the template in the modification illustrated in Figures 11 to 16, this may be identical with that shown in detail in Figures 8 and 9.

The trimmer mechanism may be associated with the grinding machine if desired so that the path traversed by the trimming points is directly in line with the work piece being ground. In this arrangement is provided, trimming is accomplished by traversing the grinding wheel into the vertical plane of the trimming points, feeding the same down to provide stock for trimming, and performing the trimming operation. When the trimming operation is complete, the wheel is traversed without further feed in a vertical direction back to the plane of the work and is properly located with respect thereto. It may also be positioned slightly out of line with the work, in which case the trimming may be accomplished by feeding the grinding wheel into the plane of the trimming points and feeding the same vertically to proper position to provide material for removal by trimming. After the trimming wheel is thus provided with properly shaped grinding surfaces, it may then be fed back to the proper vertical position for grinding and traversed back to the vertical plane of the work to be ground.

In the last case, adjustment of the trimming mechanism is made as follows: The trimming assembly as a whole is adjusted vertically to locate the template approximately in line with the work. The trimming arm and the diamond carrying arm are adjusted radially of their common shaft so that their lengths are approximately equal to the average radius of curvature of the template, and hence of the work to be trimmed respectively. The follower arm is then allowed to engage the curved surface of the template and is actuated to follow this curve while the template is adjusted up and down. The point of vertical adjustment of the template at which the swinging movement of the long arm 16 is a minimum, is observed. This is the proper position for the parts and will result in the diamond carrying arm maintaining itself substantially perpendicular to the surface of the work at all times.

It may be stated at this time that commercial diamond trimming points have a diamond located substantially at their axes, but in many cases this diamond is somewhat displaced from the axis, and instead of presenting a theoretical point it will in most cases present a flat surface of some area. Furthermore, while the diamond is, of course, very hard, it tends to wear out, and after a certain amount of usage the diamond doing the actual trimming presents a convex surface.

As emphasized in the foregoing, the present trimmer is adapted to trim the grinding wheel so as to reproduce curves on the work piece within limits of one or two ten-thousandths of an inch. Where the diamond trimmer has worn and where no means are provided for swinging the diamond carrying arm about an axis located approximately at the average center of curvature of the surface being trimmed, different portions of the diamond are employed in different portions of an arc. This results in a departure or error introduced between the point of the follower and the actual cutting point on the diamond trimmer. This in many cases introduces an error sufficiently great to reduce the over-all accuracy of the grinding machine substantially.

It will be appreciated that if the follower and

the diamond point could both be kept at a theoretical point, errors of this nature would not be introduced. This, however, is impractical, and by the present invention is rendered unnecessary.

Reference has previously been made to the fact that wear on the diamond is reduced by the present arrangement, and it is desired to emphasize the primary importance of this fact.

The diamonds are relatively inexpensive and when worn out may be replaced for a few dollars. This is of second importance, the principal disadvantage of having to replace the diamonds in production is that it requires interrupting the production of the machine and disturbing the accurate adjustment of the machine set-up. When a new diamond is provided, a considerable amount of time is required before the grinder is again in full production, due to the necessity for testing the diamond and making such adjustments as are shown to be necessary as a result of the tests.

It is found in practice that the diamond when employed with a mechanism of either of the foregoing embodiments will last, without replacement, several times as long as diamonds employed in conventional prior trimmers. This means that the production of the grinder need not be interrupted for replacement of diamonds for a period several times as long as that necessitated in prior trimmers. Furthermore, as explained above, the accuracy of the work is increased.

While we have illustrated and described two specific embodiments of our trimming mechanisms, it will be understood that this has been done solely to enable those skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What we claim as our invention is:

1. Trimming mechanism for grinding wheels comprising a base, a trimmer frame vertically adjustable on said base, a template support vertically adjustable on said frame, a lever pivoted at one end to said frame, a shaft pivotally carried by the opposite end of said lever, a template follower adjustable radially of said shaft, a diamond trimmer adjustable radially of said shaft, whereby said template support may be aligned with said grinding wheel, the axis of said shaft may be located adjacent the average center of curvature of the trimmer surface of said grinding wheel, and said template follower and diamond trimmer may be spaced from the axis of said shaft by an amount substantially equal to the average radius of curvature of said trimmed surface.

2. A trimmer comprising a base having vertical posts thereon; a frame vertically adjustable on said posts; a vertically adjustable template support on said frame; a shaft carried by said frame for oscillation about an axis remote from and parallel to its own axis, and for rotation about its own axis; off-set supports adjacent opposite ends of said shaft; and means on said supports for mounting a template follower, and a diamond trimmer for adjustment radially of said shaft.

3. In a trimming mechanism, a swinging frame having a shaft housing adjacent the swinging end thereof, a shaft in said housing carrying a diamond and a follower at opposite ends, a stop carried by said housing at one end, and adjustable abutments carried by said shaft for limiting rotation of said shaft in said housing.

4. In a trimming mechanism, a swinging frame having a shaft housing adjacent the swinging end thereof, a shaft in said housing carrying a diamond and a follower at opposite ends, a stop carried by said housing at one end, and adjustable abutments carried by said shaft for limiting rotation of said shaft in said housing, said adjustable abutments comprising a pair of collars having overlapping cut-away portions for receiving said stop, said collars being independently adjustable on said shaft.

5. In a trimmer, a rotatable shaft, a follower support and a diamond support on opposite ends of said shaft, one of said supports comprising a carrier rotatable on said shaft, said shaft having a pair of generally radial seats thereon separated by a radial web providing a concentric bearing surface between said seats, and adjustable abutments on said carrier engageable with said seats for adjusting said support about the axis of said shaft.

6. In a trimmer, a rotatable shaft, a follower support and a diamond support on opposite ends of said shaft, one of said supports comprising a carrier rotatable on said shaft, said shaft having a pair of generally radial seats thereon separated by a radial web providing a concentric bearing surface between said seats, said seats facing substantially in the same direction and adjustable abutments on said carrier engageable with said seats for adjusting said support about the axis of said shaft.

7. A trimmer comprising a base, a frame vertically adjustable on said base, a pair of levers swingable about parallel axes on said frame, a template support adjustable on said frame toward and away from said axes, rotatable shafts carried by the free ends of said levers, said shafts having a template follower and a diamond trimmer at opposite ends.

8. A trimmer comprising a base, a frame vertically adjustable on said base, a pair of levers swingable about parallel axes on said frame, a template support adjustable on said frame toward and away from said axes, rotatable shafts carried by the free ends of said levers, said shafts having a template follower and a diamond trimmer at opposite ends, resilient means urging both of said levers into operative position, and latch means for retaining either of said levers in inoperative position.

9. A trimmer comprising a base, a frame vertically adjustable on said base, a pair of levers swingable about parallel axes on said frame, a template support adjustable on said frame toward and away from said axes, rotatable shafts carried by the free ends of said levers, said shafts having a template follower and a diamond trimmer at opposite ends, resilient means urging both of said levers into operative position, and means for rotating both of said shafts about their axes including a single manually movable member and connections between said member and each of said shafts.

10. A trimmer comprising a base, a frame vertically adjustable on said base, a pair of levers swingable about parallel axes on said frame, a template support adjustable on said frame toward and away from said axes, rotatable shafts carried by the free ends of said levers, said shafts having a template follower and a diamond trimmer at opposite ends, resilient means urging both of said levers into operative position, and means for rotating both of said shafts about their axes including a pair of gears, a manually

operable lever for rotating one of said gears, and connections between each of said gears and one of said shafts.

11. A wheel trimmer comprising a frame, a template support vertically adjustable thereon, a pair of shafts each having a template follower thereon and rotatable about its own axis, and swingable on said frame about an axis remote from said first named axis, said axes being located on opposite sides of the vertical center line of said template, means urging both of said shafts toward said template support, and means for swinging either of said shafts away from said template support and latching the same in inoperative position.

12. Trimming mechanism for a grinder of the type having a horizontal work slide, comprising a trimmer base on the slide, a frame vertically adjustable on said base, a template vertically adjustable on said frame, a lever pivotally supported at one end on said frame, a shaft pivoted to the other end of said lever, a trimming arm and a template following arm on said shaft, both of said arms being radially adjustable of said shaft, whereby said template may be aligned with the periphery of the grinding wheel, the axis of said shaft located at the average center of curvature of the template, and following and trimming arms may be adjusted in length to equal the average radius of curvature of the template.

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