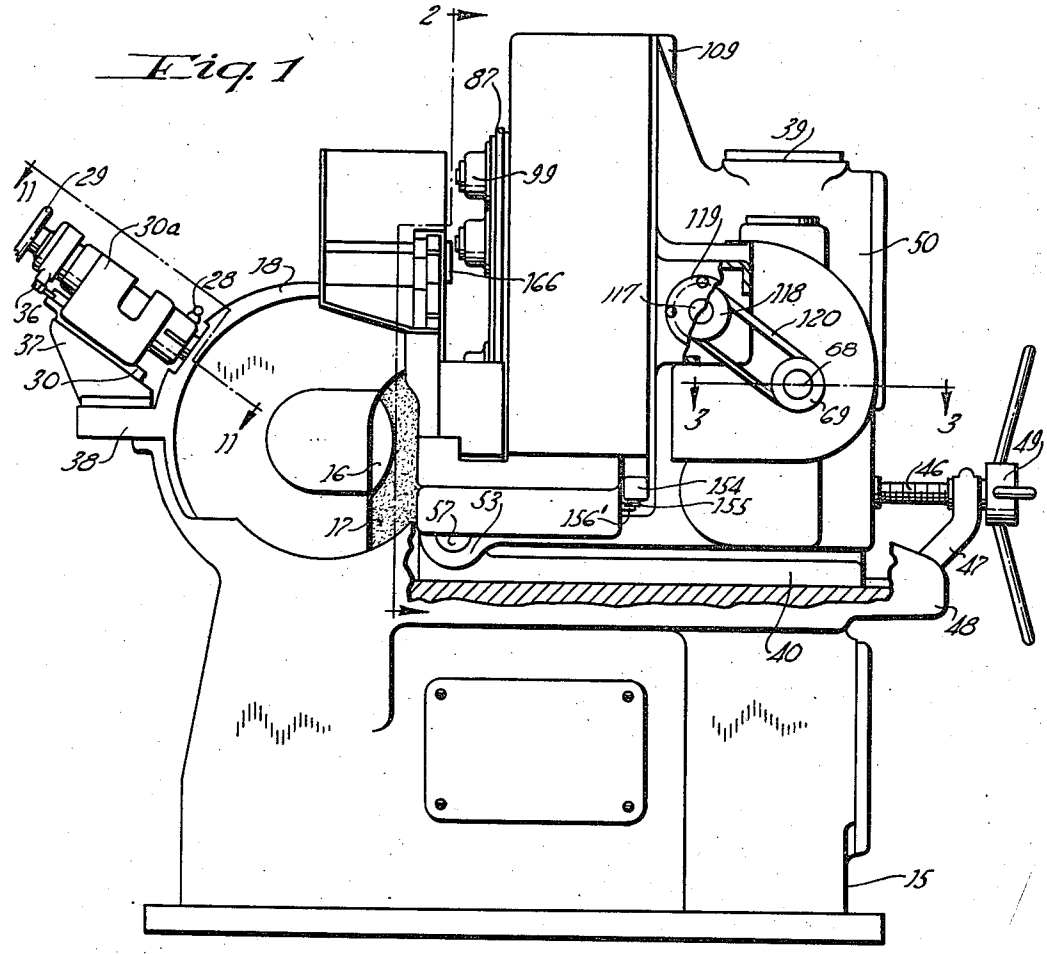
March 31, 1936. G. W. BINNS ET AL 2,035,737

GRINDING MACHINE

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Fig. 1



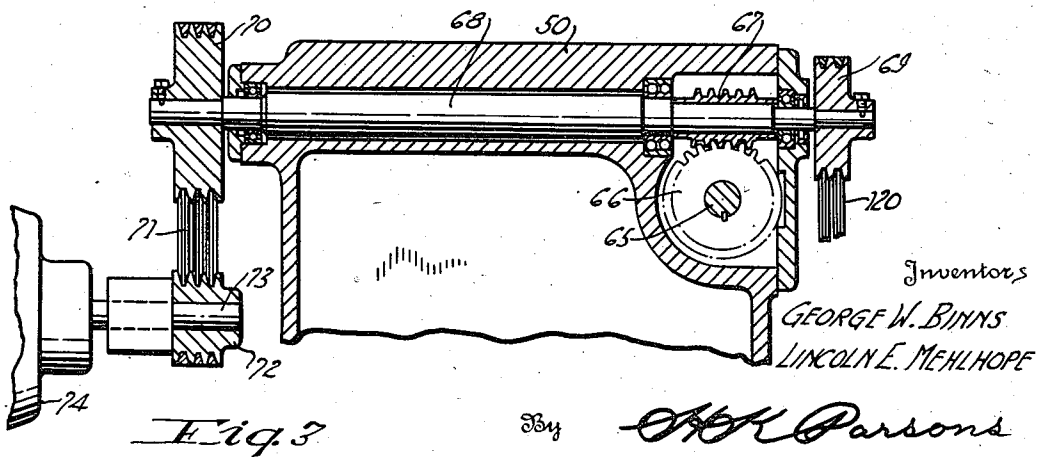


Fig. 3

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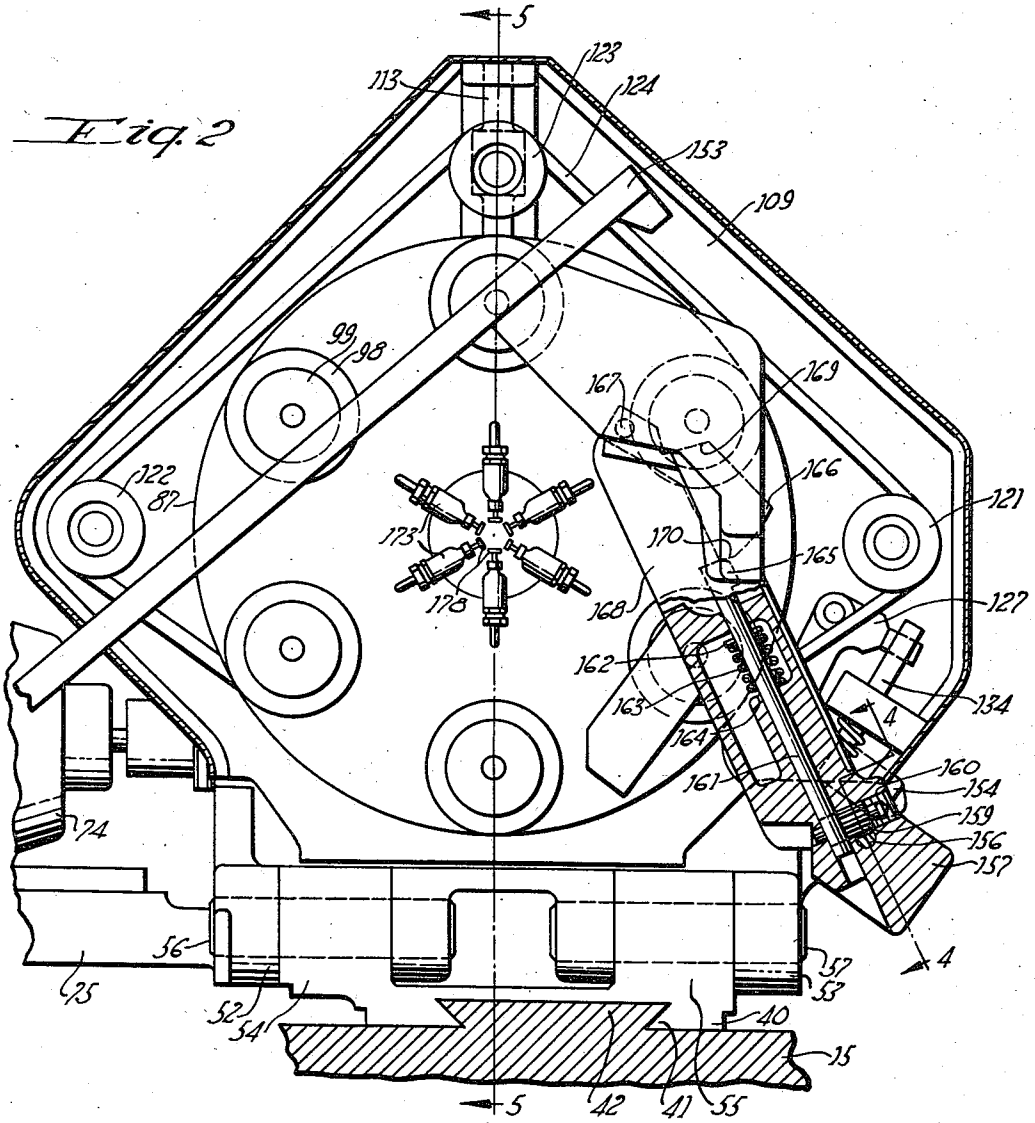
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GRINDING MACHINE

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Fig. 2



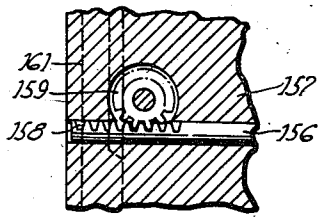


Fig. 4

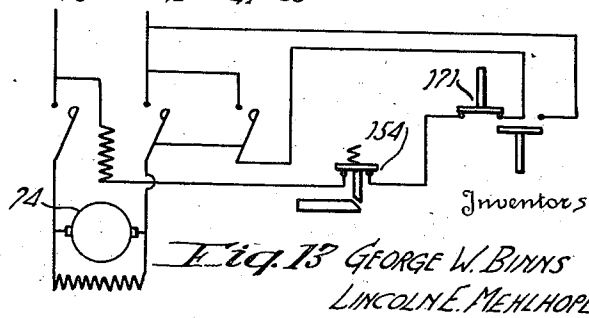


Fig. 13

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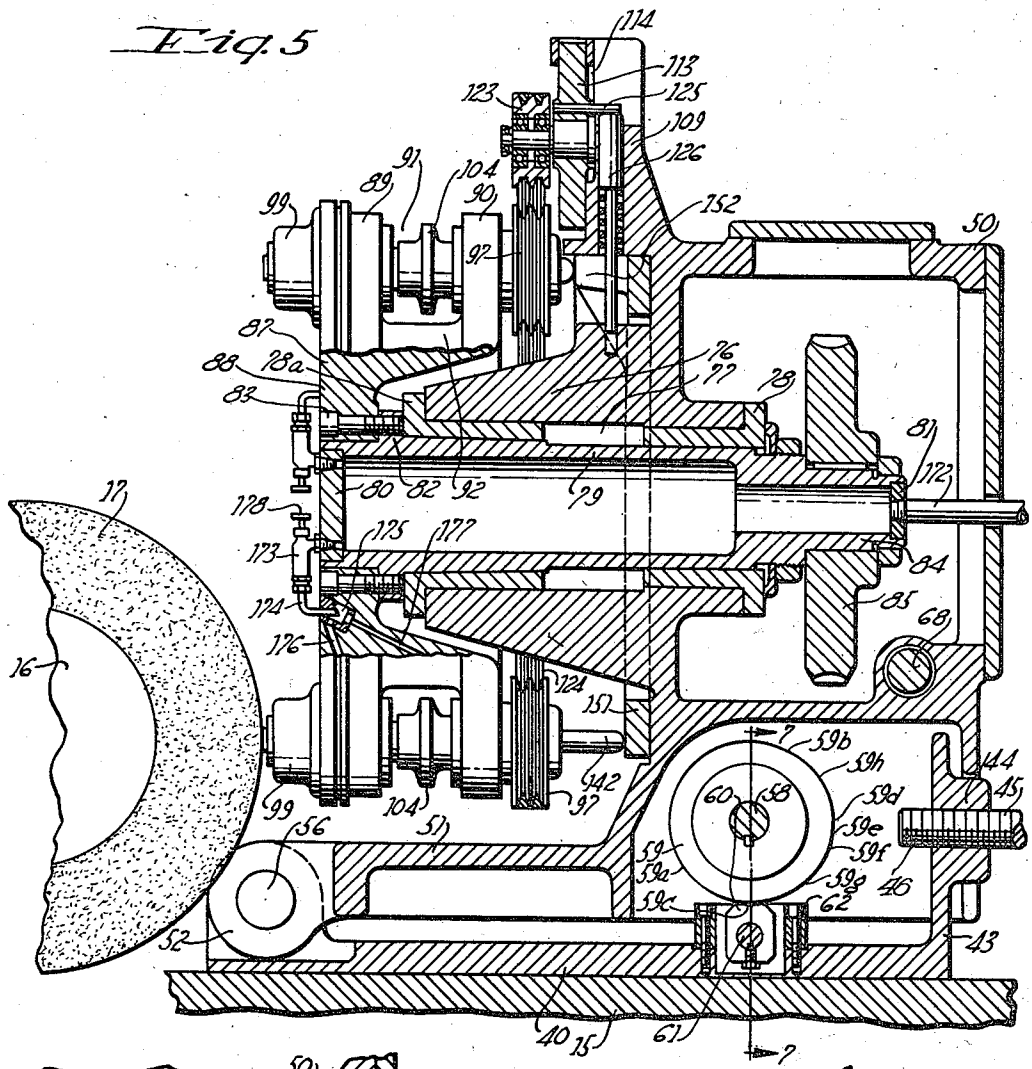
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GRINDING MACHINE

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Fig. 5



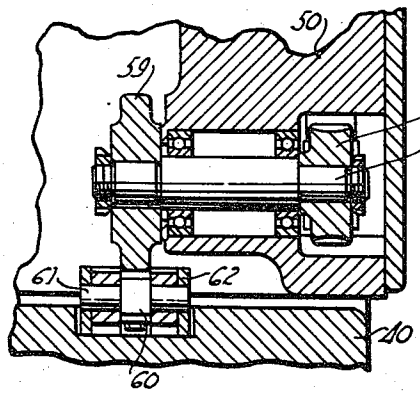


Fig. 7

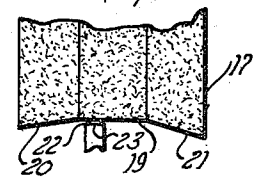


Fig. 12

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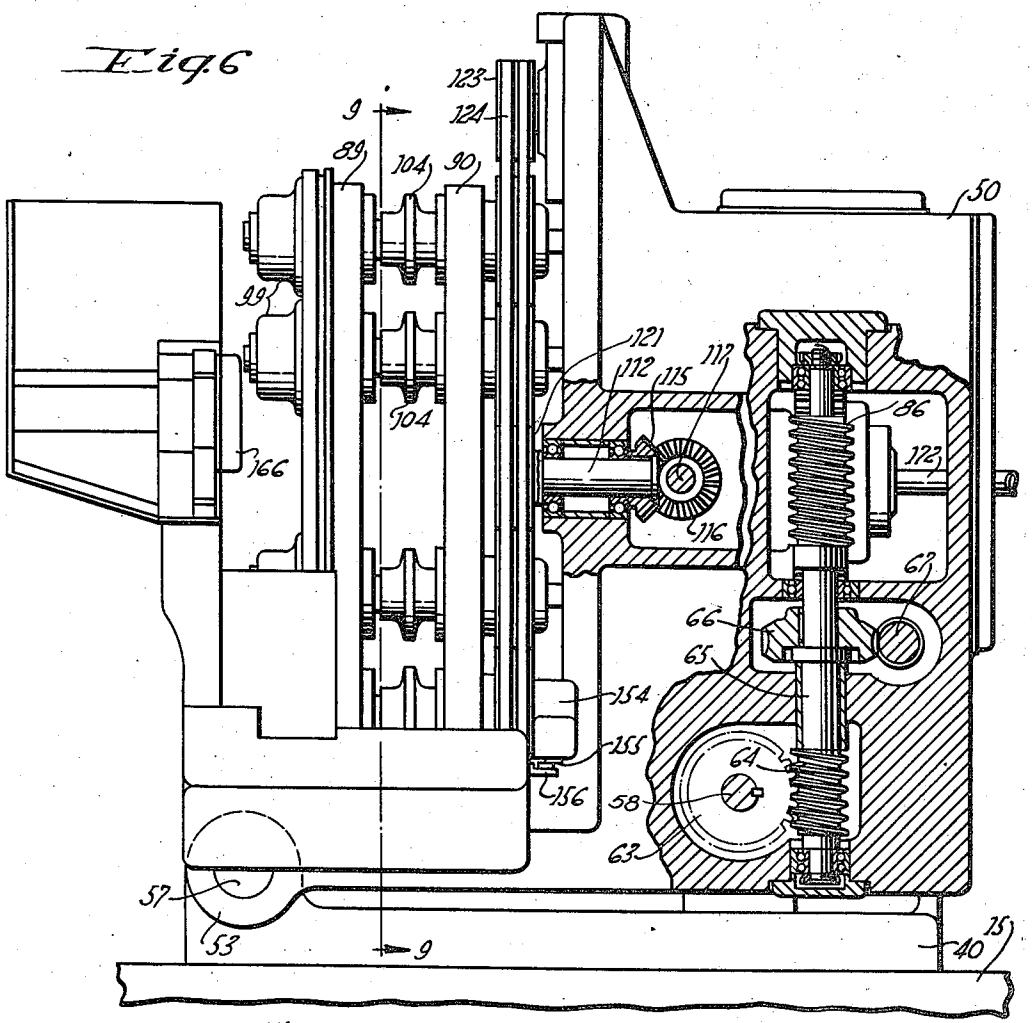
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GRINDING MACHINE

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Fig. 6



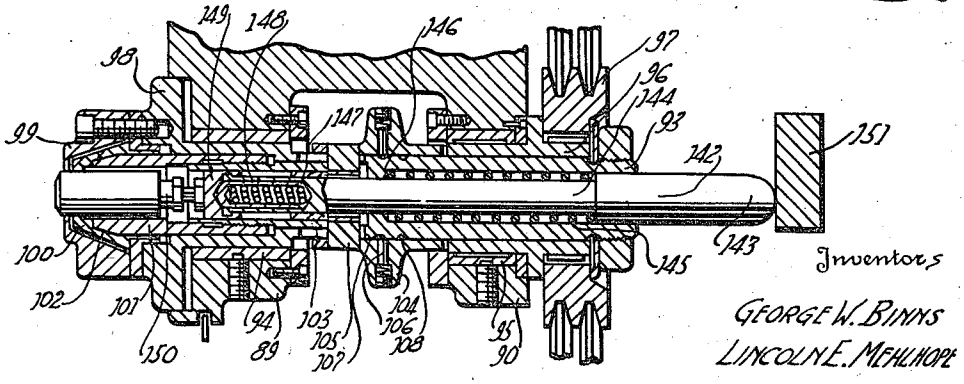


Fig. 8

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GRINDING MACHINE

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Fig. 11

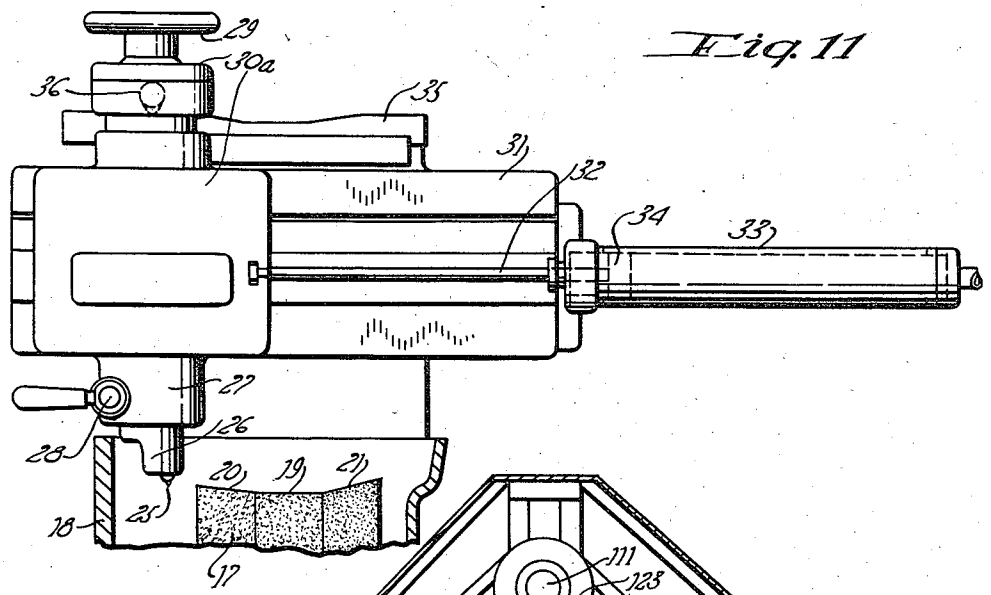
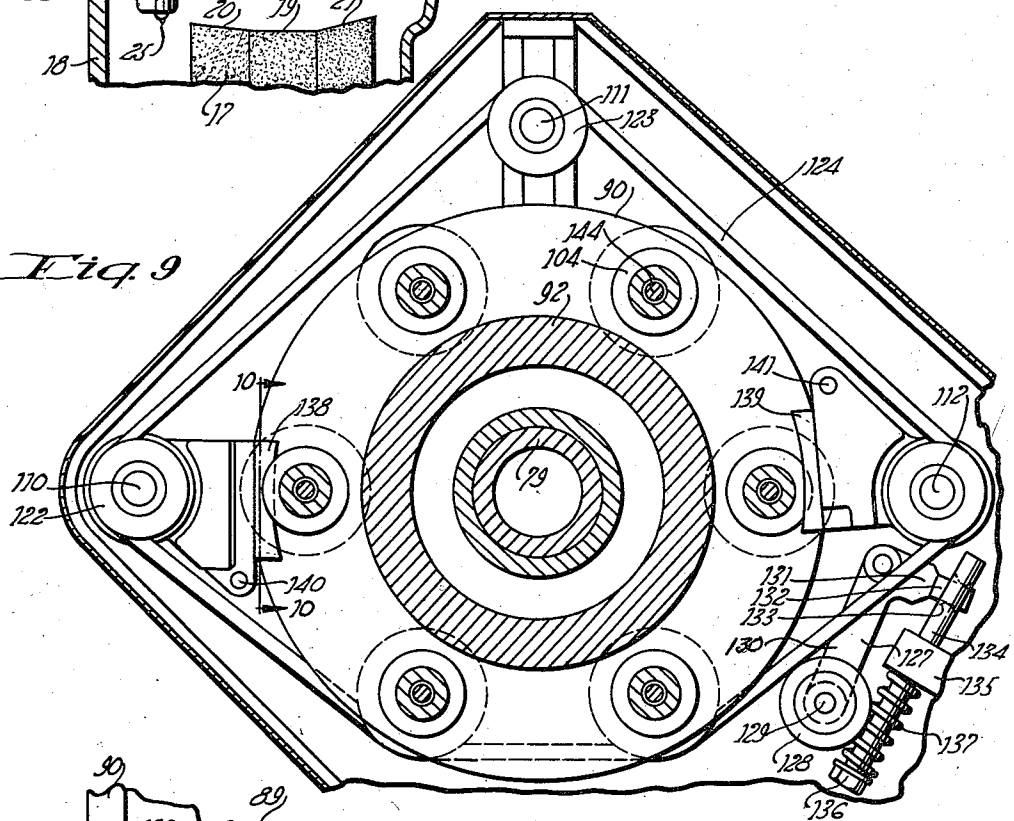


Fig. 9



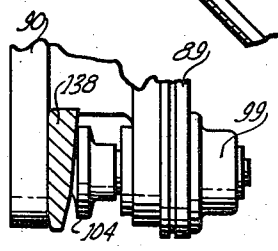


Fig. 10

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Patented Mar. 31, 1936 2,035,737

UNITED STATES PATENT OFFICE

2,035,737

GRINDING MACHINE

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Application March 3, 1934, Serial No. 713,900

13 Claims. (Cl. 51—108)

This invention relates to improvements in machine tools and particularly to improvements in grinding machines for producing formed work pieces.

One of the principal objects of the present invention is therefore the provision of a grinding machine for producing formed work pieces, that is, work pieces having a plurality of surfaces disposed in angular relation to one another.

Another object of the invention is the provision of a grinding machine for producing at a single operation work pieces having a plurality of angularly disposed surfaces and each successive work piece to the same contour and dimension.

A still further object of the invention is the provision of a substantially automatic machine for effecting a substantially continuous production of such formed work pieces.

It is also an object of the invention to provide a machine of the type above referred to which will automatically stop in the event the work piece is not in proper position relative thereto for an operation to be preformed thereon.

Additionally, it is an object of the present invention to provide a grinding machine for producing formed or irregular work pieces that automatically rotates the work, presents same to the grinding wheel and ejects it from the machine at the conclusion of the grinding operation, requiring an operator to merely load same.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification, considered in conjunction with the accompanying drawings forming a part thereof and it is to be understood that any modifications may be made in the exact structural details there shown and described, within the scope of the appended claims, without departing from or exceeding the spirit of the invention.

In the drawings:

Figure 1 is a front elevation of a grinding machine embodying the improvements of this invention.

Figure 2 is a transverse sectional view taken substantially on line 2—2 of Figure 1.

Figure 3 is a fragmentary sectional view taken on line 3—3 of Figure 1.

Figure 4 is a fragmentary sectional view on line 4—4 of Figure 2.

Figure 5 is a longitudinal sectional view through the portion of the machine at the right hand end thereof as seen in Figure 1, or as seen on line 5—5 of Figure 2.

Figure 6 is a view of the portion of the machine at the right hand end thereof with the guard removed and showing parts in elevation and parts in section, the parts in section being in a plane to the right of the plane of Figure 5 as seen in Figure 2.

Figure 7 is a sectional view taken on line 7—7 of Figure 5.

Figure 8 is a longitudinal sectional view through one of the work supporting and rotating chucks and forming a detail of the invention.

Figure 9 is a transverse sectional view as seen, for example, from line 9—9 on Figure 6.

Figure 10 is a fragmentary sectional view on line 10—10 on Figure 9.

Figure 11 is a view of the trueing mechanism as seen on line 11—11 of Figure 1.

Figure 12 is a view showing a fragment of the grinding wheel with the work in operative relation thereto, and as it passes said wheel.

Figure 13 is a wiring diagram showing the electrical circuit which includes the safety feature.

Throughout the several views of the drawings similar reference characters are employed to denote the same or similar parts.

The machine embodying this invention comprises a bed 15 having rising therefrom at one end thereof a bearing in which is journaled a spindle 16 for a grinding wheel 17. The wheel 17 is enclosed within a suitable guard 18 secured to the spindle supporting bearing. As shown in Figures 11 and 12, the operative portion of the wheel 17 is provided with a central cylindrical portion 19 and lateral inclined portions 20 and 21 on each side of the central cylindrical portion. These portions of the wheel co-operate to generate the contour on the terminal portion of the work which is shown in Figure 12 which comprises a conical portion 22 and a circular flat portion 23.

In order to maintain the shape of the wheel 17 there is provided a trueing tool in the nature of a diamond 25 secured in the outer end of a bar 26. The bar 26 is mounted for axial adjustment in a sleeve like portion 27 and the bar is held in adjusted positions by a suitable clamp 28. A screw adjusting mechanism is associated with the outer end of the bar and sleeve and is operated by a hand wheel 29. Since this adjusting mechanism forms no particular part of the present invention, and since it is well known it is not considered necessary to further

illustrate or describe same. The bar supporting sleeve 27 is in effect integral with a slide 30a movable transversely of a second slide 30 in turn movable longitudinally of a guide plate 31 whereby to effect a traverse of the diamond 25 across the face of the wheel. To effect the movement of the slide 30 it has connected therewith one end of a piston rod 32 which enters a cylinder 33 where it has secured to it a piston 34. An hydraulic medium under pressure is introduced into the cylinder at opposite ends thereof for effecting the movement of the piston 34 relative thereto and the consequent movement of the slide 30.

To produce the contour on the wheel it is necessary that the trueing tool or diamond 25 approach the axis of the wheel 17 and recede therefrom during the traverse relative thereto. To effect this in and out movement of the said diamond there is provided a cam 35 having substantially the same shape or contour to be produced on the wheel.

Co-operating with the cam 25 is a follower 36 associated with the upper or diamond bar slide 30a for effecting the said movement. The cam is secured to a carrier or support 37 which also carries the lower or guiding slide 31. The support 37 is in turn secured to a ledge or shelf 38 projecting outwardly from the wheel guard 18.

Opposite to the grinding wheel 17 and supported by the bed 15 is the work rotation and control unit indicated generally by the numeral 39, Figure 1. The said unit 39 is supported by a lower slide 40 having formed in its under surface a dovetail guide way 41, see Figure 2, receiving a correspondingly shaped tongue 42 projecting upwardly from the upper surface of the bed 15. The rear end of the slide 40 terminates in an upward flange 43, see Figure 5, in which is formed a threaded bore 44 meshing with the threads 45 of an adjusting screw 46. The adjusting screw 46, as seen in Figure 1, is rotatably journaled in a bracket 47 rising from the bed 15 or an extension 48 thereof. The screw 46 projects beyond the bracket 47 and to this projection is secured in any desirable manner a pilot or hand wheel 49 whereby the screw 46 is rotated to adjust the position of the slide 40.

The work rotation and control unit comprises a casting or housing 50 from which projects at its lower end a flange 51. At opposite sides the flange is provided with a pair of projecting arms 52 and 53 respectively straddling lugs 54 and 55 upstanding from the lower slide 40. The arms 52 and 53 and the lugs 54 and 55 are respectively provided with bores in axial alignment through which extend trunnions 56 and 57. From this it will be seen that the work rotation and controlling unit is mounted for oscillation toward and from the grinding wheel. In order to effect the said oscillation the casting or housing 50 carries the work and is oscillated by means of a cam 59 secured to one end of a shaft 58 which is rotatably journaled in the said housing 50. The cam 59 rides on a follower or pillow block 60 secured to a stud 61, in turn secured in a bracket 62 carried by the lower slide 40.

As seen in Figure 5, the cam 59 has a high portion 59a extending from the point 59b to a point 59c which is concentric with the axis of the driving shaft 58. From the point 59b to the point 59d is a relatively rapid rise, 59h followed by a concentric portion 59e extending from the point 59d to a point 59f. From the point 59f to the point 59c is a relatively slow decline 59g. During operation the cam 59 is rotated in a clockwise direction with the work and wheel relatively stationary as far as relative movement toward and from one another is concerned during the major portion of the grinding operation. That is, the portion 59a of the cam is riding on the pillow block 60 at the time the work contacts with the wheel at the point or edge of the wheel formed by the inclined portion 20 thereof and the adjacent side face. In view of the fact that the work is traversed across the wheel in an arcuate path it is considerably above the center thereof when initial contact is had. Therefore, as the work swings through its arcuate path it approaches the center of the wheel and is by this movement fed into the wheel. The portion 20 of the wheel therefore generates a substantial conical point on the work as it passes thereby. The work, on passing the plain cylindrical portion of the wheel, has the point of the cone ground off by the said cylindrical portion of the grinding wheel with the resultant truncated conical end on the work. During this movement of the work relative to the wheel the cam 59 was riding on the portion 59a, as above noted, and is so related to the work that when the work starts to engage with the inclined portion 21 of the wheel, the cam portion 59g of the cam comes into operation. This, of course, being a decline permits the work supporting and rotation control unit to fall away from the wheel, thereby giving in effect a retraction of the work from the wheel as they are traversed, thereby effecting a finish grind on the conical portion 22 of the work. This relative retraction of the work and wheel and simultaneous traverse thereof continues until the flat portion 23 of the work is free of the wheel whereupon the work controlling and rotation unit is held stationary until the said flat portion passes beyond the side of the wheel adjacent the inclined portion 21. The relatively rapid rise portion 59h between the point 59d and 59b immediately comes into play for again shifting the unit toward the grinding wheel when the portion 59a holds the parts stationary in the grinding position. The shifting of the unit toward the grinding wheel takes place after one work piece leaves the wheel and before a second work piece engages same, whereupon the cycle of movement is again repeated for generating the conical end of the work.

The shaft 58, and therefore the cam 59, is rotated through a worm wheel 63 secured to the end of the shaft 58 opposite to that carrying the cam 59. The said worm wheel 63 meshes with a worm 64 integral with or secured to a shaft 65 vertically disposed in the housing 50. Intermediate its ends the shaft 65 has keyed or otherwise secured to it a worm wheel 66, in turn meshing with a worm 67 on a shaft 68 disposed transversely of the housing 50. The shaft 68 extends through and beyond the lateral sides of the said housing 50 and to each projecting end is secured a pulley or sheave 69 and 70. The sheave 70 has trained thereabout a plurality of V belts 71, in turn extending about a pulley or sheave 72 on a motor shaft 73. The motor shaft 73 is associated with an electric motor or prime mover 74 fastened to a rearwardly projecting motor support 75 integral with the lower slide 40.

From the foregoing it will be noted that the work supporting unit is oscillatable toward and from the grinding wheel as seen in Figure 5. As has been previously described, this oscillation of the unit takes place partly while the work piece

is passing across the face of the grinding wheel 17 and partly before the work engages same.

The casting or housing 50 is provided with an enlarged circular portion or boss 76 through which is formed a bore 77 receiving in opposite ends bushings 78 and 78a. Rotatably mounted in said bushings is a relatively large sleeve or spindle 79. The spindle 79 is substantially hollow and closed at one end by a head 80 and at the other end by a head 81. Near the head 80 the spindle 79 is provided with a radial flange and nose 82 to which is secured, as by screws 83, the work holding mechanism 87. The rear end of the spindle 79 or adjacent the head 81 is reduced in diameter as at 84, to which reduced portion is keyed or otherwise secured a worm wheel 85. The worm wheel 85 meshes with a worm 86 integral with or secured to the vertical shaft 65. From this it will be seen that the spindle 79 is rotated relative to the housing 50.

The work supporting mechanism 87 is in the nature of a drum having an inner radial flange 88 which fits on the nose 82 of the spindle and through which the attachment bolts 83 pass. The drum 87 is in the form of a pair of spaced annular members 89 and 90, providing therebetween the space 91, which in effect is a circumferential groove closed at the bottom by the webbing 92 which connect the annular members or flanges 89 and 90.

The annular members 89 and 90 are pierced with a plurality of bores circumferentially spaced relative to the axis of the said drum. Each bore in one of the annular members or flanges is in axial alignment with a corresponding bore in the other, and the said aligned bores carry the work chucks with the chuck operating mechanism disposed in the space or annular groove 91 between the flanges 89 and 90. Each of the chucks are identical in construction and it is believed that a description of one of them will suffice for all, and the said chuck is illustrated in detail in Figure 8.

The chuck comprises a main or supporting sleeve or spindle 93 rotatably journaled in bushings 94 and 95 respectively secured in the bores in annular members 89 and 90. Keyed or otherwise secured to the spindle 93 at its rear end is a driving sleeve 96 to which is keyed or otherwise secured a pulley or sheave 97. The forward end of the chuck spindle 93 terminates in a head 98 for a spring arm chuck 99. The chuck 99 includes spring fingers 100 so arranged as to exert a yielding gripping pressure on the work during the grinding operation. In order to release the work from the grip of the fingers 100 there is provided for sliding movement interiorly of the head end of the spindle a plunger 101 having a conical end 102 for engagement with correspondingly shaped portions of the fingers 100. The plunger 101 is threaded to a rod 103, likewise slideable interiorly of the spindle 93. The rod 103 and plunger 101 are shifted by a shifter member 104 which carries a pin 105, in turn extending through the hollow rod 103. The shifter member 104 is slideable on the exterior of the spindle 93 to an operative position and an inoperative one and adapted to be yieldably held in said positions. For this purpose the shifter 104 carries one or more spring pressed detents 106 co-operating on their inner ends with V shaped notches 107 and 108 formed in the exterior of the spindle 93. From the foregoing it will be noted that the work may be clamped or held in the chuck or released therefrom upon movement of the member 104.

As was noted above, the work drum has a plurality of work supporting chucks which are movable with the drum relative to the grinding wheel as the said drum is actuated through the rotation of its supporting spindle. Also, as above noted, each chuck has associated therewith a driving pulley or sheave 97 which is utilized for effecting rotation of the individual chucks and work supported thereby. It will be appreciated that it is only necessary to rotate the work while it is being operated upon by the grinding wheel. For this reason the chuck pulleys or sheaves engage with the driving belt only at the time the drum is passing through the portion of its circle while the work is being operated upon or, as shown in Figures 2 and 9, when the chucks are at the bottom of the circle as seen in these figures.

The work supporting housing 50 behind the drum 87 is provided with a face plate 109 in which is journaled idler pulley or sheave spindles 110 and 111 and driving pulley or sheave spindle 112. The idler spindle 110 is fixed so far as its axis is concerned, while the idler spindle 111 is carried by a block 113 disposed in a guide way 114 formed vertically through the plate 109. The driving spindle 112 is rotatably journaled in the wall or face plate 109 and projects therethrough into the interior of the housing 50. Secured to said internally projecting end of the driving spindle 112 is a bevel gear 115, see Figure 6, meshing with a bevel gear 116 on a shaft 117 which extends at right angles to the spindle 112. The shaft 117 projects beyond the forward wall of the housing 50, as seen in Figure 1, to which projecting end is secured a pulley or sheave 118 disposed in the final assembly beneath a cover plate 119.

The sheave or pulley 118 is in alignment with the sheave or pulley 69 on the transverse shaft 68 and about the said sheaves 118 and 69 are trained a plurality of flexible transmission members or V belts 120, all as seen in Figures 1 and 3.

Fastened in any desirable manner to the driving shaft or spindle 112 projecting forwardly of the face plate 109 is a pulley or sheave 121, while loosely journaled on the idler spindles 110 and 111 are similar pulleys or sheaves 122 and 123. As shown in Figure 6, the pulleys or sheaves 121, 122 and 123 are of the multiple groove type about which is trained a plurality of V belts 124. The pulleys 121, 122 and 123 are so arranged with respect to each other that when the chucks reach the lower portion of the circle of rotation of the drum the pulleys or sheaves thereof take up the said belts 124, and since the said belt is constantly rotating the chucks will be correspondingly driven. This is shown clearly in Figures 2 and 9, in the former of which the lower three chucks have their pulleys engaged with the driving belts, while in Figure 9 but two of the said chucks are being rotated, the first pulley having passed beyond the belts while the following pulley has not yet reached said belts. From the foregoing it should now be evident that the chucks, together with the work supported thereby, are rotated at the time the work is passing and engaging the grinding wheel.

In order to take the slack out of the said belts 124, the block 113 which supports the upper idler pulley spindle 111, has projected therefrom a pin 125 in constant engagement with a spring pressed plunger 126 carried by the housing 50 and at all times urging said idler pulley assembly in a direction to tension the belts. Additionally, to take the slack out of the belts 124 and to insure proper contact with the chuck pulleys the

plate 109, see Figure 9, has pivotally mounted thereon, a bell crank 127 having a plane faced roller 128 rotatably mounted at 129 at one end of its one arm 130. The roller 128 is adapted to engage with the backs of the said V belts 124. The second arm 131 of the bell crank 127 is provided with a circular lug portion 132 received in a bore or notch 133 formed in a rod 134. The rod 134 is slidably mounted in a lug 135 projecting forwardly of the housing plate 109. Below the lug 135 the rod 134 is provided with a head 136 and surrounding the rod and disposed between the said head 136 and the plate lug 135 is a spring 137 yieldably urging the rod downwardly, as seen in Figure 9. This movement of the rod 134 tends to rotate the bell crank 127 in a clockwise direction, which through the roller 128 urges the belts 124 toward the chuck pulleys as they come within the grinding zone.

In order to clamp and unclamp the work relative to the chucks or clamping fingers 100, the plunger 101 is automatically shifted first in one direction and then in the opposite direction during each rotation thereof with the drum. This automatic shifting of the plunger 101 is effected by a pair of cams 138 and 139 engaging first on one side of the shifter member 104 and then on the other. The cams 138 and 139 are shown in Figure 9 as disposed at diametrical points and in a horizontal plane as respects the machine. From this it will be seen that the chucks have the work clamped therein when passing through the lower half of the circle and loose therein when passing through the upper half of the circle.

Any suitable or desirable means may be utilized for securing the said cams in operative position, such as pins or bolts 140 and 141 respectively employed with cams 138 and 139.

The work pieces are adapted to be automatically ejected from their respective chucks, for which purpose the spindles of the chucks are hollow and carry for sliding movement relative thereto an ejector rod 142 having an enlarged or guiding portion 143 and a reduced portion 144. Surrounding the reduced portion 144 is a spring 145 which abuts on one end with the guiding portion 143 and on the other end with the bottom 146 of the bore in the spindle through which the guide 143 acts. The spring 145 tends to urge the ejector rod 143 to the right as seen in Figure 8, at which time the chuck may be loaded. The inner end of the plunger 142 is provided with a socket 147 containing a spring loaded plunger 148 abutting against an abutment plate 149 from which projects an adjustable abutment, in the nature of a headed bolt, 150 which contacts with the adjacent end of the work to limit or position same with respect to the movement of the chuck and for ejecting the work from the chuck when the rod 142 is shifted to the left. The means for shifting the rod 142 to eject the work from the chuck is a cam plate 151 against which the outer end of the rod 142 is held by the spring 145. As seen in Figure 5 the cam plate 151 is substantially parallel throughout most of its extent, having only a high point or lug 152 at the upper portion thereof or substantially beneath the idler pulley spindle 111.

From this it will be seen that the work may be loaded in the chucks just after they pass top center and ejected therefrom upon substantially a complete revolution thereof or at about the time they again reach the said top center. The work is pushed free of the chucks by the rod 142 where they fall by gravity into a trough 153 Figure 2, down which they travel by gravity to a suitable receptacle (not shown) placed at the end thereof to receive same.

The operation of the mechanism is as follows:

The motor 74 is started as is the motor (not shown) for rotating the grinding wheel at its usual high rate of speed. The portion of the cycle of rotation of the drum 87 between the idler pulley or sheave spindle 111 and the driving pulley or sheave spindle 112 constitutes the loading zone and it is while the chucks on the drum are passing through this zone that the work pieces are inserted individually therein. At this time, of course, the ejector rod 142 of these chucks have their heads riding on the low portion of the cam 151 with their stops 150 properly positioned relative to the chuck fingers. The work pieces are therefore inserted into the chuck fingers until the inner end thereof contacts with the stop 150.

Through the transmission mechanism from the motor 74 and including the worms and worm wheels 86, 64, 85, and 63, the drum spindle 79 and cam shaft 58 are rotated in timed sequence. The ratio existing between the said spindle 79 and shaft 58 is such that the cam 59 makes six revolutions to one revolution of the work spindle. The contour of the cam 59 is located in such a manner with respect to the chucks on the drum 87 that the work is oscillated with respect to the grinding wheel, or the work supporting and controlling unit is oscillated about the trunnions 56 and 57 from the grinding wheel during the time that, as fully explained above, each work piece passes across the inclined face 21 of the grinding wheel. From this it will be seen that the work supporting and controlling unit, as a whole, oscillates as many times during each revolution of the drum 87 as there are work supporting chucks thereon.

In view of the fact that the individual chuck driving sheaves are free of the belts when passing through the loading zone it will be appreciated that the said chucks are not rotated, thereby materially facilitating the loading of said chucks. As the chucks with their work approach the grinding zone the sheaves thereon individually pick up the driving belts 124 so that during the actual grinding operation the work pieces are being rotated. Upon passing out of the grinding zone the chuck sheaves leave the belts 124 and the rotation of the work therefore stops. As the individual chucks approach the loading zone the cam face of the cam 151 reaches the high point 152 for shifting the ejector rod relative to the chuck spindles 93 to eject the work from the chucks. This ejection of the work from the chuck takes place over the discharge chute 153 which receives the work and delivers same to a suitable receptacle placed to receive it.

As was set forth above, after the work is placed in the chucks the drum carries same down past the clamping cams 139 which shifts the chuck actuator to secure the work therein. The chucks after passing through the grinding zone, have their actuator engaged by the releasing cam 138 which releases the work from the chuck fingers so that the ejector rod may then eject the work from the said chucks.

As is usual in grinding machines, a relatively small amount of stock is removed per pass of the work relative to the wheel. In the present in-

stance due to the relatively small diameter of the work, compared to the relatively wide face of the wheel, a little greater amount of stock may be removed from the work than is usual, being due partly to the arcuate path of the work with the face of the wheel and partly due to the retraction of the work from the wheel by the cam 59 during the relative traverse thereof. However, it is necessary that the work be accurately positioned with respect to the wheel to determine the proper amount of stock removal and to prevent a wreck. This is determined by the projection of the work from the chuck as determined by the stop 150. It is possible that the operator may not insert the work within the chuck a sufficient distance, thereby causing the work to project beyond the chuck too far, or the work may be of an irregular length and again project beyond the chuck a distance greater than that allowed. This excess projection of the work would engage the side of the wheel and thereby either wreck the machine, damage the wheel or cause some other relatively expensive accident. To prohibit this possibility, a safety device has been incorporated in the machine which when this condition occurs will stop the machine.

This safety device comprises a switch 154 included in the electrical circuit to the motor 74, as seen in Figures 1 and 13. The switch 154 has an actuator 155 adapted to be operated by the nose 156[1] of a sliding plunger 156. The plunger 156 is slideable through a bracket 157 secured to the work controlling unit 50, and the said plunger 156 has formed at its other end rack teeth 158 meshing with a relatively wide rack pinion 159. The pinion 159 is rotatably mounted in a bore 160 in the housing 157 and has meshing with it the rack teeth of a vertically disposed rack bar 161. As seen in Figure 2, the bar 161 is slideable relatively vertically as respects the machine and projects above the housing 157. Extending transversely of the rod 161 is a pin 162 forming one abutment for a spring 163 which encircles the rod 161 and the said spring 163 abuts on its other end with a shoulder 164 provided by the housing 157. The spring 163 actuates the parts through the rack pinion 159 in a direction to leave the switch 154 free and closed.

Above the housing 157 the rod 161 is provided with an enlarged head 165 which underlies an arm 166. The arm 166 is pivotally mounted at 167 to an extension 168 secured to the housing 157 and projecting thereabove. The arm 166 is provided intermediate its ends with a step or shoulder 169. The arm 166 is confined by the housing extension 168 against any movement other than a rotary one about the axis of the pivot 167. In the final assembly, and as shown in Figure 1, the arm 166 is positioned with respect to the work that if the work is projecting from the chucks the right distance no interference is had but if the work projects beyond the allowable distance, it engages with the shoulder 169 and thereby oscillates the arm 166. The arm 166 through the cam face 170 thereon pushes the rod 161 downwardly against the resistance of its spring 163. This movement of the rod 161 through the rack gear 159 shifts the rod 156 to the right as seen in Figure 1 for opening the switch 154 and interrupting the electrical circuit to the motor 74.

As seen in Figure 13 the limit switch 154 is wired in series with the starting and stopping switch 171. It is believed that the wiring diagram is self-evident without further description since the opening of the switch 154 would be the same as the opening of the stop switch of the starting and stopping switch 171.

In order to maintain the individual chuck spindles properly lubricated during the rotation thereof the main spindle 79, as mentioned above, is hollow, being closed at opposite ends by the heads 80 and 81. Use is made of the hollow interior of the spindle as an oil or lubricant reservoir for supplying the lubricant to the said individual chuck spindles. For this purpose the rear head 81 has tapped therein the terminus of a lubricant supply pipe 172 which supplies lubricant from any suitable source to the interior of the spindle. The forward head 80 is provided with as many tapped holes as there are chucks in the drum 87 and into each tapped hole is screwed the inlet end of a valve body 173. The other side of each valve body 173 is connected by a discharge pipe 174 with an oil well 175 formed above each of chuck spindles 93. The oil wells 175 supply through ducts 176 and 177 lubricant to the bearings formed respectively in the annular or ring members 89 and 90. In order to control the amount of lubricant delivered to said bearings each of the valve bodies 173 contain a throttle valve operable by the knobs 178 projecting from each of the said valve bodies. From the foregoing it will be seen that the individual chuck spindles are adequately lubricated during rotation, while rotating the work in contact with the wheel.

What is claimed is:

1. In a grinding machine of the class described the combination of a bed, a grinding wheel rotatably supported thereby, a work supporting drum mounted for rotation about an axis at right angles to the face of the grinding wheel, means for effecting a continuous rotation of the drum, a plurality of work supporting units carried by said drum for passing successive work pieces in an arcuate path transversely of the face of the wheel as the drum is rotated, means for rotating the individual work supporting units when the work thereof is in contact with and traversing the grinding wheel as the drum rotates, and power operated means for automatically shifting the drum a prescribed distance toward and from the grinding wheel during the traverse of the work relative thereto whereby the contour produced on the work by grinding is a resultant of the transverse contour of the grinding wheel and the automatic shifting movement imparted to the work.

2. In a grinding machine of the class described the combination of a bed, a grinding wheel rotatably supported thereby, a work supporting drum mounted for rotation about an axis at right angles to the face of the grinding wheel, means for effecting a continuous rotation of the drum a plurality of work supporting units carried by said drum for passing successive work pieces in an arcuate path transversely of the face of the wheel as the drum is rotated, means for rotating the individual work supporting units when the work thereof is in contact with and traversing the grinding wheel as the drum rotates, power operated means for automatically shifting the drum a prescribed distance toward and from the grinding wheel during the traverse of the work relative thereto whereby the contour produced on the work by grinding is a resultant of the transverse contour of the grinding wheel and the automatic shifting movement imparted to the work, and means for ejecting the work

pieces from the supporting units after the grinding operation.

3. In a grinding machine for grinding the terminal portion of circular work pieces the combination of a rotating grinding wheel, and a work rotating, feeding and traversing unit mounted on the bed and comprising a spindle rotatable abount an axis normal to the face of the wheel, a work supporting drum carried by the spindle for rotation therewith, a plurality of work supporting and rotating chucks associated with the drum individually supporting a work piece for terminal engagement with the wheel during the rotation thereof and traversing said terminal portion of the work relative to the face of the wheel, a pivotally mounted carriage for supporting the work supporting and controlling unit and means for oscillating said carriage toward the grinding wheel to effect an approach and retraction of the work and the wheel.

4. In a grinding machine for grinding the terminal portion of circular work pieces the combination of a rotating grinding wheel, and a work rotating, feeding and traversing unit mounted on the bed and comprising a spindle rotatable about an axis normal to the face of the wheel, a work supporting drum carried by the spindle for rotation therewith, a plurality of work supporting and rotating chucks associated with the drum individually supporting a work piece for terminal engagement with the wheel during the rotation thereof and traversing said terminal portion of the work relative to the face of the wheel, a pivotally mounted carriage for supporting the work supporting and controlling unit means for oscillating said carriage toward the grinding wheel to effect an approach and retraction of the work and the wheel, a slide mounted on the bed and supporting the carriage, and means for shifting the slide relative to the bed toward and from the carriage.

5. In a grinding machine for grinding the terminal portion of circular work pieces the combination of a rotating grinding wheel, and a work rotating, feeding and traversing unit mounted on the bed and comprising a spindle rotatable about an axis normal to the face of the wheel, a work supporting drum carried by the spindle for rotation therewith, a plurality of work supporting and rotating chucks associated with the drum individually supporting a work piece for terminal engagement with the wheel during the rotation thereof and traversing said terminal portion of the work relative to the face of the wheel, a pivotally mounted carriage for supporting the work supporting and controlling unit, means for oscillating said carriage toward the grinding wheel to effect an approach and retraction of the work and wheel, and means for synchronizing the rotion of the work supporting drum and carriage oscillating means whereby the carriage is oscillated at the time a work piece is traversing the wheel:

6. In a grinding machine for grinding the terminal portion of circular work pieces the combination of a rotating grinding wheel, and a work rotating, feeding and traversing unit mounted on the bed and comprising a spindle rotatable about an axis normal to the face of the wheel, a work supporting drum carried by the spindle for rotation therewith, a plurality of work supporting and rotating chucks associated with the drum individually supporting a work piece for terminal engagement with the wheel during the rotation thereof and traversing said terminal portion of the work relative to the face of the wheel, each of said chucks having an open work receiving position and an alternative closed work gripping position, a chuck actuating member individual to each chuck for determining the opening or closing thereof, said member having a cam engaging groove formed therein, and spaced cam members adjacent the drum successively engageable in said grooves for alternately opening and closing individual chuck devices during rotation of the drum.

7. In a grinding machine for grinding the terminal portion of circular work pieces the combination of a rotating grinding wheel, and a work rotating, feeding and traversing unit mounted on the bed and comprising a spindle rotatable about an axis normal to the face of the wheel, a work supporting drum carried by the spindle for rotation therewith, a plurality of work supporting and rotating chucks associated with the drum individually supporting a work piece for terminal engagement with the wheel during the rotation thereof and traversing said terminal portion of the work relative to the face of the wheel, each of said chucks having an open work receiving position and an alternative closed work gripping position, a chuck actuating member individual to each chuck for determining the opening or closing thereof, said member having a cam engaging groove formed therein, and spaced cam members adjacent the drum successively engageable in said grooves for alternately opening and closing individual chuck devices during rotation of the drum, and independent means for automatically ejecting the work from the chucks after the grinding operation.

8. In a grinding machine for grinding the terminal portion of circular work pieces the combination of a grinding wheel having its peripheral face contragenerically formed to the contour to be produced on the terminus of the work, means for supporting a work piece for traversing movement relative to the grinding wheel, means to shift the work piece transversely of the peripheral face of the grinding wheel during the grinding operation, a chuck for supporting the work for rotation about an axis normal to the face of the wheel, means for automatically clamping the work in the chuck prior to the traversing movement, means for automatically releasing the work from the chuck at the end of the traversing movement, means for automatically ejecting the work from the chuck upon release thereof, and cam means having a contour complementary to the transverse contour of the periphery of the grinding wheel for automatically effecting an approach and retraction of the work and the wheel during the traversing movement whereby the contour produced on the work by the grinding operation will be the resultant of the combined reactions of the contoured face of the grinding wheel and the movement with respect thereto as determined by said cam means.

9. In a grinding machine for grinding the terminal portion of circular work pieces the combination of a grinding wheel having its peripheral face contragenerically formed to the contour to be produced on the terminus of the work, means for supporting a work piece for traversing movement relative to the grinding wheel, means to shift the work piece transversely of the peripheral face of the grinding wheel during the grinding operation, a chuck for supporting the work for rotation about an axis normal to the face of the wheel, means for automatically clamping the work in the chuck prior to the traversing

movement, means for automatically releasing the work from the chuck at the end of the traversing movement, means for automatically ejecting the work from the chuck upon release thereof, cam means having a contour complementary to the transverse contour of the periphery of the grinding wheel for automatically effecting an approach and retraction of the work and the wheel during the traversing movement whereby the contour produced on the work by the grinding operation will be the resultant of the combined reactions of the contoured face of the grinding wheel and the movement with respect thereto as determined by said cam means, and means for feeding the chuck and work toward the wheel.

10. In a grinding machine for contour grinding the terminal portions of work pieces, the combination with a grinding wheel having a transversely contoured peripheral face, of a carrier mounted to rotate about an axis parallel with the plane of rotation of the grinding wheel, means to impart a continuous rotative movement to said carrier, a plurality of work holding members mounted on the carrier whereby the same are successively shiftable in an arcuate path transversely of the contoured periphery of the grinding wheel upon rotation of the carrier, means to selectively rotate an individual work holder upon the carrier during the traversing movement of said individual work carrier with respect to the grinding wheel, and means for effecting individual oscillatory movements of the carrier toward and from the periphery of the grinding wheel during traverse of its individual work holders with respect to the grinding wheel.

11. In a grinding machine for contour grinding the terminal portions of work pieces, the combination with a grinding wheel having a transversely contoured peripheral face, of a carrier mounted to rotate about an axis parallel with the plane of rotation of the grinding wheel, means to impart a continuous rotative movement to said carrier, a plurality of work holding members mounted on the carrier whereby the same are successively shiftable in an arcuate path transversely of the contoured periphery of the grinding wheel upon rotation of the carrier, means to selectively rotate an individual work holder upon the carrier during the traversing movement of said individual work carrier with respect to the grinding wheel, means for effecting individual oscillatory movements of the carrier toward and from the periphery of the grinding wheel during traverse of its individual work holders with respect to the grinding wheel, motive means for effecting the continuous rotation of the carrier, and a safety device adjacent the carrier engageable by incorrectly mounted work pieces in the individual work holders in advance of their presentation to the grinding wheel whereby the motive means may be automatically rendered ineffective on the carrier prior to such engagement.

12. A machine for the purpose described including a bed, a grinding wheel supported thereby, a housing pivotally supported by the bed for oscillation about an axis parallel with the axis of the grinding wheel, a carrier supported by the housing for rotation about an axis at right angles to that of the grinding wheel, a plurality of individual work piece holders mounted on the carrier and successively presentable by rotation thereof in operative relation to the periphery of the grinding wheel, and cam means for effecting an oscillation of the housing about its pivotal support in a direction toward and from the grinding wheel for determining the effective engagement of an individual work piece on the carrier with the grinding wheel.

13. A machine for the purpose described including a bed, a grinding wheel supported thereby, a housing pivotally supported by the bed for oscillation about an axis parallel with the axis of the grinding wheel, a carrier supported by the housing for rotation about an axis at right angles to that of the grinding wheel, a plurality of individual work piece holders mounted on the carrier and successively presentable by rotation thereof in operative relation to the periphery of the grinding wheel, cam means for effecting an oscillation of the housing about its pivotal support in a direction toward and from the grinding wheel for determining the effective engagement of an individual work piece on the carrier with the grinding wheel, power means for effecting a continuous rotation of the carrier, and driving connections between the power means and the housing operating cam for effecting a rate of actuation of the cam in such ratio to the rate of rotation of the carrier that an oscillation will be imparted to the housing during each presentation of a work piece to the grinding wheel by the carrier.

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