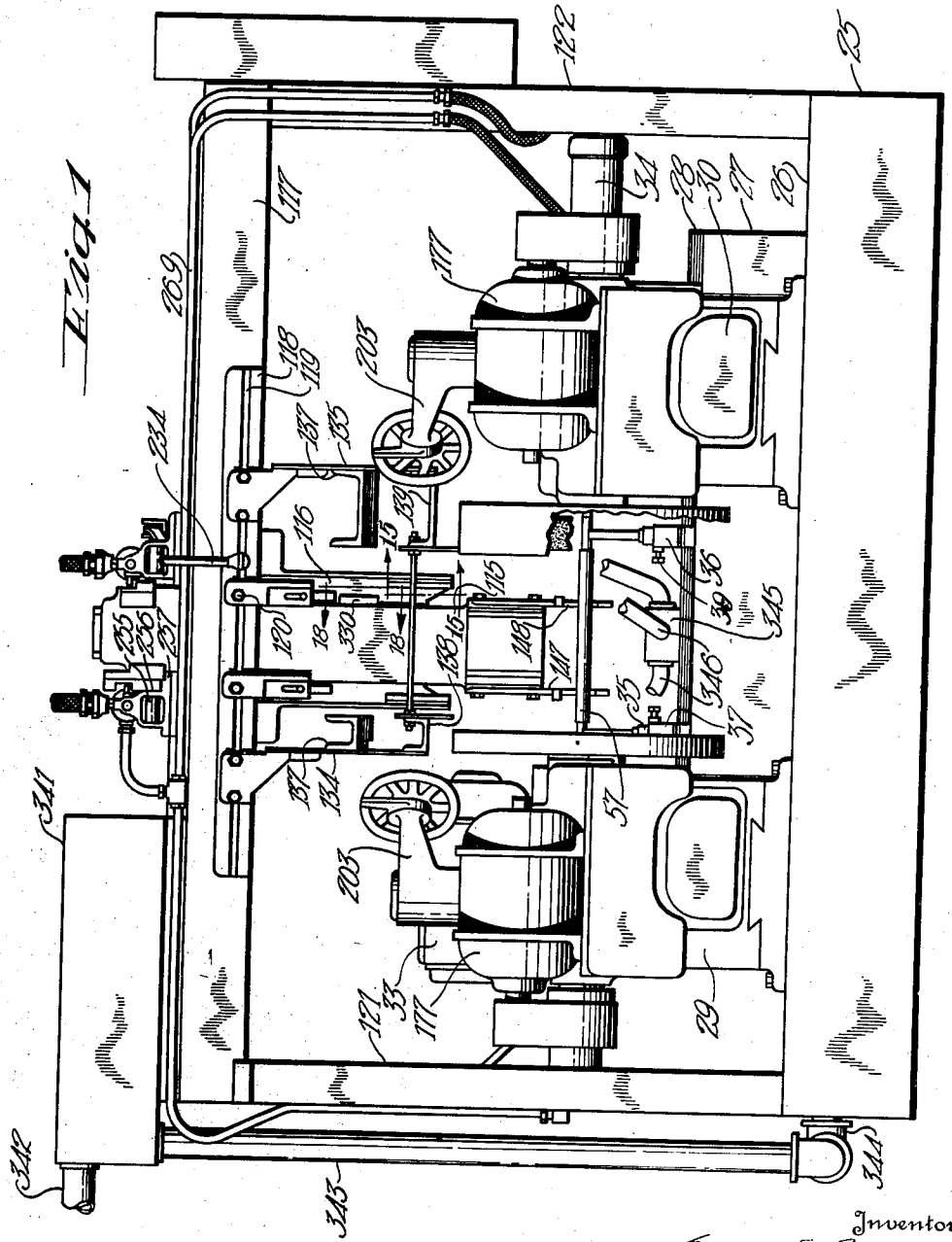
March 12, 1935. S. E. BERGSTRUM ET AL 1,993,822

GRINDING MACHINE

Filed Dec. 31, 1931 10 Sheets-Sheet 1

Fig. 1



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GRINDING MACHINE

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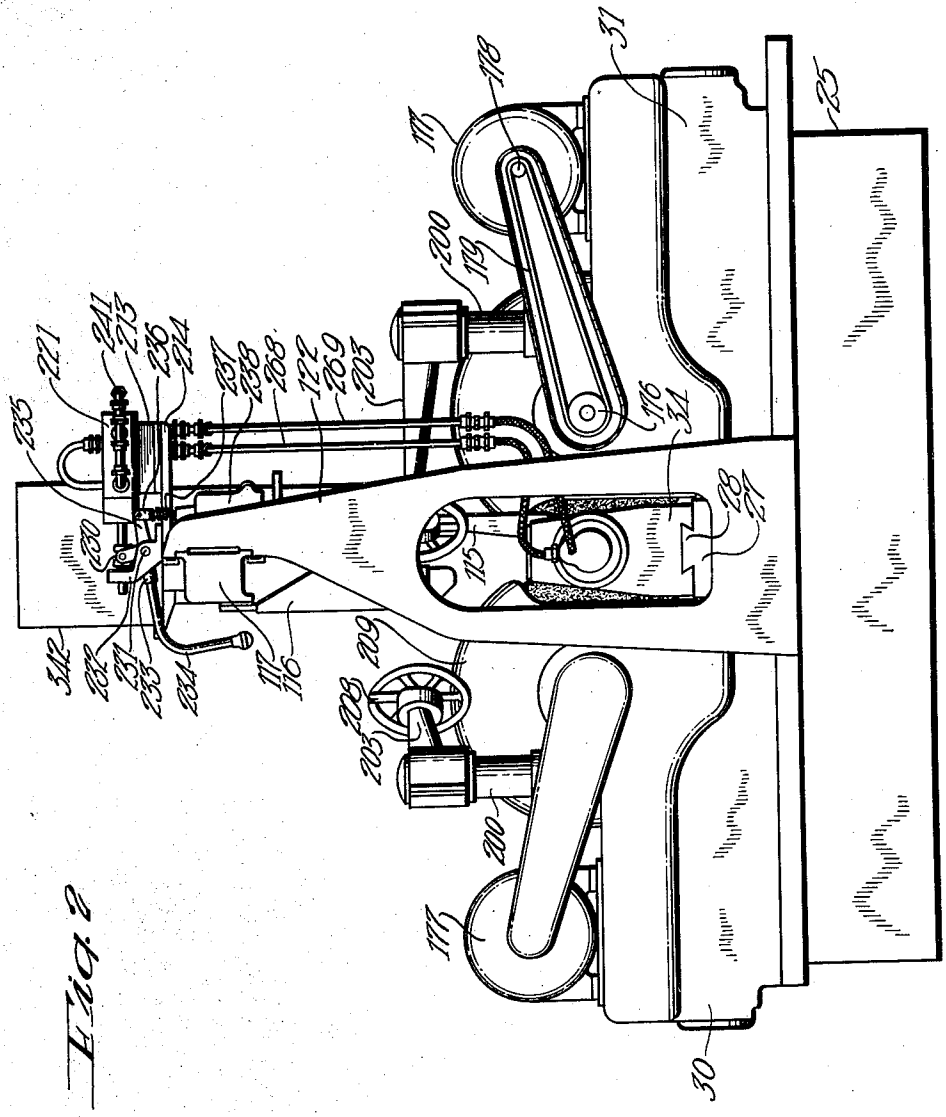


Fig. 2

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GRINDING MACHINE

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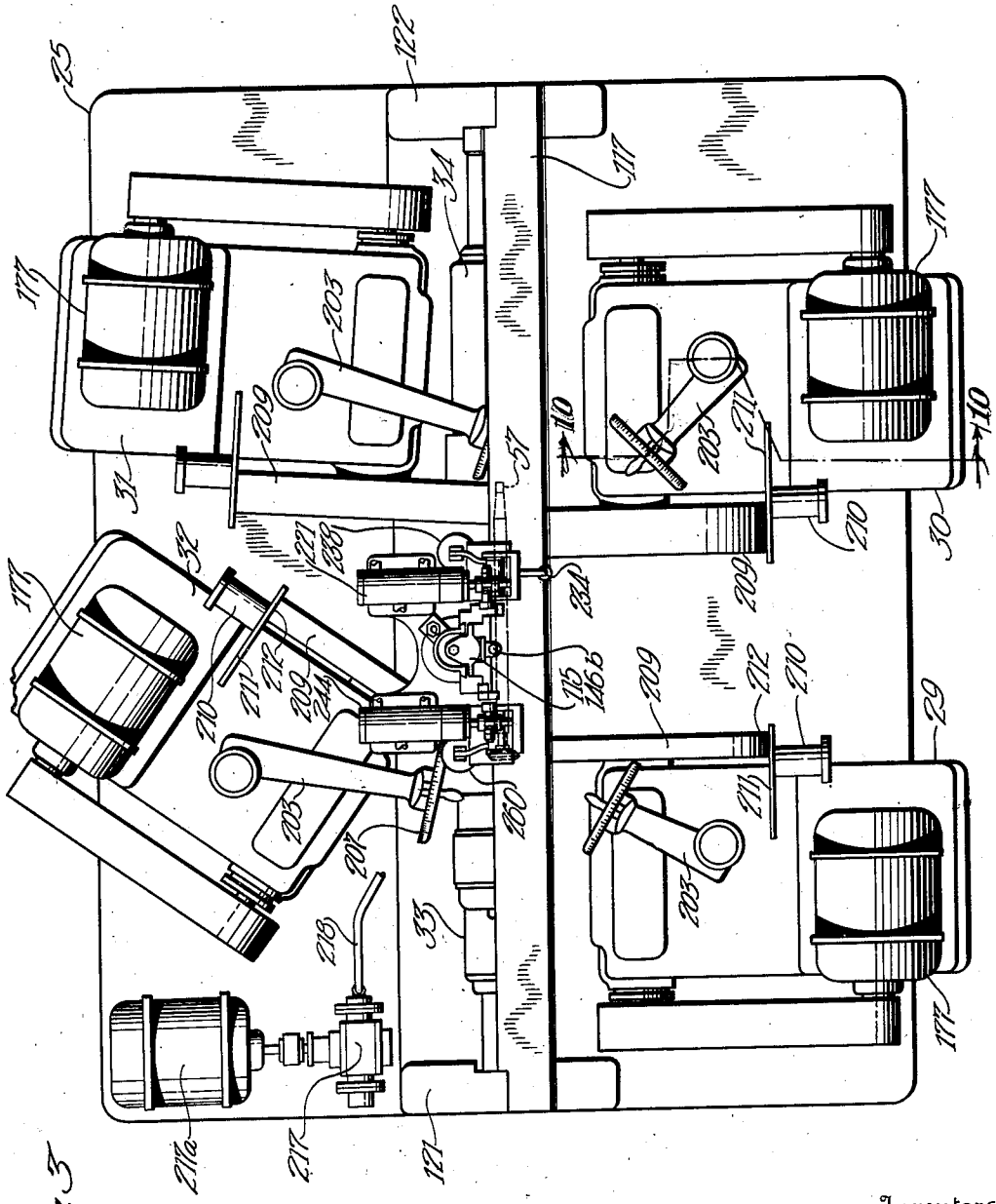


Fig. 3

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GRINDING MACHINE

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Fig. 4

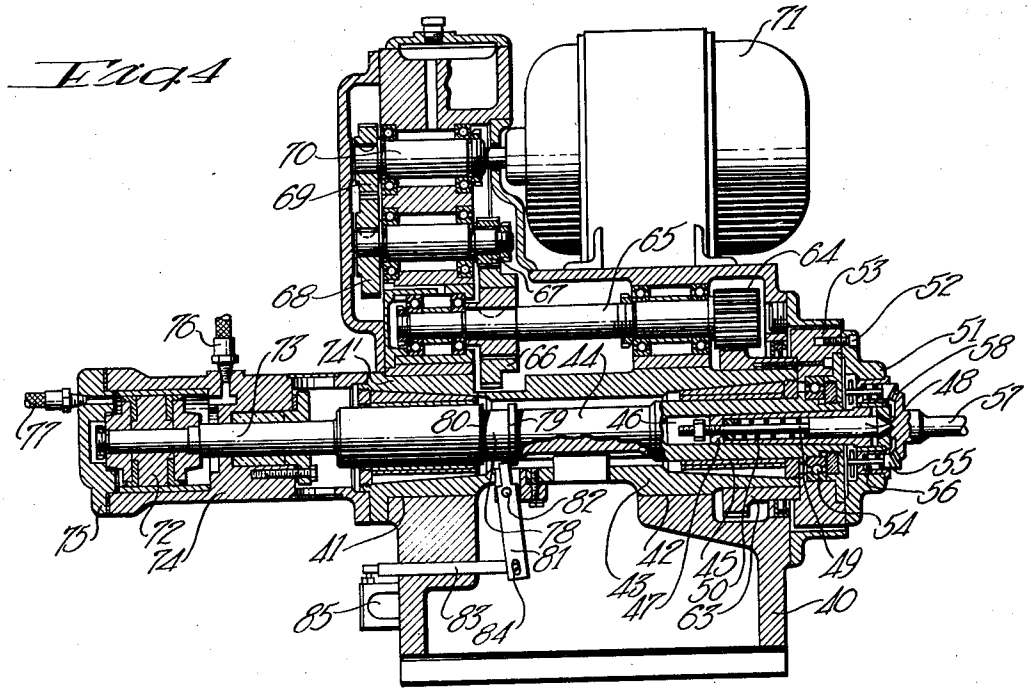
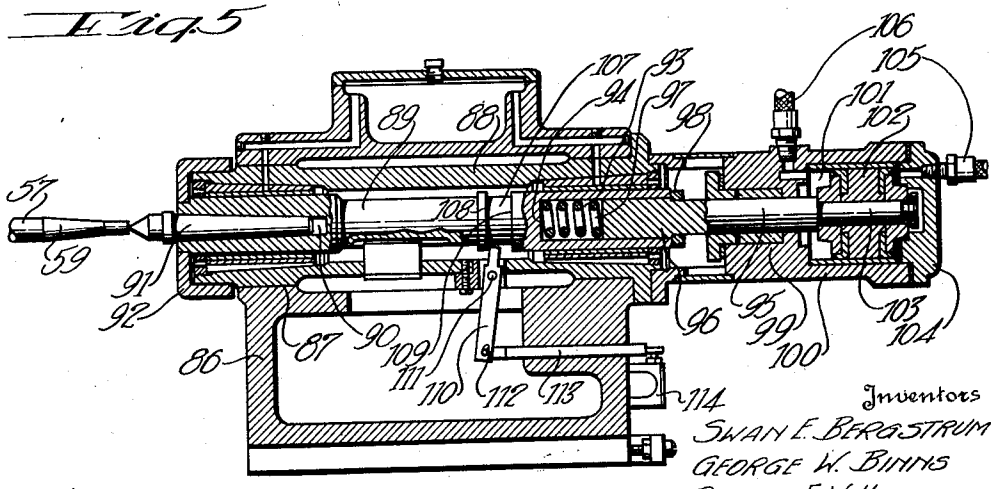


Fig. 5



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GRINDING MACHINE

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Fig. 6

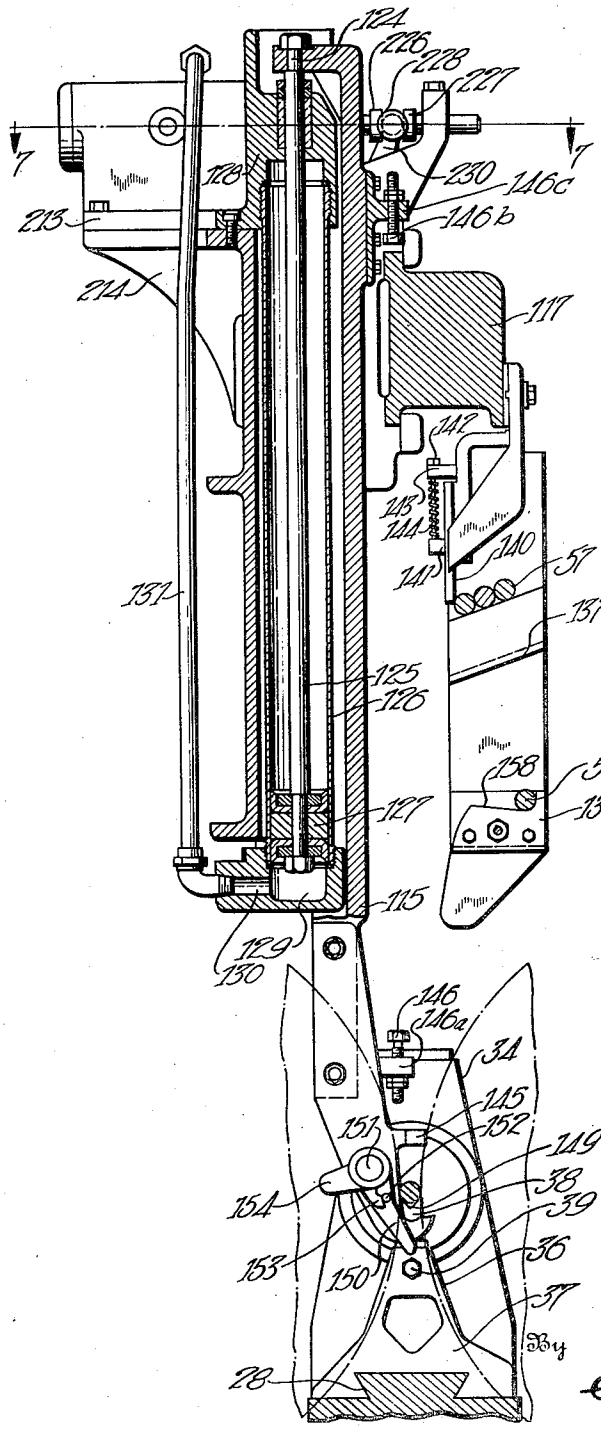


Fig. 13

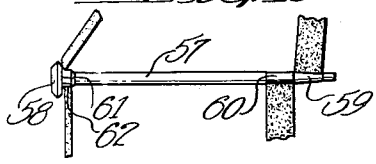


Fig. 15

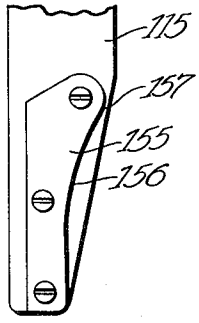
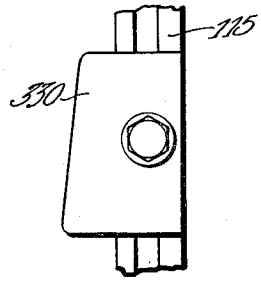


Fig. 18



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GRINDING MACHINE

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Fig. 7

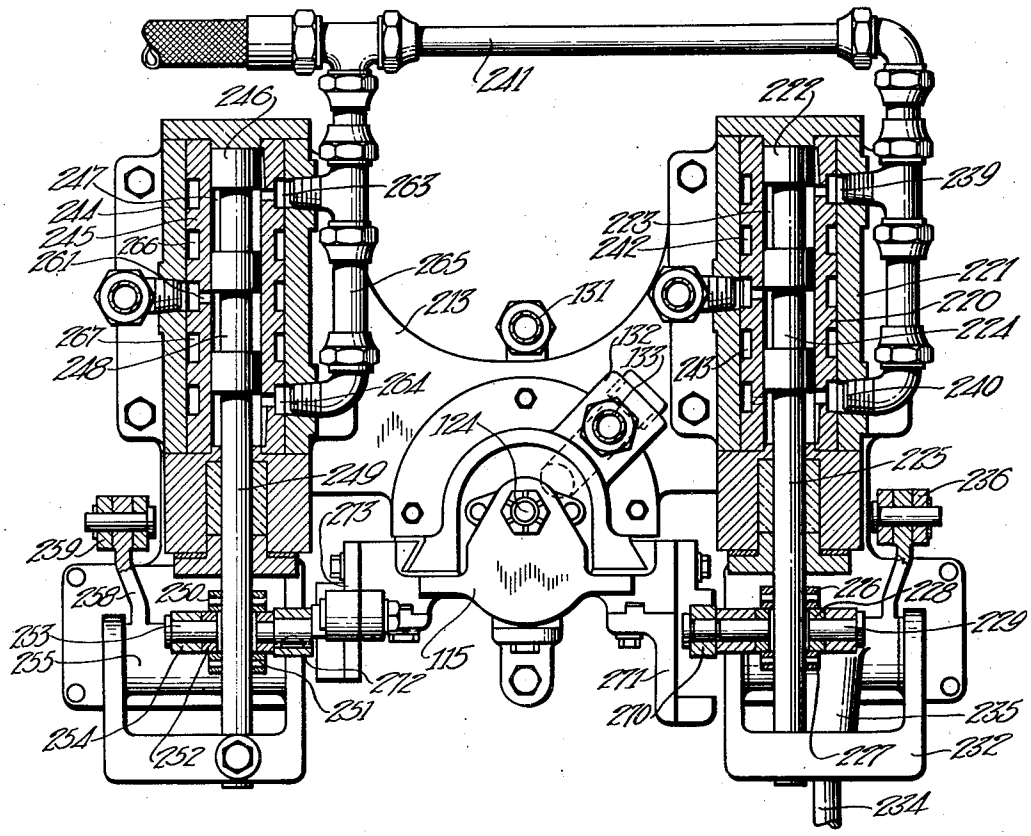
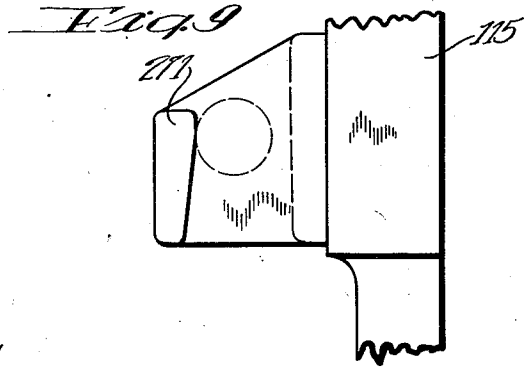


Fig. 9



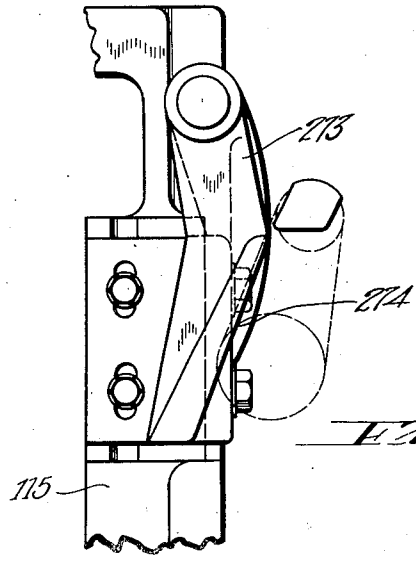


Fig. 8

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GRINDING MACHINE

Filed Dec. 31, 1931 10 Sheets-Sheet 7

Fig. 10

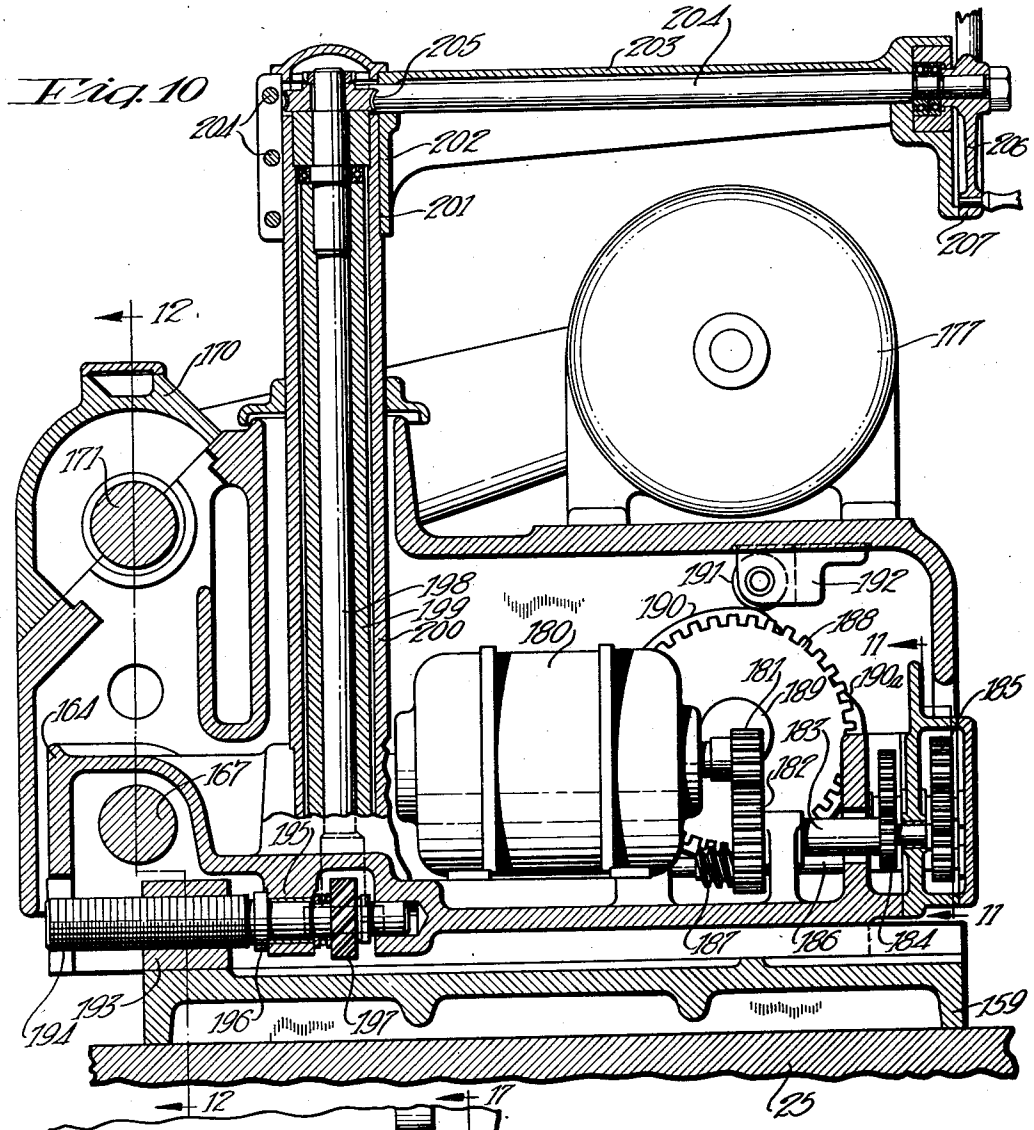
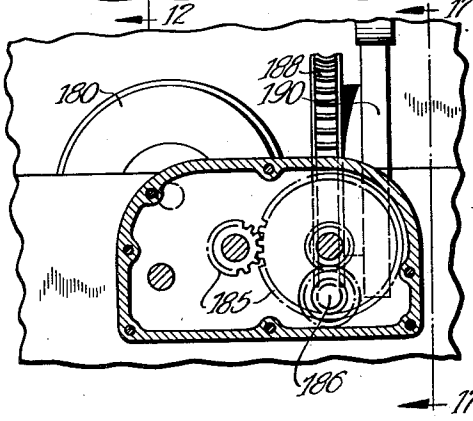


Fig. 11



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GRINDING MACHINE

Filed Dec. 31, 1931 10 Sheets-Sheet 8

Fig. 12

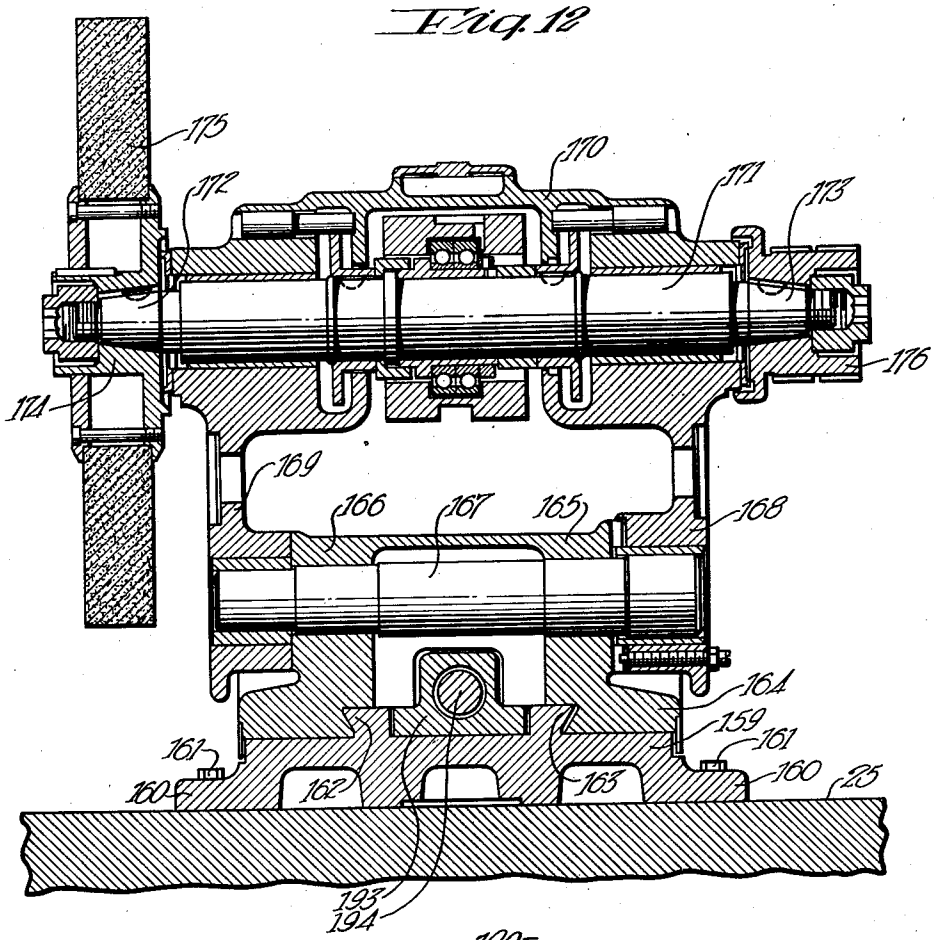
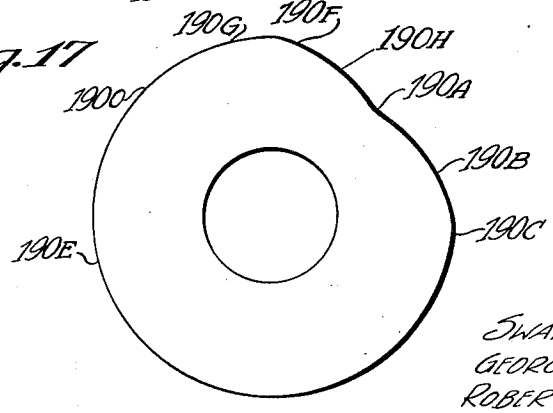


Fig. 17



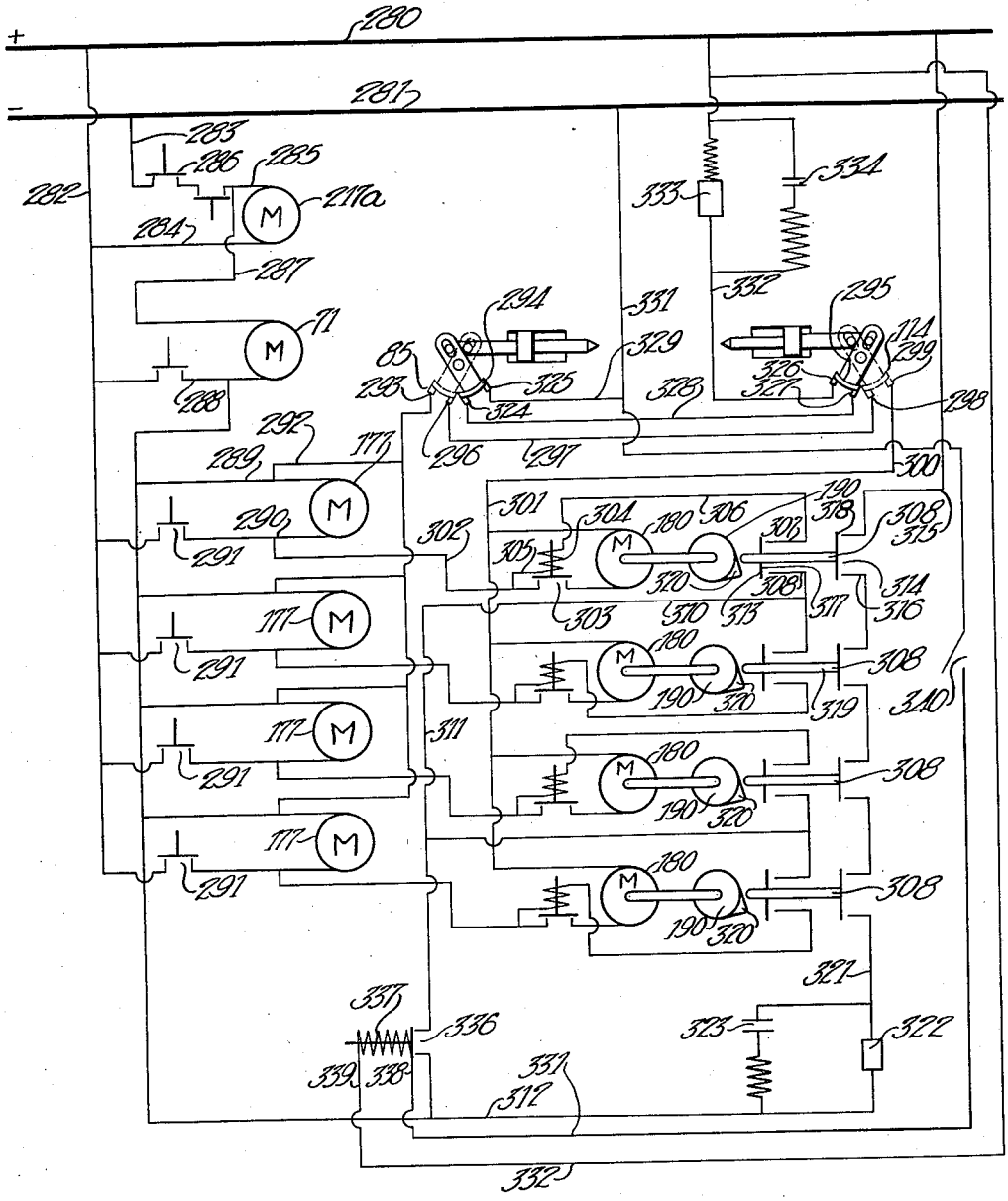
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GRINDING MACHINE

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Fig. 14



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GRINDING MACHINE

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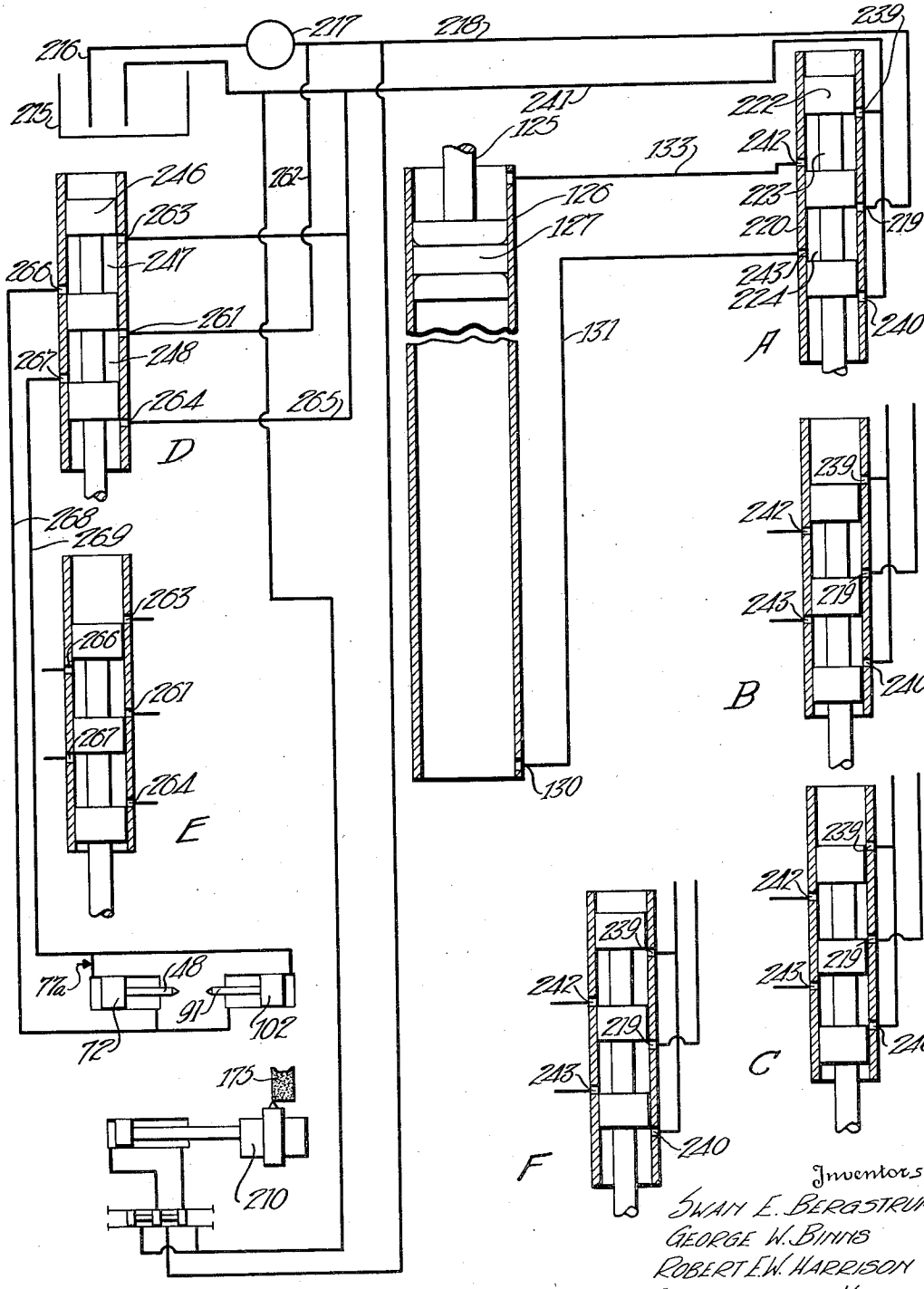


Fig. 16

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Patented Mar. 12, 1935 1,993,822

UNITED STATES PATENT OFFICE

1,993,822

GRINDING MACHINE

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Application December 31, 1931, Serial No. 584,166

33 Claims. (Cl. 51—105)

This invention relates to improvements in machine tools and especially to improvements in grinding machines.

An object of the invention is the provision of a cylindrical grinding machine of the center type for performing a plurality of grinding operations simultaneously on a given work piece.

Another object of the invention is the provision of a grinding machine capable of automatic rapid production for completely grinding a work piece having a plurality of diameters or portions thereon to be ground.

A further object of the invention is the provision of a grinding machine utilizing a plurality of grinding wheels so supported and arranged as to rapidly produce work pieces within close limits and with the desired finish thereon.

A still further object of the invention is the provision of a grinding machine as above referred to that is automatic in its nature for cyclically presenting the work to the wheels, reducing the work to the desired contour and size, retracting the wheels from the work and ejecting the work from the machine.

Other objects and advantages of the present invention should be readily apparent by reference to the accompanying drawings taken in connection with the following specification, and it is to be understood that any modifications may be made in the exact structural details there shown without departing from or exceeding the spirit of the invention as defined in the appended claims.

In the drawings:

Figure 1 is an elevational view of a grinding machine embodying this invention as seen from the operator's side of the machine.

Figure 2 is an end elevation as seen from the right hand side of Figure 1.

Figure 3 is a top plan view of the machine illustrated in Figures 1 and 2.

Figure 4 is a longitudinal sectional view through the head stock which supports the work.

Figure 5 is a longitudinal sectional view through the tail stock which is opposed to the head stock and co-operates therewith for supporting the work.

Figure 6 is a vertical sectional view through the work loading and ejecting mechanism.

Figure 7 is a sectional view through the control valves for controlling the movement of certain of the parts and as seen from line 7—7 of Figure 6.

Figure 8 is an enlarged detail view of the control cam carried by the loading and ejecting mechanism.

Figure 9 is an enlarged detail view of another control cam associated with the loading and ejecting mechanism.

Figure 10 is a transverse sectional view through one of the wheel heads as seen from line 10—10 of Figure 3 and forming a detail of the invention.

Figure 11 is a view on line 11—11 of Figure 10, certain parts being in elevation and certain in section.

Figure 12 is a sectional view taken on line 12—12 of Figure 10.

Figure 13 is a plan view of a work piece for which the machine illustrated is particularly adapted.

Figure 14 is a wiring diagram illustrating the electrical circuit involved in this invention.

Figure 15 is a sectional view taken on line 15—15 of Figure 1.

Figure 16 is a diagrammatic view illustrating the hydraulic circuits involved in this invention.

Figure 17 is an elevational view of one of the infeed cams employed in the machine and forming a detail of the invention.

Figure 18 is an elevational view of the valve operating cam as seen from line 18—18 of Figure 1.

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

The general purpose of this machine is the simultaneous grinding of a plurality of spaced portions on a single work piece. This grinding operation is performed by what is known as plunge cutting or by feeding the grinding wheel into the work and retracting it therefrom. The machine illustrated in the accompanying drawings for accomplishing this result comprises a comparatively low, flat bed plate centrally of which is mounted the opposed head and tail stocks supporting between them the work to be operated upon. Arranged on the bed and on both sides of the work are a plurality of wheel heads carrying grinding wheels for engagement with different restricted portions of the work. The work piece is automatically brought to the supporting head and tail stocks whereupon the wheel heads are actuated toward the portions of the work to be operated upon thereby. At the conclusion of the grinding operation the wheel heads are retracted and the work automatically released from the head and tail stocks and ejected from the machine.

Specifically the machine consists of a bed or base 25 of a comparatively shallow height and terminating in the upper surface 26. Extending centrally of the bed 25 is a raised portion

or rib 27 having formed on the upper end thereof a dove-tailed guide 28. Arranged on the bed 25 along the sides of the rib 27 are the wheel heads 29, 30, 31 and 32, while mounted on the rib 27 and guided by the guideway 28 for adjustment toward and from one another are the head stock 33 and the tail stock 34 from which project, as will later appear, supporting centers for the work. The rib 27 further carries the work supports 35 and 36, having V-shaped cradles in the upper ends which temporarily hold the work in alignment with the head and tail stock centers from which the work is lifted thereby. The work supports 35 and 36 are similar in construction and each comprises a block 37 adapted to engage the dove-tailed guide 28 for adjustment therealong. Supporting posts 38 project from the block 37 and are clamped in adjusted position relative thereto by means of clamp screws 39.

The head stock 33 adjacent the support 35 consists of a housing 40 having formed therein bores 41 and 42 receiving the spindle sleeve 43 in which is mounted for a sliding movement relative thereto the spindle 44. The spindle 44 has its forward end mounted in a sleeve 45 and is provided in the said forward end with a counter-bore 46 in which is mounted the sleeve 47. The sleeve 47 encloses a yielding center 48 which has projecting from its rear end the stud 49 encircled by a spring 50 which abuts on opposite ends with the center 48 and closed end of sleeve 47. The end of the sleeve 47 is slidably received in a face plate 51 which is secured, as by cap screws or the like 52, to a flange 52 journaled on the forward end of the spindle 44. Suitable anti-friction bearings 54 are secured to the end of the spindle intermediate itself and the flange 53. Driving lugs 55 are yieldably projected by means of springs 56 from the face plate 51 for rotating the work.

As shown in Figure 13 the work 57 is in the nature of an automobile rear axle having on one end the pinion 58 and on the other end a tapered shank portion 59. Of this work piece it is desired to grind the tapered shank portion 59 and the bearing portion 60 adjacent thereto and extending toward the gear 58. In addition it is desired to grind the rear face 61 of the gear 58 as well as the cylindrical bearing portion 62 extending from the face 61. The work is driven by means of the lugs 55 which enter the space between a pair of adjacent teeth of the gear 58 at a plurality of spaced points.

The face plate 51 and flange 53 are driven by a gear 63 that is rotatably journaled on a reduced bearing portion of the spindle sleeve 43. The gear 63 which is of relatively narrow face meshes with a compartively wide pinion 64 secured to or integral with the driving shaft 65 mounted in suitable antifriction bearings carried by the head stock housing 40. The shaft 65 in turn carries the pinion 66 which is driven through a chain of gears including gears 67, 68 and 69. The gear 69 is mounted on the end of a sleeve 70 secured in any desirable manner to a prime mover or motor 71 mounted on the upper end of the head stock housing 40. The gears 68 and 69 are of the change gear type capable of being substituted by other gears of a different ratio for varying the speed at which the work piece 57 may be driven.

The work center 48 and face plate 51 are adapted to be actuated relative to the housing 40 by axially shifting the spindle 44. This axial adjustment is accomplished hydraulically by means of a piston 72 secured to the reduced extension 73 of the spindle 44. The piston 72 is enclosed within a cylinder 74 secured in any desirable manner to the end of the spindle sleeve 43 and having between them a spacer 74' forming a cylinder head for one end of the cylinder. The other end of the cylinder is closed by a head 75 secured thereto in any desirable manner. Conduits 76 and 77 respectively connect the opposite ends of the cylinder 74 through ports formed in heads 74' and 75 with an hydraulic pressure source for actuating the piston 72 relative to the cylinder 74. Intermediate its ends the spindle 44 is provided with a circumferential groove 78 providing shoulders 79 and 80 at opposite sides thereof. The shoulders 79 and 80 form abutments for oscillating a lever 81 pivotally mounted as at 82 to the spindle sleeve 43. An arm 83 is slidably mounted in the housing 40 and has a lost motion connection at 84 with the lever 81. The other end of the arm 83 is connected with an electrical switch 85 for opening and closing said switch for a purpose that will later appear.

Opposed to the head stock, as noted above, is the tail stock 34 which comprises a housing 86 having formed therein a bore 87 in which is secured a sleeve 88 having slidably journaled therein a spindle 89. The spindle 89 has formed at one end a tapered bore 90 receiving the tail stock center 91. The spindle 89 has secured to it an end cap 92 which prevents moisture, dirt and the like from finding their way to the sliding bearings of the sleeve and spindle 88—89. The rear end of the spindle 89 is provided with a counter-bore 93 which terminates in the base or wall 94 at the inner end thereof. The spindle 89 similar to spindle 44 is adapted to be axially shifted relative to the housing 86 for which purpose there is provided a piston rod 95 having on one end a plunger 96 of a diameter to snugly fit within the counterbore 93. Enclosed within the counterbore 93 is a coiled spring 97 abutting with the base 94 of the counterbore on one end and with the end of the plunger 96 on the other end. The piston rod 95 carries at the end of the plunger 96 a nut 98 which limits the movement of the plunger 96 in the counterbore 93 under the influence of the hydraulic pressure. The piston rod 95 is guided by a bearing 99 which is carried by a bracket 100 having formed interiorly therein a cylinder 101. Within the cylinder 101 is a piston 102 secured to the reduced end 103 of the piston rod 95. The cylinder is closed on its one end by a cylinder head 104 and on its other end by the bearing bracket 100. Conduits 105 and 106 through ports formed in the cylinder heads are employed for connecting the opposite ends of the cylinder 101 with the hydraulic pressure source.

The tail stock spindle 89 similar to the head stock spindle 44 is provided intermediate its end with circumferential groove 107, providing shoulders 108 and 109 adapted to engage and oscillate the lever 110 pivoted at 111 to the tail stock housing 86. The lower end of the lever 110 has a lost motion connection as at 112 with a sliding link 113 slidably mounted in the housing 86. This link 113 similar to the member 83 has its free end connected with an electrical switch 114 for a purpose which will later appear.

The work piece 57 is lifted from the work supports 35 and 36 through the cam action of the centers of the head and tail stocks being actuated toward one another. The work is automatically brought to the rests 35 and 36 by means of an hydraulically controlled lowering and lifting fix-

ture which consists of a vertical reciprocable slide 115 guided in its movement by means of the frame or bracket 116. This frame or bracket 116 is carried by the overhead rail 117 having secured thereto attachment bracket 118 having a T slot 119 receiving the supporting bolts 120. The overhead rail 117 is carried on the upper end of the uprights 121 and 122 which have their lower ends bolted or otherwise secured to the base or bed 25.

The slide 115 is secured as at 124 to the free end of a piston rod 125 which extends through the hydraulic cylinder 126 and carries at its other end the piston 127. The cylinder 126 is fastened at one end into the block 128 of the guide frame 116 which forms the head for the upper end of the piston. The lower end of the piston is likewise closed by a piston head 129 which is provided with a port 130 for the hydraulic conduit 131. The block or upper piston head 128 is also provided with a port which is enclosed in the lug 132 extending at an angle to the vertical axis of the piston and cylinder for connecting the hydraulic conduit 133 with the upper end of the cylinder 126.

Secured to the attachment plate 118 on opposite sides of the guide bracket 116 are frames 134 and 135 supporting the work loading and ejecting mechanism. The loading mechanism or the means for holding an unfinished work piece which is to be subsequently carried to the grinding throat, consists of inclined angle irons 137, one secured to each of the frames 134 and 135 and extending toward the other. These angle irons are placed near the upper end of the frames 134 and 135. A second pair of angle irons 138 and 139 are likewise respectively secured to the frames 134 and 135 at a point beneath the irons 137 near the lower extremity of the frames 134 and 135. A retaining shutter 140 is carried by the frame members and normally lies in a position to prevent discharge of the unfinished work piece 57 from the irons 137. This shutter has projecting from it a lug 141 from which a guide bolt 142 projects. The guide bolt 142 is guided by a lug 143 extending from the frame and forming one abutment for a coiled spring 144, coiled about the bolt 142 and abutting on its other end with the lug 141. The slide 115 has near its lower extremity a lug 145 projecting therefrom, adapted on the upward movement of the frame 115 to engage the work retaining shutter lug 141 and actuate it against the resistance of the spring 144 thereby permitting discharge of the work pieces from the angle irons or loading magazine 137.

As will be noted from the above, as the work carrying slide reaches the upper limit of its travel a new unfinished work piece is released. This work piece is received in a cradle formed in the lower end of carrying arms 147 and 148 respectively depending from opposite sides of the lower extremity of the slide 115. These arms are hollowed out to form cradles conforming substantially to the contour of the work piece and carry the work piece to the work supports 35 and 36 depositing said work in the V shaped opening 149 formed at the upper end of said work rests.

At the conclusion of the grinding operation the slide 115 is actuated upwardly causing the arms 147 and 148 to pick up the work piece from the supports 35 and 36 carrying same upwardly therewith. The arms 147 and 148 have pivoted on their exterior surface ejector fingers 150 loosely journaled or pivoted about studs 151 extending outwardly from the said arms 147 and 148. Each arm 150 has projecting from it a pin 152 which abuts the lug 153 of a gravity actuated trigger 154. The guide frame 116 carries on opposite sides thereof and in alignment with the trigger 154 suitable cam members 155 having a tapered cam face 156 terminating in a lug 157. It will be noted that, from Figure 15, the cam faces 156 of the cams 155 engage the tail of the trigger 154 actuating it in a counter clockwise direction as viewed in Figure 6, carrying with it through the lug and pin 153 and 152 the ejector arm 150 which throws the work from the cradle away from the slide 115 on to the inclined surface 158 of the angle irons 138 and 139 so that said work rolls to the front end of the frames 134 and 135 to be removed by the operator.

As was noted above there are four portions or surfaces of the work piece 57 to be operated upon and a wheel head is provided for each surface to be ground. The wheel heads are identical in construction and may be positioned at any desirable point upon the upper surface 26 of the bed 25. The wheel heads each consist of a base 159 having flanges 160 extending from opposite sides thereof through which clamp bolts 161 extend for securing the said base 159 to the bed 25. The particular arrangement of the heads shown in Figure 3 is for the purpose of effectively finishing work pieces illustrated in Figure 13 but it is to be understood that additional wheel heads may be provided if the work piece to be operated upon requires same. Also, it is to be understood that one or more of the wheel heads illustrated in Figure 3 may be removed or that the wheel heads may be shifted to various other positions, being controlled entirely by the type and size of the work being operated upon. It will be noted that the wheel heads 29 and 30 are mounted to have the axis of the grinding wheel spindles substantially parallel with the axis of the work being operated upon for grinding substantially plain cylindrical portions thereon while the wheel heads 31 and 32 are positioned to have their axes at an angle to the axis of the work for respectively finishing the tapered shank 59 and vertical flat face 61.

Referring now particularly to Figures 10, 11 and 12 which illustrate the construction of one of the wheel heads, the base plate 159 has formed on its upper surface the dovetailed guide 162 received in a correspondingly shaped guideway 163 formed in the under surface of slide 164. The slide 164 has extending upwardly at its forward end lugs 165 and 166 forming bearings for trunnion or pivot shaft 167 which extends therethrough. Mounted on the projecting extremities of the trunnion shaft 167 are the arms 168 and 169 of spindle carrier 170. The spindle carrier 170 has journaled therein the grinding wheel spindle 171 which has its opposite ends correspondingly tapered as at 172 and 173. The tapered ends 172 and 173 are identical so that the parts mounted thereon may be exchanged one for the other thereby providing a wheel head for grinding a portion of the work on either side thereof. As shown in Figure 12 the left hand end of the spindle has secured to it the collet 174 for a cylindrical grinding wheel 175, while the other end of the spindle carries a chain sprocket 176 having a drive chain extending from the motor 177. The motor 177 is mounted on the upper surface of the carriage 170 and carries the motor pinion 178 for driving the silent chain

179 which extends between the motor shaft and the spindle 171.

Carried by the slide interiorly of the carriage 170 is a motor 180 having the motor pinion 181 meshing with a gear 182 on the end of a shaft 183. The shaft 183 in turn is provided with a pinion 184 for driving the chain of gears which terminate in change gears 185 on one end of a worm shaft 186. The worm shaft 186 has integral therewith or secured thereto the worm 187 meshing with a large worm wheel 188 secured to cam shaft 189. The cam shaft 189 rotates about an axis at right angles to the axis of the motor 180 and in such a direction as to effect oscillation of the carriage 170 about the axis of the trunnion shaft 167 toward and from the work; for this purpose the cam shaft 189 carries a cam 190 contacting with an anti-friction bearing 191 rotatably mounted in a bracket 192 secured to the under surface of the spindle carriage 170.

The cam 190 has a low portion or point 190A at which time the carriage 170 is in its fully retracted position. The periphery of the cam is provided adjacent the low point 190A with a rapid incline 190B which extends to the point 190C for rapidly advancing the carriage toward the work to a point where the grinding wheel just touches the work. From the point 190C to the point 190D the periphery 190E of the cam rises gradually to effect the actual stock removal or grinding on the work from which point to the point 190F the periphery 190G is concentric allowing a dwell in the relative movement of the work and grinding wheel permitting a sparking out of the grinding wheel. The periphery 190H of the cam sharply falls away or declines from the high point 190F to the low point 190A for rapidly retracting the grinding wheel from the work after it has been reduced to the desired size and finish. From this it will be seen that the grinding wheels rapidly approach the work, reduce same to size, dwell to properly clean up and finish the work and then rapidly withdraw from the work.

For adjusting the carriage 164 and parts carried thereby relative to the base 159, the said base has extending upwardly from it a nut 193 threadedly receiving a screw 194 rotatably journaled in the carriage 164 and held against axial movement relative thereto by the lug 195 and shoulders 196. Secured to the screw in any desirable manner is a spiral gear 197 meshing with a complementary gear or worm on the end of vertical shaft 198 rotatably journaled in a slide 199 and enclosed within column 200 extending upwardly from the carriage 164. The column 200 terminates at a point above the carriage 170 and is provided on its upper surface with a swivel bearing 201 for the sleeve 202 of arm 203. The sleeve 202 is of the split type and has extending therethrough clamp bolts 204 whereby it may be clamped in any desired angular position relative to the column 200. Journaled in suitable bearings at opposite ends of the arm 203 is a shaft 204 carrying on its inner end a worm meshing with worm wheel 205 keyed or otherwise suitably secured to the upper end of the vertical shaft 198. The outer end of the shaft 204 has secured to it a hand wheel 206 whereby it is rotated for effecting, through the transmission line above described, rotation of the adjusting screw 194. The hand wheel has its upper surface 207 flat for carrying suitable graduation marks co-operating with a pointer 208 extending from the arm 203 whereby the amount of rotation of the shaft 204 is readily determined.

Referring to Figure 3 the zone or area between the wheel heads 29 and 30 is the operator's station and in order to afford complete control of the machine from this station the arms 203 are swiveled as above noted. Also these arms may be of different lengths as shown in said Figure 3 for causing the control hand wheels 206 to terminate within convenient reach of the operator's station.

Each grinding wheel is enclosed within a guard 209 which forms the support for hydraulically actuated trueing attachment 210. Each trueing attachment carries with it a guard 211 snugly fitting a guideway 212 formed in the guard 209 thereby preventing any escape of coolant or drip from the confines of the guard during the grinding operation.

The hydraulic operation of the work carrying slide and the hydraulic shifting of the work supporting centers is controlled by a pair of valves mounted in a housing 213 carried by a bracket or shelf 214 secured to the upper surface of the overhead rail 117. These parts are shown structurally in Figure 2 and diagrammatically in Figure 16. In the diagrammatic circuit, shown in Figure 16, there is illustrated a tank or sump 215 for a supply of the hydraulic medium, preferably oil, which is drawn from the tank through conduit 216 by means of a pump 217. The hydraulic medium is discharged from the pump 217 into main pressure line 218 which terminates at port 219 formed in the valve sleeve 220 of the right hand valve shown structurally in Figure 7 to which reference is now to be had. The sleeve 220 is pressed into cylindrical portion 221 of the valve housing 213 and is mounted on the right hand side of the vertical center of the machine as viewed from the operator's station. The slide valve 222 contained within the bushing 220 is provided with two cannelures 223 and 224. The stem 225 extends from the valve 222 and has secured near its outer end a pair of collars 226 and 227. Mounted in the space between the collars 226 and 227 on opposite sides of the stem 225 is an anti-friction roller 228 which is carried by the stud 229 in the end of arm 230. The arm 230 forms the stem of a T-shaped valve actuator which is pivoted at 231 to a bracket 232 mounted on the shelf support 214. A lug 233 extends from the actuating member outwardly toward the operator and has a socket therein for receiving a handle 234 whereby the valve 222 is initially operated. The arm 235 extends from the valve actuator 230 in the opposite direction from the lug 233 and has pivoted thereto the clevis 236 of solenoid core 237. This core is enclosed in a suitable solenoid 238 for actuating the valve in the opposite direction for a purpose that will later appear.

The valve bushing 220 has formed therein ports 239 and 240 connecting through branch conduits with the main return conduit 241 terminating in the sump or tank 215 and employed for returning the spent hydraulic medium to the tank for future use. The bushing 220 is further provided with ports 242 and 243, the former going to the top of the cylinder 126 and connecting with the conduit 133 extending therefrom, while the latter goes to the bottom of the said cylinder connecting with the conduit 131.

The valve housing 213 has formed on the left hand side of the vertical center of the machine a cylindrical portion 244 enclosing a sleeve 245 which is similar to the sleeve 220. This sleeve also houses a valve 246 having cannelures 247 and 248

as well as a stem 249 extending therefrom. Secured to the stem 249 is a pair of collars 250 and 251 providing a space therebetween in which is mounted on opposite sides of the stem anti-friction rollers 252. Each roller is secured to a stud 253 carried in the upper end of fork arm 254. The arm 254 forms part of a bell crank 255 pivoted at the junction of its arms at 256 to a bracket 257 secured to the shelf 214. The other arm 258 of the bell crank 255 similar to the arm 235 of the right hand valve actuator is connected to a clevis 259 of a solenoid 260. The valve sleeve 245 has formed therein a port 261 for the terminus of the branch pressure conduit 262 which extends from the main pressure line 218. The bushing 245 is further provided with ports 263 and 264 connected by branch conduits with the main branch return line 265. The bushing 245 is further provided with ports 266 and 267 for conduits 268 and 269, the latter connecting the hydraulic pressure source with conduits 77 and 105 which are respectively carried by the rear ends of cylinders 74 and 101 while the former connects with the conduits 76 and 106, respectively connected with the forward end of the said cylinders.

The valves 222 and 246 are adapted to be actuated sequentially for effecting the operation of the work carrying slide and centers in timed sequence. For this purpose one of the studs 229 is extended toward the slide and carriers on the extended portion a roller 270 adapted to be engaged by a cam 271 for operating the valve actuator 230. Similarly the stud 253 adjacent the work carrying slide is extended and has secured thereto a roller 272 likewise for engagement with a cam 273 on the work slide 115.

The operation of the valves is as follows. In the diagrammatic illustration in Figure 16 the valve position A of the right hand valve is the position when the machine is not operating, that is when the work slide is in the uppermost position. It will be noted that the port 219 is slightly uncovered permitting the pressure to flow into the valve bushing 220 where it is directed by the cannelure 224 to the conduit 131 for maintaining the pressure on the piston 127 in an upward direction and holding the said slide in its upward position. At this time an adjustable stop 146, see Figure 6, in the nature of a screw threadedly carried by a lug 146A extending from the slide 115 is abutting the rail 117. The operator now grasps valve handle 234 for shifting the valve to the position indicated at B. It will now be noted that the pressure conduit 218 is connected through the cannelure 223 with the port 242 directing the pressure to the conduit 133 and thereby lowering the work carrying slide and depositing the work piece on the supports 35 and 36. As the slide nears the lower limit of its travel the cam 271 engages the roller 270 for operating the valve actuator and the valve to a position indicated at C in this figure. Simultaneously with the engagement of cam 271 with the roller 270, the cam face 274 of the cam 273 engages the roller 272 for actuating the left hand valve 246 to the position indicated in Figure 16 as D. At this time the pressure in the main pressure line 218 which is slightly uncovered and connected with the port 242 and conduit 133, holds the piston in its lowermost position thereby insuring no movement of the work carrying frame during the grinding operation. When the slide is in the lowermost position a stop 146B, see Figure 6, in the nature of a screw threadedly carried by a lug 146C projecting from the upper end of the slide 115 is abutting the rail 117 on its upper surface. At the same time the pressure in main branch pressure line 262 is directed by the cannelure 248 to the port 267 and conduit 269 connected with the rear ends of cylinders 74 and 101 for actuating the centers 48 and 91 toward the work to pick same up as above described.

By reference to Figure 16 it will be noted that the conduit 77 is provided with a needle or choke valve 77A while the conduit 105 is unrestricted. By this construction the actuation of the tail stock center ahead of the head stock center and face plate is insured so that the work is held by the tailstock center before rotation thereof by the face plate driving dog which would tend to throw the work from the machine if the tailstock end were not engaged.

The infeed motors are now started for effecting the relative feed between the grinding wheels and work and retracting the said wheels from the work by means and through suitable electrical control circuits later to be described. As soon as the grinding wheels are completely retracted the solenoid 260 is energized for retracting the valve 246 to the position indicated at E, at which time the pressure in the branch pressure conduit 262 is connected by means of the cannelure 247 with the port 266 and conduit 268. This conduit 268 terminates in the forward ends of cylinders 74 and 101 for retracting the pistons therein and withdrawing the centers from the work. As soon as the said centers are retracted to the limit of their movement and completely free of the work, the solenoid 238 is energized for shifting the right hand valve 222 to the position indicated at F in Figure 16 and thereby connecting the pressure line 219 with the conduit 131 and the bottom of the work carrying slide cylinder. This effects an upward movement of the piston and slide carrying with it the finished work piece. Just before the slide 115 reaches the upper limit of its travel a cam 330 carried thereby, see Figure 18, engages the roller 270 and oscillates the valve actuator for shifting the valve 222 from the position shown at F to the position shown at A.

The wiring diagram illustrated in Figure 14 consists of the main line 280 and 281 from which main branch parallel lines 282 and 283 extend. The pump motor 217A and head stock motor 71 are electrically intercoupled so that the head stock motor cannot be operated unless the pump motor is operating. In fact all of the motors are so intercoupled one with the other that none of them will operate prior to the operation of the pump and head stock motors. The electrical circuit including the pump motor 217A includes branch positive line 284 and negative line 285, in which is placed the starting and stopping switch 286. A branch line 287 is taken off the line 285 and connected to the motor 71 which has also connected therewith the branch line 288 terminating in the positive branch line 282. It will be noted that the line 287 between the motor 71 and line 285 connects with the line 285 at a point between the starting and stopping switch whereby the said motor cannot be operated prior to the closing of the starting and stopping switch which effects actuation of the pump motor. The grinding wheel motors 177 are each included in a circuit connected to the main lines by means of a line 289 extending from one side of the motor to the head stock motor branch line 288 and a second line 290 extending from the other side of the wheel head motor 177 and the main positive branch line 282. Each of the circuits includes

therein a switch 291 whereby any desired motor or motors may be operated or allowed to remain stationary.

In order that the wheel heads are not fed toward the work to feed a dead or stationary wheel into the work, the infeed motors 180 are electrically connected with the wheel head motors 177 so that unless the grinding wheel is rotating the infeed motors are disconnected. Also the infeed motors cannot operate until the work supporting centers 48 and 91 have been actuated toward each other and have completely lifted the work from the rests and it is rotating about the axis determined thereby. For this purpose the switches 85 and 114 are provided. The wheel head motor has extending from its one line 289 a line 292 which terminates at a contact 293 of the switch 85. As diagrammatically illustrated in Figure 14, the switch 85 consists of four fixed contacts adapted to be closed by a sliding contact 294 operated by the arm 83 with the movement of the head stock 48, also the switch 114 has four fixed contacts adapted to be bridged by means of a sliding contact 295 operated through the arm 113 upon movement of the tail stock center 91. The circuit being considered at present includes the contact 296 of the switch 85 which is electrically connected by lead 297 with a contact 298 of the switch 114. The remaining contact 299 of the pair of contacts of switch 114 in the infeed motor circuit is connected by means of branch lines 300 and 301 with one side of the infeed motor 180. The motor 180 has extending from its other side a line 302 which terminates in the wheel head motor line 290 at a point between the control switch 291 and the motor.

From the foregoing it will be noted that if the switch 291 is closed the current will flow from the main lead 280 through branch lead 282 to lead 290 through the motor 177 and back through branch line 289 and conduits connected therewith, terminating in the negative lead 281. At the same time the current will tend to flow through the conduit 302 which when completed by bridging contacts 293 and 296 and 298 and 299 flows through the motor 180, branch line 301 sliding contact 299, branch line 297, sliding contact 293 and the line 292 which terminates in the wheel head motor line 289. Each of the wheel heads are similarly included in a circuit tied in with the switches 85 and 114 so that any number of units may be employed by merely closing the control switches 291.

It will be noted that the infeed motor line 302 is interrupted by means of solenoid switch 303 which is normally closed. The switch 303 includes a coil 304 having one side thereof connected by wire 305 with the lead 302 and the other side of the coil 304 connected by means of a wire 306 with one contact 307 of a double switch 308.

The second contact 309 of said switch 308 is connected by a line 310 with a line 311 terminating in a connection with main negative branch line 312. The contacts 307 and 309 are part of a switch 313 while contacts 315 and 316 are a part of a second switch 314 which together with switch 313 constitutes the double limit switch 308. The switch 313 is adapted to be closed by contact plate 317 while switch 314 is closed by contact plate 318, both contact plates being on one stem 319 so that when one switch is opened or closed the other switch is correspondingly conditioned. A similar double switch 308 is associated with each infeed motor 180 and as noted above each motor 180 operates an infeed cam 190. As shown diagrammatically in Figure 14, the cams are each provided with a raised portion 320 adapted to engage the stem of its associated double switch 308 for closing same and completing the electrical circuit which includes the switch 303 and stopping further rotation of the infeed motor.

The mechanism just described insures the stopping of the infeed motors 180 at the conclusion of each grinding operation which consists in feeding the grinding wheel toward the work to reduce it to the desired size and then retracting it to its initial position. From the above description it will be noted that as soon as the switch 313 is closed the electrical circuit is completed for conducting the current from the branch line 290 and 302 through the line 305, coil 304, line 306, switch 313, lines 310, 311 and 312 back to the other side of the current source. The energization of the coil 304 breaks branch line 302 thereby cutting off further current to the motor 180 and insuring its stopping through the application of a dynamic brake or other suitable mechanism for checking the coasting rotation thereof.

The switches 314 are connected in series in an electrical line 321 which extends from the main positive lead 280. This line 321 has wired therein a time relay 322 for retarding or determining the closing of a solenoid switch 323 which energizes the solenoid or coil 260 which shifts the valve on the left hand side of the machine for connecting the hydraulic pressure with the head and tail stock center pistons. It is to be noted however that each operating grinding wheel must be completely retracted and its double limit switch closed before the time relay 322 is energized and it is only after a definite time elapse, determined by the relay 322, that the centers are retracted.

The retraction of the head stock center actuates the sliding contact 294 of the switch 85 for connecting spaced contacts 324 and 325. The retraction of the tail stock spindle 91 likewise actuates the sliding contact 295 and the switch 114 for connecting the contacts 326 and 327. The contacts 324 and 327 are electrically connected by means of a conduit 328. The contact 325 of the switch 85 is connected with lead 281 through electrical conductors 329 and 331. A second electrical conductor 332 extends from the other lead to the contact 326 and has included therein a definite time relay 333. The time relay effects the closing of a solenoid switch 334 after a definite time interval has elapsed which insures the complete retraction of the centers 48 and 91 before energizing the coil 324 of the solenoid for actuating the hydraulic valve and effecting a vertical movement of the work carrying slide together with the work thereon.

Conduit 311 above referred to and constituting one line of the circuit of all of the solenoid switches 303 is provided with a master solenoid switch 336 which has a coil 337 having its opposite ends connected respectively by lines 338 and 339 with branch leads 331 and 332 so that it is energized after the centers have been completely retracted and the electrical circuit for operating the work carrying slide complete. This switch 336 is necessary to de-energize the solenoid switches 303 so that they may resume their normal position preparatory to the next cycle of operation. One of the branch leads 338 or 339 extending from the solenoid switch coil 337 is broken by a switch 340 which is operated by a cam on the slide 115 for breaking the circuit and thereby completing the solenoid switch 303 circuit

when the slide has reached the upper limit of its movement.

The rail 117 has mounted on the upper side thereof near one end a tank 341 fed from a supply by means of a pipe or conduit 342. The coolant flows from the tank 341 by gravity through the pipe or conduit 343 to a pipe or conduit 344, which is mounted in the base or bed 25 and connects with a coolant header 345 mounted on the bed rib 27 near the center thereof. The coolant header 345 has extending therefrom a plurality of nozzles 346 which terminate adjacent the point of contact between the grinding wheels and the several portions of the work pieces being operated upon. From this it will be seen that the coolant is fed by gravity to the points of use.

The operation of the complete machine is as follows. The work piece is placed in the loading trough formed by the angle irons 137 which deliver said work piece to the work carrying members on the end of the slide 115. The operator then grasps and actuates the valve handle 234 in a counter-clockwise direction which shifts the valve to the position indicated by valve position B on Figure 16, which lowers the piston in the cylinder for lowering the work carrying slide. Near the bottom of the travel of the work carrying slide the cam 271 actuates the valve to the position C for holding the said slide at its lowermost position. The work slide has at this time deposited the work piece onto the work supports 35 and 36 whereupon the head and tail stock centers approach one another for picking up the work from the supports 35 and 36. The centers are actuated hydraulically upon shifting of the left hand valve to the position indicated at D on Figure 16 by means of a cam carried by the said slide. As soon as the head and tail stock centers have reached their innermost positions, switches 85 and 117 are closed for completing the electrical circuit to the several infeed motors 180. The said motors are then energized for effecting the relative feed between the grinding wheels and work, which after they have completed one cycle are automatically stopped The stopping of the last motor completes an electrical circuit for electrically shifting the left hand valve to the position indicated at E on Figure 15 whereupon the head and tail stock centers are retracted from the work. After the said centers have reached the limit of their retraction, the limit switches 85 and 114 are again closed for energizing an electrical circuit that shifts the right hand valve to the position indicated at F on Figure 15, which initiates the ascent of the work carrying slide for carrying the work piece from the work support. Near the upper end of the slide's travel a cam 155 on the slide guiding frame engages and actuates the work ejecting mechanism which shifts the work from the work slide to the finished work trough made up by angle irons 138 and 139. Continued upward movement of the slide 115 lifts the shutter 140 and permits an unfinished work piece previously mounted in the work loading trough to fall onto the carrying fingers of the work slide. As the slide reaches its upper limit of travel the cam thereon engages and shifts the right hand valve back to the position indicated at A which holds the machine at rest until it is again shifted manually by the operator.

What is claimed is:

1. In a grinding machine of the class described, the combination with a bed plate, and work supports carried by the plate for supporting a work piece between them, of a plurality of independent tool heads removably secured to the bed plate, each head including a grinding wheel, a base, a carriage for the wheel, and means for cyclically feeding the carriage relative to the base toward and from the work supports.

2. In a grinding machine of the class described, the combination with a bed plate, and work supports carried by the plate for supporting a work piece between them, of a plurality of independent tool heads removably secured to the bed plate, each head including a grinding wheel, a base, a carriage for the wheel, means for cyclically feeding the carriage relative to the base toward and from the work supports, said feeding means including a rotatable cam for feeding the grinding wheel into the work and retracting same therefrom, a prime mover for rotating the cam, and a second prime mover for rotating the grinding wheel.

3. In a grinding machine of the class described, the combination with a bed plate, and work supports carried by the plate for supporting a work piece between them, of a plurality of independent tool heads removably secured to the bed plate, each head including a grinding wheel, a base, a carriage for the wheel, means for cyclically feeding the carriage relative to the base toward and from the work supports, said feeding means including a rotatable cam for feeding the grinding wheel into the work and retracting same therefrom, a prime mover for rotating the cam, a second prime mover for rotating the grinding wheel, and means for varying the position of the carriage relative to the base to change the zones through which the grinidng wheels are operated by the cams.

4. In a machine tool organization, the combination of a bed, work supports mounted thereon, a pair of terminal work engaging means for engagement with the work to raise it from the supports for rotation about a predetermined axis, means for rotating the work, hydraulic means for axially shifting each of the terminal engaging means in predetermined relation, and hydraulically actuable means for placing on and removing the work from the support.

5. In a machine tool organization, the combination of a bed, work supports mounted thereon, a pair of terminal work engaging means for engagement with the work to raise it from the supports for rotation about a predetermined axis, means for rotating the work, hydraulic means for axially shifting each of the terminal engaging means in predetermined relation, hydraulically actuable means for placing on and removing the work from the support, said means comprising a vertically shiftable piston, a cylinder therefor, a carrier connected with the piston, means for discharging work pieces on to the carrier when in one position and for receiving work pieces from the carrier when in another position.

6. In a grinding machine of the class described, the combination of a base, a headstock mounted thereon, a tailstock on the base in opposition to the headstock, axially shiftable centers carried by the head and tail stocks, hydraulic means for effecting the said axial shifting of the centers, an hydraulic pressure source, a valve connecting the hydraulic pressure source with the centers, hydraulic means for positioning the work relative to the centers and removing it therefrom, and a second valve connecting the hydraulic pressure source with the said work pisitioning means.

7. In a grinding machine of the class described,

the combination of a base, a headstock mounted thereon, a tailstock on the base in opposition to the headstock, axially shiftable centers carried by the head and tail stocks, hydraulic means for effecting the said axial shifting of the centers, an hydraulic pressure source, a valve connecting the hydraulic pressure source with the centers, hydraulic means for positioning the work relative to the centers and removing it therefrom, a second valve connecting the hydraulic pressure source with the said work positioning means, means carried by the work positioning means for actuating the centers control valve, and means operated by the centers for actuating the positioning means control valve.

8. In a machine tool organization, the combination of a base, opposed head and tail stocks carried thereby, axially shiftable centers mounted in the head and tail stocks, a rail above the base, a vertically shiftable carrier supported by the rail, hydraulic means for effecting the vertical shifting of the carrier, hydraulic means for effecting the axial shifting of the centers, a valve for controlling the carrier shifting means, a valve for controlling the center shifting means, and means associated with the carrier and centers for operating the other's control valve.

9. In a grinding machine for grinding simultaneously a plurality of independent portions of a work piece, the combination of a bed, means on the bed for terminally engaging the work for rotation about a predetermined axis, a plurality of independent self-contained tooling units mounted on the bed each adjacent one of the several portions of the work to be tooled, means associated with each tooling unit for effecting its independent feed relative to the work, a central operator's station on the bed, and means terminating adjacent the central operating station for effecting the independent adjustment of each tool relative to its feeding means.

10. In a grinding machine for operation on a plurality of independent portions of a work piece, the combination of a grinding wheel for each portion of the work, opposed terminal engaging means for supporting and rotating the work while in contact with the grinding wheels, means for positioning the work relative to the terminal engaging means and withdrawing it therefrom comprising a carrier, supporting members on the carrier for movement therewith, a magazine for depositing work on the members, a discharge chute for receiving the work from the carrier after the grinding operation has been completed, an ejector finger pivotally mounted on the carrier, a cam in fixed relation to the carrier, a tail piece on the ejector finger for engagement with the cam whereby the finger is oscillated about its pivot for ejecting the work from the supporting members into the discharge chute.

11. In a grinding machine for operation on a plurality of independent portions of a work piece the combination of a grinding wheel for each portion of the work, opposed terminal engaging means for supporting and rotating the work while in contact with the grinding wheels, means for positioning the work relative to the terminal engaging means and withdrawing it therefrom comprising a carrier, supporting members on the carrier for movement therewith, a magazine for depositing work on the members, a discharge chute for receiving the work from the carrier after the grinding operation has been completed, an ejector finger pivotally mounted on the carrier, a cam in fixed relation to the carrier, a tail piece on the ejector finger for engagement with the cam whereby the finger is oscillated about its pivot for ejecting the work from the supporting members into the discharge chute, an hydraulic piston connected with the carrier, and an hydraulic circuit for actuating the piston and carrier thereby.

12. In a grinding machine of the class described the combination of a bed, a head stock and a tail stock mounted on the bed in opposition to one another, axially shiftable centers mounted in the head and tail stocks, an hydraulic piston associated with each center, an hydraulic circuit connecting the rear ends of the pistons whereby the centers are actuated simultaneously in a forward direction, an hydraulic circuit for connecting the forward ends of the pistons whereby the centers are simultaneously actuated in a retracting direction, and means in one of the circuits for retarding the movement of one of the centers in one direction.

13. In a grinding machine of the class described, the combination of a bed, a head stock and a tail stock mounted on the bed in opposition to one another, axially shiftable centers mounted in the head and tail stocks, an hydraulic piston associated with each other, an hydraulic circuit connecting the rear ends of the pistons whereby the centers are actuated simultaneously in a forward direction, an hydraulic circuit for connecting the forward ends of the pistons whereby the centers are simultaneously actuated in a rectracting direction, means in one of the circuits for retarding the movement of one of the centers in one direction, an hydraulic pressure source, a valve for connecting the pressure source with either of the circuits, mechanical means for shifting the valve in one direction and electro-magnetic means for shifting the valve in the other direction.

14. In a grinding machine of the class described, the combination of a bed, a head stock and a tail stock mounted on the bed in opposition to one another, axially shiftable centers mounted in the head and tail stocks, an hydraulic piston associated with each center, an hydraulic circuit connecting the rear ends of the pistons whereby the centers are actuated simultaneously in a forward direction, an hydraulic circuit for connecting the forward ends of the pistons whereby the centers are simultaneously actuated in a retracting direction, means in one of the circuits for retarding the movement of one of the centers in one direction, a loading and ejecting mechanism for presenting the work to the centers and withdrawing it therefrom, a grinding wheel for operation on the work supported by the centers, mechanical means operable by the loading and ejecting mechanism for shifting the valve in one direction, and electro-magnetic means operated by the grinding wheel mechanism for reversely shifting the valve.

15. In a grinding machine for grinding simultaneously independent portions of a work piece, the combination of a grinding wheel for each portion of the work to be ground, axially shiftable centers for terminally engaging the work, an hydraulic circuit for simultaneously shifting the centers in reverse directions for engaging the work prior to the grinding operation and releasing same at the conclusion of said grinding operation, feeding mechanisms for effecting a relative feed between the grinding wheels and work, a loading and ejecting mechanism for presenting a work piece to the centers and removing

same therefrom, a valve for controlling the hydraulic circuit of the centers, means operated by the work loading and ejecting mechanism for shifting the valve for effecting the engagement of the centers with the work after the work has been positioned relative thereto, and means associated with the feeding mechanisms for retracting the centers from the work at the conclusion of the grinding operation.

16. In a grinding machine of the class described, the combination of a bed, means on the bed for terminally engaging a work piece adapted to have a plurality of portions thereon simultaneously tooled, a plurality of independent self-contained units on the bed, each unit adjacent a portion of the work to be operated upon, means for presenting the work piece to and retracting same from the centers, hydraulically actuable means associated with the centers and work presentation and retraction means, an hydraulic unit mounted on the bed for operating the centers and work presentation and retracting means and having a prime mover for actuating the same, means including a prime mover for rotating the work while supported by the centers, and an interlock between the hydraulic unit prime mover and the work rotation prime mover whereby the work cannot be rotated prior to the actuation of the hydraulic unit and parts controlled thereby.

17. In a grinding machine of the class described, the combination of a bed, means on the bed for terminally engaging a work piece adapted to have a plurality of portions thereon simultaneously tooled, a plurality of independent self-contained units on the bed, each unit adjacent a portion of the work to be operated upon, means for presenting the work piece to and retracting same from the centers, hydraulically actuable means associated with the centers and work presentation and retraction means, an hydraulic unit mounted on the bed for operating the centers and work presentation and retracting means and having a prime mover for actuating the same, means including a prime mover for rotating the work while supported by the centers, an interlock between the hydraulic unit prime mover and the work rotation prime mover whereby the work cannot be rotated prior to the actuation of the hydraulic unit and parts controlled thereby, a prime mover associated with each independent tooling unit for effecting the rotation of the tool, and an interlock between the tool prime movers and the work rotation and hydraulic unit prime movers whereby the tools cannot be rotated prior to the energization of the prime movers of the hydraulic unit and work rotation.

18. In a grinding machine of the class described, the combination of a bed, means on the bed for terminally engaging a work piece adapted to have a plurality of portions thereon simultaneously tooled, a plurality of independent self-contained units on the bed, each unit adjacent a portion of the work to be operated upon, means for presenting the work piece to and retracting same from the centers, hydraulically actuable means associated with the centers and work presentation and retraction means, an hydraulic unit mounted on the bed for operating the centers and work presentation and retracting means and having a prime mover for actuating the same, means including a prime mover for rotating the work while supported by the centers, an interlock between the hydraulic unit prime mover and the work rotation prime mover whereby the work cannot be rotated prior to the actuation of the hydraulic unit and parts controlled thereby, a prime mover associated with each independent tooling unit for effecting the rotation of the tool, an interlock between the tool prime movers and the work rotation and hydraulic unit prime movers whereby the tools cannot be rotated prior to the energization of the prime movers of the hydraulic unit and work rotation, a second prime mover associated with each tooling unit for operating a feed mechanism and effecting a relative feed between the tools and the work, and means connecting the feed prime mover with the tool rotation prime mover whereby the feed will not be operated unless the tool is being rotated.

19. In a grinding machine of the class described, the combination of a bed, means carried thereby for supporting a work piece adapted to have individual portions thereof simultaneously ground, a grinding wheel for operation on each portion, means for rotating each wheel including a prime mover for each wheel, a feeding mechanism for feeding each wheel toward the work and including a prime mover for each feeding mechanism, and an interlock between the wheel rotation prime mover, and feeding prime mover of each wheel whereby a non-rotating wheel cannot be fed into the work.

20. In a grinding machine of the class described, the combination of a bed, means carried thereby for supporting a work piece adapted to have individual portions thereof simultaneously ground, a grinding wheel for operation on each portion, means for rotating each wheel including a prime mover for each wheel, a feeding mechanism for feeding each wheel toward the work and including a prime mover for each feeding mechanism, an interlock between the wheel rotation prime mover and feeding prime mover of each wheel, whereby a non-rotating wheel cannot be fed into the work, means for presenting the work to the grinding wheels and removing same therefrom after the conclusion of the grinding operation, hydraulic means for operating the work presentation and withdrawing means including a valve, electromagnetic means for operating the valve, and an interlock between the feeding means and the electromagnetic valve and operating means whereby the work is not withdrawn from the wheels until the work is completely formed.

21. In a grinding machine of the class described, the combination of a bed, means carried thereby for supporting a work piece adapted to have individual portions thereof simultaneously ground, a grinding wheel for operation on each portion, means for rotating each wheel including a prime mover for each wheel, a feeding mechanism for feeding each wheel toward the work and including a prime mover for each feeding mechanism, an interlock between the wheel rotation prime mover and feeding prime mover of each wheel, whereby a non-rotating wheel cannot be fed into the work, centering means for the work associated with the work supporting means, hydraulic means for axially shifting the centers toward and withdrawing same from the work including a valve, electromagnetic means for operating the valve, and an interlock between the feeding means and the electromagnetic valve operating means whereby the centers are not withdrawn until the work is completely formed.

22. In a grinding machine of the class described, the combination of a bed, means carried thereby for supporting a work piece adapted to

have indvidual portions thereof simultaneously ground, a grinding wheel for operation on each portion, means for rotating each wheel including a prime mover for each wheel, a feeding mechanism for feeding each wheel toward the work and including a prime mover for each feeding mechanism, an interlock between the wheel rotation prime mover and feeding prime mover of each wheel, whereby a non-rotating wheel cannot be fed into the work, centering means for the work associated with the work supporting means, hydraulic means for axially shifting the centers toward and withdrawing same from the work including a valve, electromagnetic means for operating the valve, an interlock between the feeding means and the electromagnetic valve operating means whereby the centers are not withdrawn until the work is completely formed, and means delaying the operation of the electromagnetic valve operating means for a definite time interval after the stopping of the feeding means to insure proper positioning of the parts.

23. In a grinding machine of the class described, the combination of a bed, a rail disposed in overlying relation to the bed, means on the bed beneath the rail for supporting a work piece, a plurality of toolheads on the bed, each including a grinding wheel for operation on spaced portions of the work, a coolant supply tank disposed on the rail, a gravity conduit from the tank to carry the coolant to the bed, a distributor head connected with the conduit, and nozzles extending from the head and terminating adjacent individual grinding wheels.

24. In a unit type grinding machine the combination of a supporting base, a plurality of self-contained tooling units disposed on said supporting base, an operator's station on said base, control and adjusting means for each tooling unit adjacent the operator's station, work supporting means on the supporting base, means for placing work on the support and removing same therefrom, and control means for the loading and ejecting mechanism disposed at the operator's control station.

25. In an automatic grinding machine the combination of a bed plate, a tooling unit on the bed plate, a pair of terminal work engaging members on the bed plate, work loading and ejecting mechanism for presenting the work to the terminal supporting members and removing same therefrom, and control means associated with each of said terminal supporting members in series with one another for energizing the work ejecting means at the conclusion of the tooling operation whereby the work is completely released prior to the ejection thereof.

26. In a mechanism of the class described the combination of a pair of work supporting centers, work loading and ejecting mechanism for presenting the work to the centers and removing it therefrom, valve controlled hydraulic means for effecting the operation of the loading and ejecting means, and electric means operated by the retraction of the centers for energizing the ejecting means.

27. In a mechanism of the class described the combination of a pair of work supporting centers, work loading and ejecting mechanism for presenting the work to the centers and removing it therefrom, valve controlled hydraulic means for effecting the operation of the loading and ejecting means, and electric means operated by the retraction of the centers for energizing the ejecting means, said control means comprising a switch member associated with each center, and a series electric connection between the switches to insure full retraction of each center prior to the operation of the ejecting means.

28. In an automatic grinding machine of the class described the combination of a bed plate, a plurality of self-contained tooling units removably secured to the bed plate, each tooling unit including its own tool feeding and retracting mechanism, work supporting means for supporting a work piece for simultaneous operation thereon by each of the tooling units, said work supporting mechanism including a pair of retractible terminal engaging members, automatic means for retracting the terminal engaging means, and an interlock between the automatic means and each of the feeding means whereby the automatic means is not energized until each feeding means is completely retracted.

29. In an automatic grinding machine of the class described the combination of a bed plate, a plurality of self-contained tooling units removably secured to the bed plate, each tooling unit including its own tool feeding and retracting mechanism, work supporting means for supporting a work piece for simultaneous operation thereon by each of the tooling units, said work supporting mechanism including a pair of retractible terminal engaging members, automatic means for retracting the terminal engaging means, an interlock between the automatic means and each of the feeding means whereby the automatic means is not energized until each feeding means is completely retracted, an hydraulically actuated loading and ejecting mechanism for presenting and removing the work to and from the supporting centers, control means for actuating the loading and ejecting mechanism, and means associated with the said centers for operating the control means and interlocked to insure complete retraction of each center before the operation of the ejecting mechanism.

30. In an automatic grinding machine of the class described the combination of a bed plate, a plurality of self-contained tooling units removably secured to the bed plate, each tooling unit including its own tool feeding and retracting mechanism, work supporting means for supporting a work piece for simultaneous operation thereon by each of the tooling units, said work supporting mechanism including a pair of retractible terminal engaging members, automatic means for retracting the terminal engaging means, an interlock between the automatic means and each of the feeding means whereby the automatic means is not energized until each feeding means is completely retracted, an hydraulically actuated loading and ejecting mechanism for presenting and removing the work to and from the supporting centers, control means for actuating the loading and ejecting mechanism, means associated with the said centers for operating the control means and interlocked to insure complete retraction of each center before the operation of the ejecting mechanism, and manual means for additionally operating the control means and initiating a work presentation movement of the mechanism.

31. In an automatic grinding machine of the class described the combination of a bed plate, a plurality of independent self-contained tooling units carried by the bed plate, work supporting mechanism including axially shiftable terminal engaging members, a work loading and ejecting mechanism for presenting the work to the centers

and removing same therefrom, a source of energy for effecting the operation of the loading and ejecting mechanism and the axial shifting of the terminal engaging mechanism, an independent source of energy for each of the tooling units, and an interlock between the loading and ejecting mechanism and centers source of energy and the independent tooling units' sources of energy whereby the former must be in operation before the latter are utilizable.

32. In an automatic grinding machine of the class described the combination of a base plate, a plurality of independent tooling units each including a feeding mechanism and a source of energy therefor, axially shiftable work terminal supporting members, a loading and ejecting mechanism for disposing the work in operative relation to the terminal supporting members and removing same therefrom, an hydraulic pressure source including a prime mover for operating the loading and ejecting mechanism and the terminal supporting members, and an electrical interlock between the hydraulic pressure source prime mover and the tooling units' feeding mechanism prime movers whereby the hydraulic pressure source is operated prior to the feeding mechanisms.

33. In an automatic grinding machine of the class described the combination of a base plate, a plurality of independent tooling units each including a feeding mechanism and a source of energy therefor, axially shiftable work terminal supporting members, a loading and ejecting mechanism for disposing the work in operative relation to the terminal supporting members and removing same therefrom, an hydraulic pressure source including a prime mover for operating the loading and ejecting mechanism and the terminal supporting members, an electrical interlock between the hydraulic pressure source prime mover and the tooling units' feeding mechanism prime movers whereby the hydraulic pressure source is operated prior to the feeding mechanisms, a prime mover for effecting the rotation of the work, and an interlock between the work rotation prime mover and the feeding prime movers to insure the rotation of the work prior to the feeding of the tool relative thereto.

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