

July 6, 1943.

G. F. JOHNSON

2,323,401

METHOD AND MACHINE FOR TRUING GRINDING WHEELS

Filed Sept. 15, 1941

4 Sheets-Sheet 1

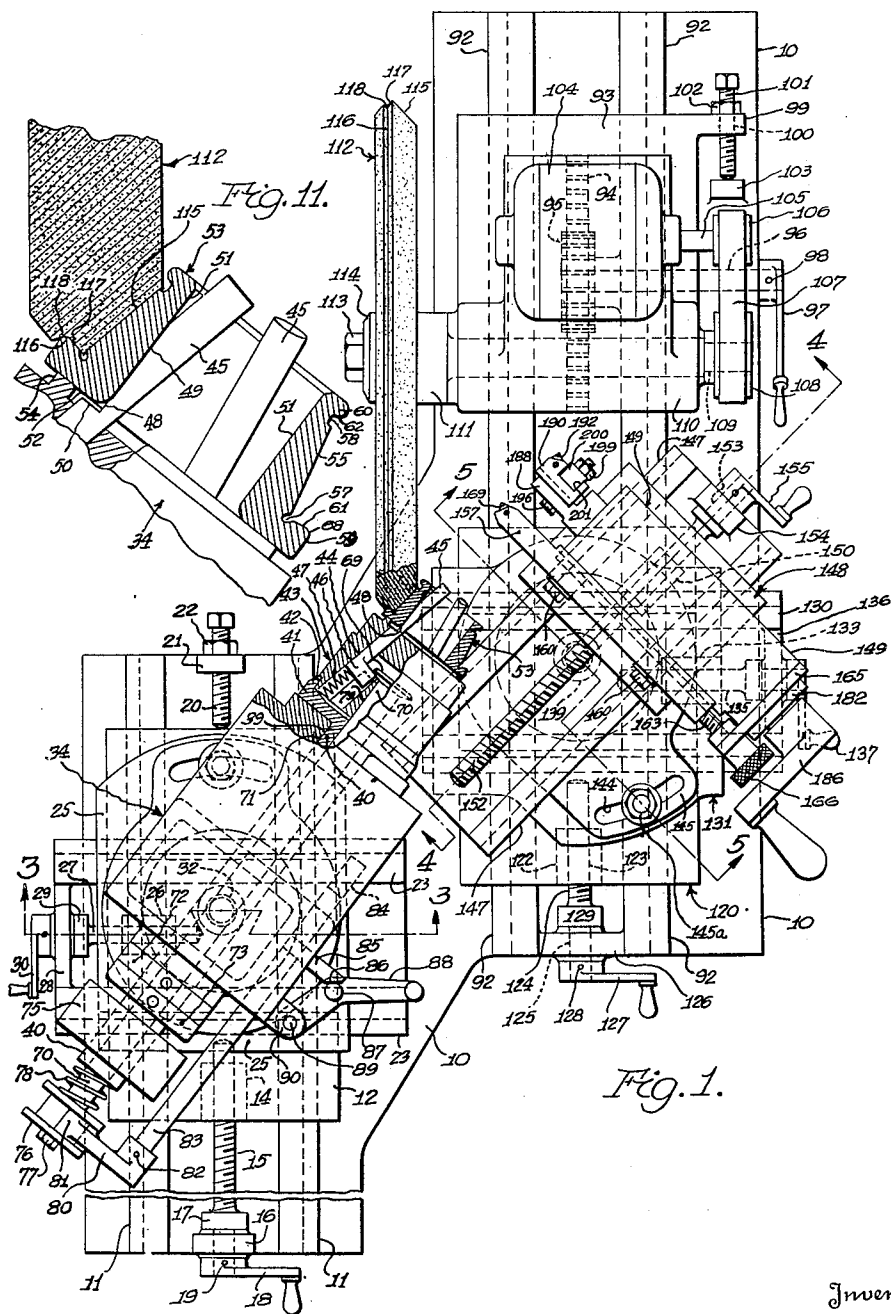


Fig. 1.

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4 Sheets-Sheet 2

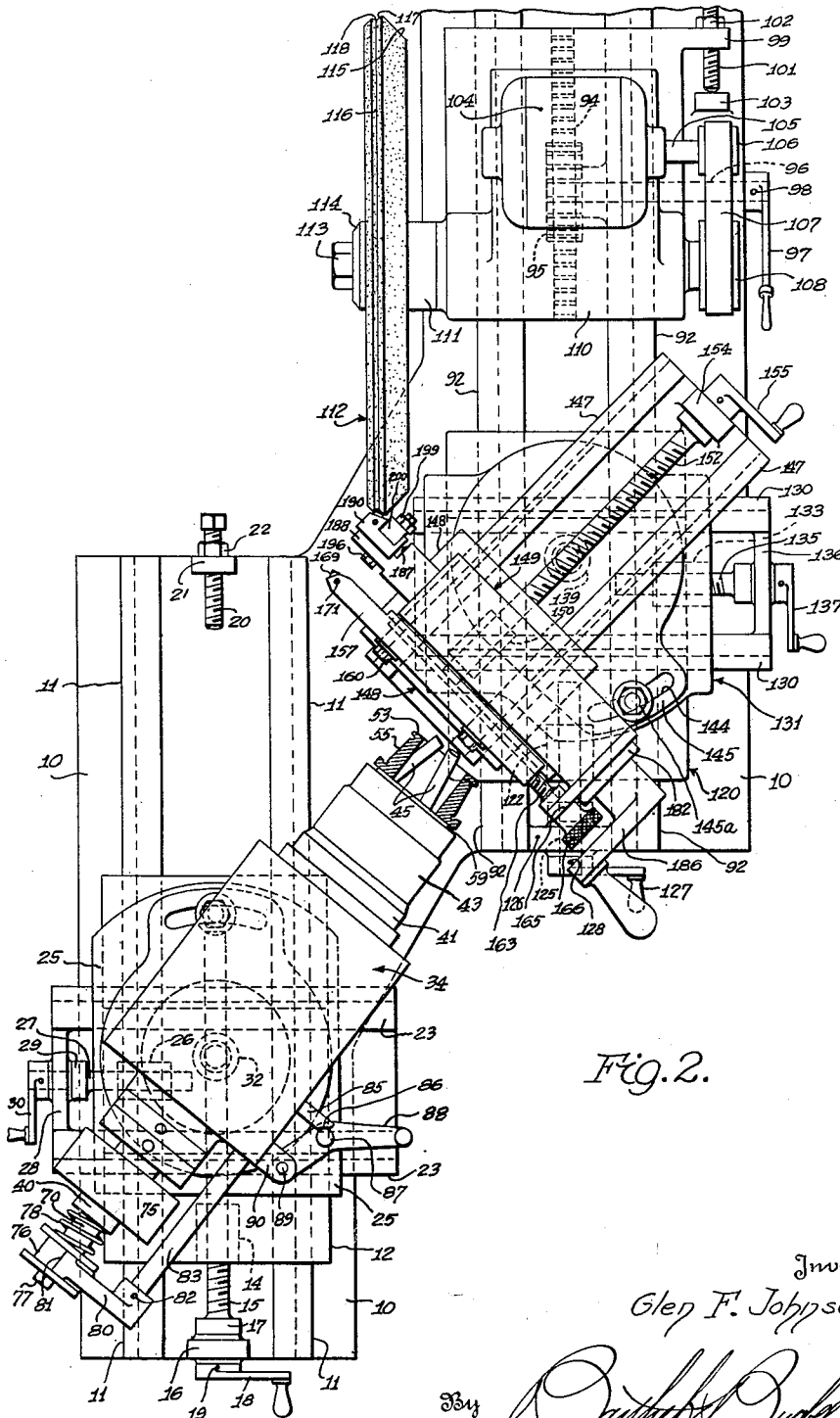


Fig. 2.

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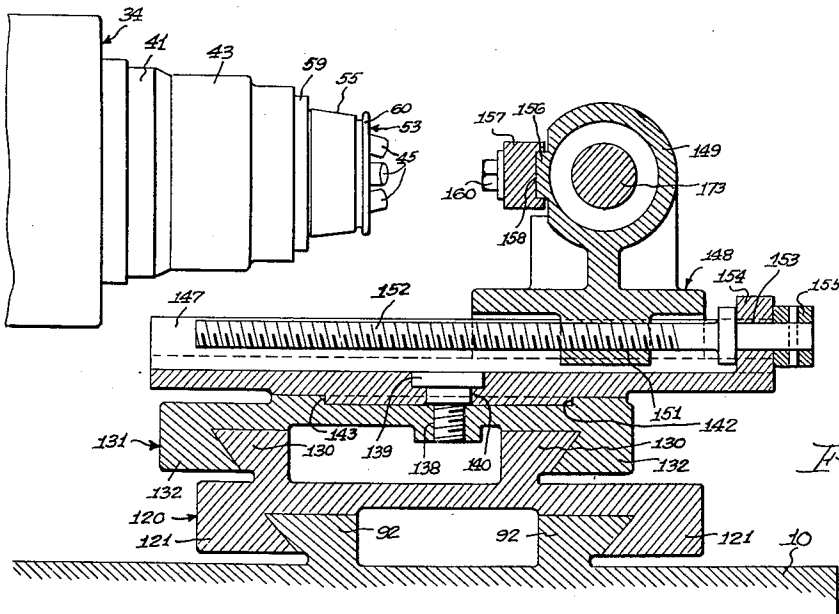


Fig. 4.

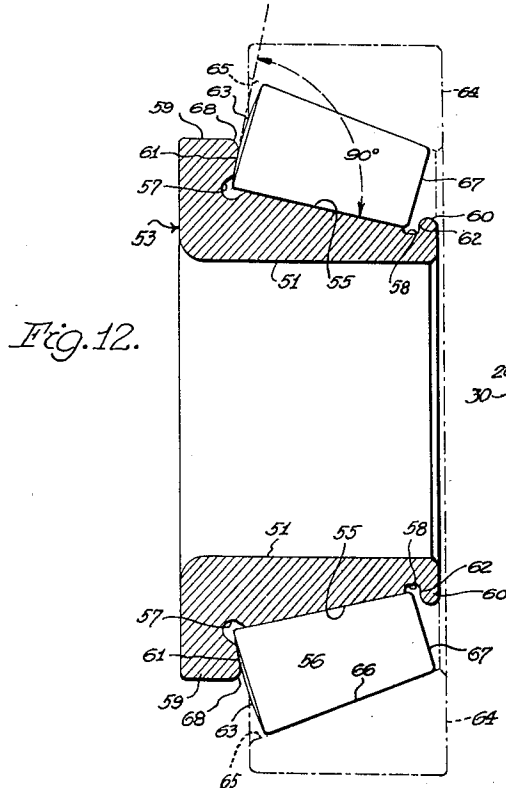


Fig. 12.

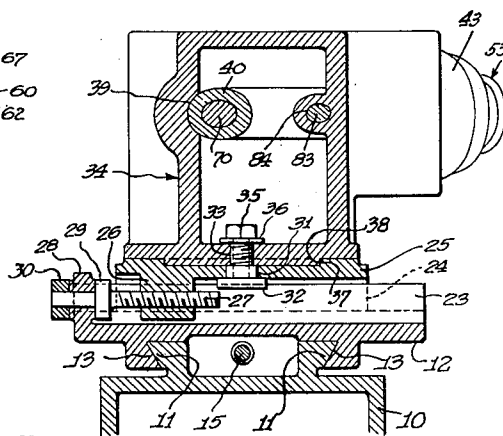


Fig. 3.

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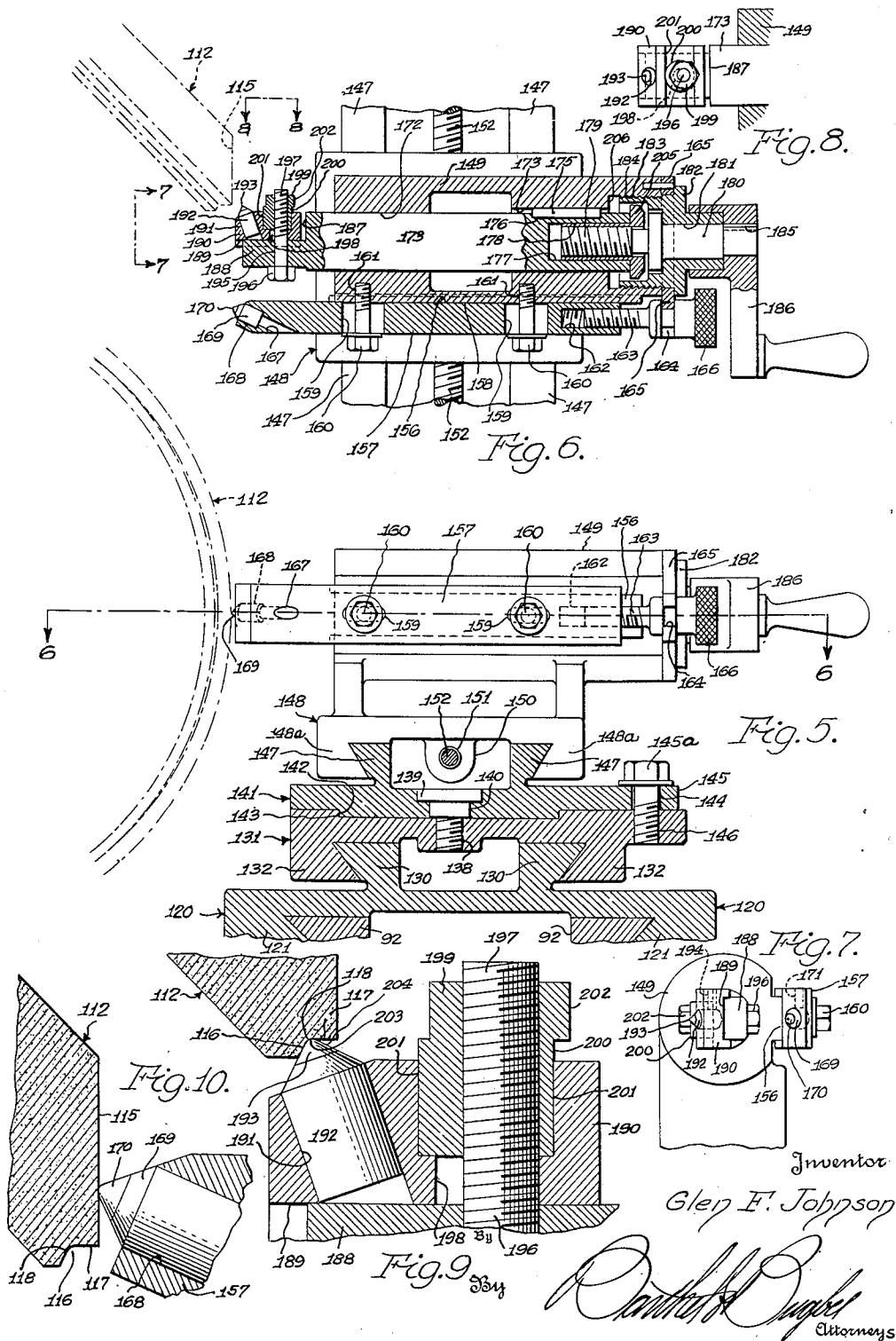
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UNITED STATES PATENT OFFICE

2,323,401

METHOD AND MACHINE FOR TRUING
GRINDING WHEELS

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Original application December 23, 1940, Serial No.
371,297. Divided and this application September
15, 1941, Serial No. 410,818

2 Claims. (Cl. 125—11)

This invention relates to abrading methods and apparatus and in particular to such method and apparatus for truing the abrading wheels used therein.

One object is to provide mechanism for and a method of truing a grinding wheel for substantially simultaneously grinding the raceway and one side wall and one edge of an anti-friction bearing cone.

Another object is to provide mechanism for and a method of truing a grinding wheel consisting in forming a peripheral groove in the grinding wheel having wall portions arranged for simultaneously grinding a side wall and rounding the outer edge of the side wall to a predetermined curvature.

Another object is to provide mechanism and a method of truing a grinding wheel consisting in forming an annular peripheral portion on the grinding wheel inclined to the axis of rotation thereof for grinding a bearing raceway, and forming an annular groove with a rounded bottom adjacent said annular portion adapted to grind a side wall of the bearing race adjacent the raceway and at the same time to round the outer edge thereof.

This application is a division of my co-pending application Serial No. 371,297, filed Dec. 23, 1940, for Grinding machine and method.

In the drawings:

Figure 1 is a top plan view, partly in section, of a preferred embodiment of a machine for simultaneously grinding the raceway, one side wall and an edge of an anti-friction bearing cone, together with mechanism for truing the grinding wheel to the desired configuration, with the parts in position for grinding the bearing cone.

Figure 2 is a position similar to Figure 1 but with the parts in position for truing the grinding wheel.

Figure 3 is a vertical section along the line 3—3 in Figure 1 through the work support.

Figure 4 is a vertical longitudinal section along the line 4—4 in Figure 1, through the grinding wheel truing mechanism.

Figure 5 is a vertical cross section along the line 5—5 in Figure 1, through the grinding wheel truing mechanism.

Figure 6 is a horizontal section along the line 6—6 in Figure 5.

Figure 7 is a fragmentary side elevation of the end of the grinding wheel truing mechanism, looking in the direction of the arrows 7—7 in Figure 6.

Figure 8 is a view similar to Figure 7 but at

right angles thereto, looking in the direction of the arrows 8—8 in Figure 6.

Figure 9 is an enlarged fragmentary horizontal section of the groove truing diamond shown in Figure 6 with the diamond at the end of the operation.

Figure 10 is a horizontal view of the face truing diamond during the operation of truing the face of the grinding wheel.

Figure 11 is an enlarged horizontal section of the central portion of Figure 1, showing the raceway, one side wall, and an edge of an anti-friction bearing cone being simultaneously or concurrently ground according to the invention.

Figure 12 is an enlarged longitudinal section through a tapered roller bearing cone or inner race showing the relationship between the bearing raceway, together with the tapered frusto-conical rollers arranged therebetween.

General arrangement

In general, the machine in connection with which this invention is used, consists of a grinding wheel having a novel configuration for substantially simultaneously or concurrently grinding the raceway, one side wall and one edge of an anti-friction bearing cone. The invention comprises truing mechanism for truing the face of the grinding wheel which grinds the raceway and also for truing the groove in the grinding wheel which simultaneously grinds the side wall and one edge of the bearing cone; and also includes the method of truing the grinding wheel in this manner.

Hitherto, anti-friction roller bearings have been provided with outer and inner races between which the bearing rollers have been arranged. Tapered roller bearings have been provided with a conical inner race or cone and an annular outer race coacting therewith.

In a tapered roller bearing of this type (Figure 12), the pressure exerted upon the outer bearing race is transmitted through the frusto-conical rollers and gives rise to an axial component of force which urges the ends of the rollers against one of the side walls of the inner bearing race or cone. The heat generated by the friction between the ends of these rollers and the side wall of the bearing race becomes concentrated at the edge of the side wall, with the result that the temper was frequently taken out of that portion of the bearing race and rapid wear enhanced.

Accordingly, after the inner bearing race had been completely ground, it has been customary

to round off the edge of the side wall which receives the thrust of the ends of the rollers, so that this heat is not concentrated but is distributed throughout that portion of the bearing race. This rounding of the edge has hitherto necessitated a separate and costly operation in the grinding of the bearing race or cone and has also resulted in inaccuracies of manufacture.

According to the present invention, however, a machine and method of truing the grinding wheel are provided whereby the race-way, side wall and adjacent edge of the inner bearing race or cone are ground substantially or concurrently, thereby eliminating this additional operation. To accomplish this, the grinding wheel which grinds the inner raceway is trued with a groove of predetermined configuration in such a manner that the face of the grinding wheel grinds the inner raceway of the bearing cone, whereas one wall of the groove grinds the side wall of the bearing race while the other wall of the groove rounds the edge adjacent the side wall.

Work support construction

The mechanism for supporting the work piece, namely, the inner cone of bearing race, is disposed in the lower left-hand corner of Figure 1. The entire machine is mounted upon a suitable pedestal (not shown) supporting a base 10 having V-ways 11 for slidably supporting a carriage 12 having corresponding V-ways 13 cooperating with the V-ways 11 (Figures 1 and 3).

The carriage 12 is provided with a threaded nut 14 secured thereto and receiving a screw shaft 15 rotatably mounted in a bearing boss 16 upon the base 10 and having on opposite sides thereof a collar-like enlargement 17 and a hand crank 18 secured as at 19 to the screw shaft 15. By operating the hand crank 18 in one direction, the carriage 12 may be moved inward, whereas by operating it in the opposite direction, the carriage 12 may be moved outward by means of the co-action of the screw shaft 15 and nut 14. The inward travel of the carriage 12 is limited by a stop screw 20 (Figure 1) mounted in a threaded boss 21 at the opposite end of the ways 11 from the boss 16. A lock nut 22 upon the stop screw 20 securely anchors the latter in its adjusted position. By this means, the carriage 12 may be advanced only so far as the end of the stop screw 20, which accordingly determines in part the adjustment of the work piece relatively to the grinding-wheel, as hereinafter set forth in more detail.

The carriage 12 is provided with transverse V-ways 23 co-acting with corresponding V-ways 24 upon a cross slide 25 having a threaded nut 26 secured thereto or integral therewith (Figure 3). The nut 26 receives a screw shaft 27 rotatably supported in a boss 28 upon the carriage 12 and having on its opposite sides an enlargement 29 and a hand crank 30 secured to the screw shaft 27. By turning the hand crank 30, the cross slide 25 may be moved to and fro across the carriage 12 in order to assist further in positioning the work piece or bearing cone relatively to the grinding-wheel.

The cross slide 25 is provided with a central vertical bore 31 adapted to receive a pivot screw 32 passing through a vertical bore 33 in the swivel member 34 and terminating in a retaining nut 35 and washer 36 (Figure 3). The cross slide 25 is provided with a cylindrical depression 37 co-acting with a cylindrical projection 38 upon the underside of the swivel head 34 and co-axial

with the bores 31 and 33 so as to provide additional support for the swivel movement of the swivel head 34.

The swivel head 34 is provided with bores 39 (Figures 1 and 3) rotatably supporting a tubular shaft 40 having on its forward end a flange 41 provided with a socket 42 for receiving the work-holding chuck 43.

The chuck 43 is provided with converging bores 44, three such bores being shown. These bores 44 reciprocally support the work-holding pins 45 having enlarged offset ends 46 urged forward by coil springs 47 (Figure 1). Near their forward ends the pins 45 are provided with oblique notches 48 having side walls 49 (Figure 11) and end walls 50. The side walls and end walls 49 and 50 serve respectively to engage the inner bore 51 and end surface 52 of the inner bearing race or cone 53 which constitutes the work piece. The latter is also provided support by an annular abutment 54 on the end of the chuck 43.

As hereinafter explained (Figure 11), the bearing cone 53 is also provided with a conical raceway 55 for the frusto-conical bearing rollers 56 (Figures 11 and 12) terminating in annular grooves 57 and 58 from which arise the end flanges 59 and 60 having end walls 61 and 62 respectively. The end wall 61 co-acts with the end wall 63 of the tapered roller 56, the latter being urged thereagainst by the forces exerted upon the outer bearing race or ring 64 having an inner conical surface 65 engaging the frusto-conical roller surface 66. The smaller end 67 of the bearing roller 56 is urged away from the side wall 62 (Figure 12) by the same forces which exert components in the direction of the axes of the rollers 66 toward their larger ends 63. The edge 68 of the end wall 61 on the flange 59 is rounded so as to prevent the concentration of the heat at this edge, this heat resulting from the friction generated between the roller ends 63 in the side wall 61.

The work holding pins 45 are normally held in a retracted position by the engagement of a head 69 upon a shaft 70 (Figure 1) passing through a bore 71 in the tubular shaft 40. The latter is held in position by a pair of retaining rings 72 and 73 threaded upon the rearward ends thereof and engaging a circular boss 74 on the rearward side of the swivel head 34 (Figure 1). The tubular shaft 40 also carries a pulley 75 by which the shaft 40 may be rotated. This is preferably accomplished by a belt driven from a motor (not shown) preferably mounted on top of the swivel head 34. This motor and belt have been omitted in order to prevent obstructing the parts located beneath them.

On the shaft 70 at its rearward end is mounted a flanged collar 76 secured thereto by the bolt 77. A coil spring 78 disposed between the end of the tubular shaft 40 and the flanged collar 76 urges the latter and its shaft 70 rearwardly, holding the work-holding pins 45 in a retracted position by reason of the engagement of the shaft head 69 with the offset projections 46 on the pins 45. The shaft 70 adjacent the pins 45 is reciprocally supported in a bore 79 within the chuck 43. When the pins 45 are in their retracted positions, the walls 49 of the notches 48 engage the inner bore 51 of the bearing cone 53 and urge it rearwardly against the abutment 54 (Figure 11), holding the bearing cone 53 or work piece securely against this abutment while at the same time accurately centering the work piece.

In order to advance the work holding pins 45

and withdraw their surfaces 49 from engagement with the inner bore 51 of the bearing cone 53, thereby releasing the work piece, the shaft 70 and its head 69 are moved forwardly, thereby permitting the coil springs 47 to so advance the pins 45. This is accomplished by means of a yoke 80 having a forced end 81 engaging the grooved collar 76 and secured as at 82 upon the rod 83 (Figure 1). The rod 83 is reciprocally supported in a bore 84 within the swivel head 34 (Figures 1 and 3) and carries a projecting pin 85 having a beveled cam surface 86 upon the outer end thereof. This cam surface 86 is engaged by a pin 87 mounted upon the hand lever 88 which is pivotally mounted upon the pivot pin 89 supported in the bracket 90 extending horizontally outward from the swivel head 34 (Figure 1). Thus, by pushing the hand lever 88 inward toward the swivel head 34, the pin 85 is pushed forward by the engagement of the pin 87 with the cam surface 86, moving forward the rod 83, yoke 80, flanged collar 76, shaft 70 and head 69. The latter moves forward in the chuck chamber 91, releasing the pins 45 so that they are urged forward by their coil springs 47, releasing the bearing cone or work piece 53. While the pins are in this advanced position, a new bearing cone may be placed in position, after which the hand lever 88 is released and the bearing cone simultaneously centered and chucked in a reverse manner to that previously described. When the hand lever 88 is released, the coil spring 78 pulls the pins 45 back into their chucking position under the urge of the shaft 70 and its head 69 engaging the offset portions 46 of the pins 45.

Grinding-wheel mechanism

The right-hand portion of the base 10 is provided with V-ways 92 of the dovetail type and running entirely across the base 10. Slidably mounted upon the ways 92 is the grinder carriage 93 and carrying a rack 94 upon its underside (Figures 1 and 2). Meshing with the rack 94 is a pinion 95 mounted on a shaft 96 journaled in the base and carrying a hand lever 97 secured as at 98 to the outer end of the shaft 96. By reason of this construction, the carriage 93 may be reciprocated along the ways 92 merely by swinging the hand lever 97. The carriage 93 is provided with a projection 99 having a threaded bore 100 carrying a threaded stop screw 101 which is adapted to be locked in place by a lock nut 102. The stop screw 101 engages a stop projection 103 rising from the base 10 and serving to limit the forward motion of the carriage 93.

Mounted upon the carriage 93 is a motor 104 having a shaft 105 carrying a pulley 106 which is connected by the belt 107 to a pulley 108 upon the grinder shaft 109. The latter is journaled in the portion 110 of the carriage 93 and carries on its opposite end a hub 111 on which is mounted the grinding-wheel 112. The grinding-wheel 112 is secured thereto by the cap screw 113 and washer 114.

The grinding-wheel 112 is of a peculiar configuration, especially adapted to perform the objects of the invention. For this purpose, it is provided on its periphery with a raceway grinding surface 115 and a groove 116 including a side wall grinding surface 117 and an edge rounding portion 118.

The surfaces 115 and 117 must be accurately located so as to be at the proper angular inclinations relatively to each other, as determined

by the bearing cone 53 which is to be ground. The angle between the raceway grinding surface 115 and the side wall grinding surface 117 may be 90 degrees for certain bearing cones. In order to true these surfaces of the grinding-wheel 112 to the proper angles and to maintain these angles and surfaces in the proper condition, it is necessary to provide grinding-wheel truing mechanism which is operable accurately for this purpose.

Grinding-wheel truing mechanism

The grinding-wheel truing mechanism may be mounted in any convenient location where it is accessible to the periphery of the grinding-wheel. For purposes of illustration, the arrangement has been shown in the drawings wherein the truing mechanism is brought into engagement with the front portion of the periphery of the grinding-wheel.

Mounted on the forward portions of the V-ways 92 is a truing carriage 120 having corresponding ways 121. The carriage 120 carries a nut or boss 122 with a threaded bore 123 adapted to receive a screw shaft 124. The latter passes through a bore 125 in the bridge portion 126 of the base 10 and carries a hand crank 127 secured as at 128 to the outer end of the screw shaft 124 and which cooperates with a shaft enlargement 129 on the opposite side of the bridge 126 (Figure 1).

The truing carriage 102 is provided with cross ways 130 (Figures 1, 4 and 5) arranged at right angles to the ways 92, the apparent parallel showing of the ways 92 and 130 in Figures 4 and 5 being due to the fact that the section line 5-5 in Figure 1 cuts obliquely across both of the ways 92 and 130. Mounted on the cross ways 130 is a cross slide 131 having ways 132 cooperating with the ways 130. The truing cross slide 131 carries a nut or boss 133 (Figures 1 and 2) having a threaded bore 134 adapted to receive a screw shaft 135 journaled in the bridge portion 136 and carrying a hand crank 137 on its outer end. By means of the hand cranks 127 and 137, the truing carriage 120 and the truing cross slide 131 may be manipulated at right angles to one another in order to position the truing mechanism relatively to the grinding-wheel 112.

The truing cross slide 131 is provided with a central threaded bore 138 (Figure 5) serving to receive a pivot screw 139 having its upper end mounted in a bore 140 within the truing swivel 141, the latter being provided with a cylindrical projection 142 rotatable within a cylindrical recess 143 in the truing cross slide 131 and coaxial with the pivot screw 139. The truing swivel 141 is provided with an arcuate slot 144 in a projecting portion 145 and having its center at the axis of the pivot screw 139. A clamping bolt 145a mounted in a threaded hole 146 serves to clamp the truing swivel 141 to the desired position to which it has been rotated.

Mounted upon the truing swivel 141 are the top slideways 147 (Figure 5) upon which the top slide 148 is reciprocally mounted by means of its corresponding ways 148a.

The top slide 148 is provided on its underside with a threaded boss or nut 153 having a threaded bore 151 receiving the screw shaft 152. The screw shaft 152 is journaled in the bore 153 within the bridge portion 154 and carries a hand crank 155 on its outer end (Figure 1). By rotating the hand crank 155, the top

slide 148 may be moved to and fro along the ways 147 on top of the truing swivel 141.

The top slide 148 is provided with a head 149 (Figures 5 and 6) having a slideway 156 on the side thereof (Figures 4, 5 and 6) adapted to carry a reciprocable bar 157 having a corresponding groove 158 to fit the slideway 156. The bar 157 is provided with longitudinal slots 159 through which pass the clamping bolts 160 which are threaded into holes 161 in the side of the head 149. The bar 157 is provided with a threaded longitudinal bore 162 (Figure 6) adapted to receive a screw shaft 163 journaled as at 164 in a plate 165 secured to the head 149 and carrying a knurled head 166. Thus, by loosening the clamping bolts 160 and rotating the screw shaft 163, the bar 157 may be moved in or out as desired. The outer end of the bar 157 is provided with a bore 167 terminating in a socket 168 adapted to receive a truing element 169 containing a truing crystal 170 such as a diamond or other extremely hard substance (Figure 6). The truing element 169 is held in position by a set screw 171 (Figure 7), and has for its purpose the truing of the grinding-wheel portion 115 for grinding the raceway 55 of the bearing cone 53.

The head 149 is also provided with a longitudinal bore 172 (Figure 6) adapted to slidably receive a shaft 173 and provided with a keyway 174 containing a key 175 which enters a corresponding keyway 176 in the shaft 173 to prevent rotation of the latter while it is being advanced or retracted. The shaft 173 is provided with an internal bore 177 adapted to receive a hollow nut 178 in the form of a threaded sleeve, which in turn receives a screw shaft 179. The screw shaft 179 is provided with an outer portion 180 journaled in a bore 181 within a cap 182 threaded as at 183 into a bore 184 concentric with the bores 172 and 177. Mounted as at 185 on the outer end of the screw shaft portion 180 is a hand crank 186 for rotating the screw shaft 179, and accordingly advancing or retracting the shaft 173.

The outer end of the shaft 173 is cut away as at 187 (Figure 6) and is provided with a slideway 188 (Figures 6 and 7). The latter is engaged by a corresponding groove 189 in the block 190. The latter is provided with an oblique bore or socket 191 for receiving the truing element 192 containing a truing crystal 193, such as a diamond or other extremely hard substance. The truing element 192 is likewise anchored in position by means of a set screw 194 (Figure 7).

The end of the bar 173 is provided with a transverse bore 195 (Figure 6) having smooth walls and rotatably receiving the smooth shank of a cap screw 196, the threaded portion 197 of which passes through an enlarged hole 198 into an eccentric nut 199 having a smooth cylindrical outer surface 200 seated in a vertical groove 201, the axis of which is eccentric to the axis of the bore 195. By loosening the cap screw 196 and applying a wrench to the hexagonal portion 202 of the nut 199, the latter may be rotated in its groove 201 and the block 190 thereby moved to and fro along its slideway 188. When this adjustment has been performed as desired, the cap screw 196 is tightened so as to anchor the block 190 in its adjusted position.

The relative positions of the truing elements 169 and 192 are shown in Figures 9 and 10. The tip of the truing crystal 193 is rounded as at 203 (Figure 9) in order to create the rounded portion 118 in the grinding-wheel 112. This rounded portion 118 in the groove 116 produces the round-

ed edge 68 on the bearing cone 53 at the same time that the side wall 61 is produced by the grinding-wheel portion 117 (Figures 9, 11 and 12). The truing crystal 193 is also provided with approximately conical walls 204 for finishing the opposite wall of the groove 116 of the grinding-wheel 112. In order to limit the forward motion of the shaft 173, the threaded sleeve 178 (Figure 6) is provided with a flanged head 205 which comes into engagement with the annular shoulder 206 when the shaft 173 is moved forward as far as it will go. This provides a means whereby the tips of the truing diamonds or crystals 170 and 193 may be properly positioned relatively to each other as that the groove 116 and raceway grinding surface 115 of the grinding-wheel 112 may be formed to the proper dimensions and proportions.

Operation

In the operation of the machine and the practicing of the method of the invention, the grinding-wheel 112 must first be formed to the desired configuration by the action of the truing mechanism. For this purpose, the slides 12 and 25 and the swivel are manipulated to withdraw the work holding pins 45 from their grinding position (Figure 1) to their withdrawn position (Figure 2). The slides 120 and 131, the swivel 141, and the top slide 148 are then adjusted by turning their respective hand cranks until the ways 147 of the top slide 149 are approximately parallel to the direction of the surface 115 which is to be formed upon the grinding wheel 112. In the example shown (Figure 11), the direction of the surface 115 is approximately 45 degrees to the axis of the grinding wheel shaft 109, but other angles may be found suitable with different types of work piece. The swivel 141 is then clamped by tightening the cap screws 145.

The cap screws 160 are then loosened and the bar 157 moved by turning the knurled head 166 until the tip of the truing diamond or crystal 170 is in the proper position. Meanwhile, the shaft 173 is adjusted by turning the hand crank 186 and also by loosening the cap screw 196 (Figure 6) and rotating the eccentric nut 199 until the truing diamond or crystal 193 is positioned properly relatively to the truing diamond or crystal 170. The flanged head 205 on the threaded sleeve 178 serves as a stop to limit the inward motion of the shaft 173 when it comes into engagement with the annular shoulder 206 at the end of the threaded bore 184. When this occurs, the tip of the truing diamond 193 should be in advance of the tip of the truing diamond 170 by substantially the depth of the side wall truing portion 117 of the grinding-wheel 112. Thus the raceway grinding surface 115 may be trued and the groove 116 cut immediately afterward by advancing the shaft 173 until the flange 205 engages the annular abutment or shoulder 206 (Figure 6).

To form or true the raceway grinding surface 115, the shaft 173 is retracted (Figure 6) so that the truing diamond 170 projects beyond the end of the block 190. The screw shaft 152 is then rotated by turning the hand crank 155, causing the truing diamond 170 to pass over the peripheral surface of the grinding wheel 112 (Figure 10), forming or truing the surface 115. It is, of course, understood that after the surface 115 is originally formed, it can be used only a limited time before it requires re-truing. The head 149 is then retracted by rotating the hand crank 155

in the opposite direction. The raceway grinding surface is then in its completed condition.

To form the groove 116 in the periphery of the grinding wheel 112, the hand crank 186 is then turned until the truing diamond 193 cuts its way into the periphery of the grinding wheel 112 (Figure 9), coming to a halt when the stop flange 205 engages the stop shoulder or abutment 206. As this occurs, the side wall grinding surface 117 is first formed, and the rounded portion 118 subsequently formed (Figure 9) by the rounded top 203 of the truing diamond 204 as the latter reaches the end of its travel. During this operation, the truing mechanism occupies the position shown in Figure 2. The machine is then ready for its grinding operations.

To grind a bearing race 53, the hand lever is swung inward (Figure 1) pushing the shaft 70 and its head 69 forward, permitting the work holding pins 45 to advance under the urge of the coil springs 47. A work piece on bearing cone 53 is then pushed into place over the pins 45 and the hand lever 88 released. The spring 78 then pulls the shaft 70 and head 69 backward, retracting the pins 45 and causing their surfaces 49 to tightly engage and center the inner bore 51 of the bearing race 53.

Meanwhile, the work-holding pins 45 have been brought into the proper relationship to the grinding-wheel 112 by manipulating the hand cranks 18 and 30 and swinging the swivel head 34, thus moving the parts from the truing position (Figure 2) to the grinding position (Figure 1). The motor 104 is then started and the grinding-wheel 112 rotated.

As the grinding-wheel 112 rotates, the portion 115 thereof grinds the raceway surface 55 while the portion 117 grinds the side wall 61 and the rounded portion 118 rounds off the edge 68. In this manner, the principal surfaces on the periphery of the bearing cone 53 are simultaneously or substantially simultaneously ground, thereby reducing the grinding operations to a minimum and eliminating separate operations.

When the grinding has been completed, the pins 45 are again retracted by swinging the hand lever 88 inward, whereupon the work piece may be removed and a new work piece inserted. The latter becomes centered and clamped in position when the hand lever 88 is released. These operations may be repeated indefinitely until the order has been completed or the grinding wheel 112 requires retrueing.

Thus, the invention provides a machine and method whereby a grinding wheel may be trued to simultaneously grind a raceway and a side wall, and at the same time round the edge of the latter.

The side wall 61 of the bearing cone 53 is disposed at approximately 90 degrees to the bearing raceway 53. The frusto-conical rollers 56 have a lesser angle between their sides and larger end, but this is compensated for by rounding the larger end of the roller 56, preferably to a spherical or approximately conical shape.

As previously stated, the thrust of the outer race 64 upon the bearing rollers 56 tends to urge the ends 63 thereof against the side wall 61, producing heat which becomes concentrated at the edge of the side wall 61. The rounding of this edge 68, however, reduces this concentration of heat, and reduces the noise of the bearing, so that a more silent bearing is obtained.

While a specific embodiment of the invention has been described and illustrated, it will be understood that various modifications may be made within the scope of the appended claims without departing from the spirit of the invention.

What I claim is:

1. An adjustable cutter unit comprising a holder having a guideway, a cutter carrier slidable along said guideway and having an arcuate recess therein, a bolt supported by said holder and extending transversely to said carrier and projecting into said recess, a cutter adjuster nut having an eccentric boss rotatably mounted on said bolt and having an eccentric portion engaging said recess, and said nut and bolt serving for selectively and releasably clamping said carrier to said member.

2. An adjustable cutter unit comprising a holder having a guideway, a cutter carrier slidable along said guideway and having an arcuate recess therein and an elongated aperture extending therethrough from said recess, a bolt supported by said holder transversely to said carrier and extending through said aperture into said recess, a rotary cutter adjuster rotatably mounted on said bolt and having an arcuate portion eccentric to said bolt engaging said recess and a nut having an eccentric boss engaging within said arcuate recess for selectively and adjustably clamping said carrier to said holder.

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