Dec. 22, 1936. M. ROMAINE 2,065,100

GRINDING MACHINERY

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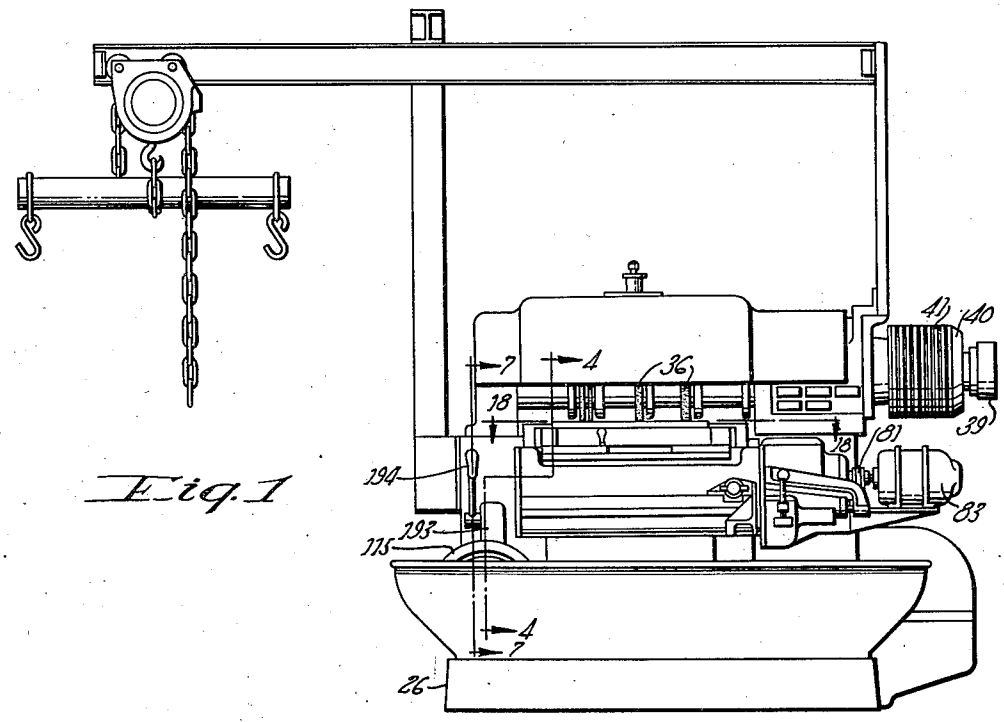


Fig. 1

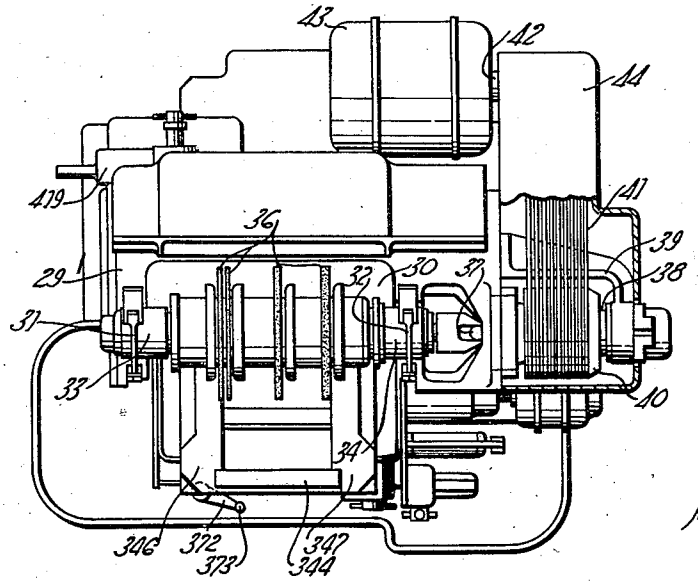


Fig. 2

Inventor

MILLARD ROMAINE

By H. K. Parsons

Attorney

Dec. 22, 1936. M. ROMAINE 2,065,100

GRINDING MACHINERY

Filed March 3, 1934 9 Sheets-Sheet 2

Fig. 5

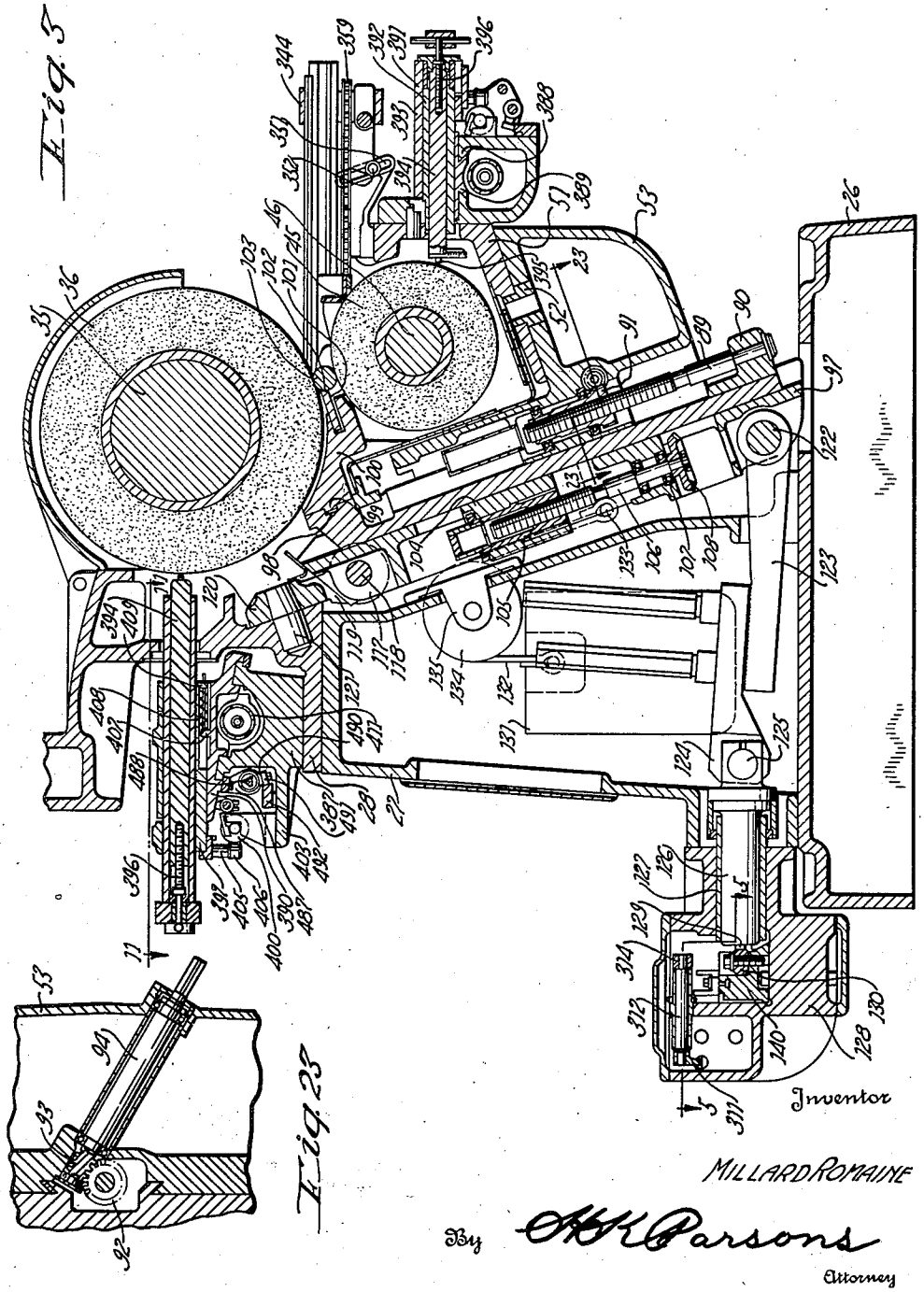


Fig 23

Inventor

MILLARD ROMAINE

By O. K. Parsons

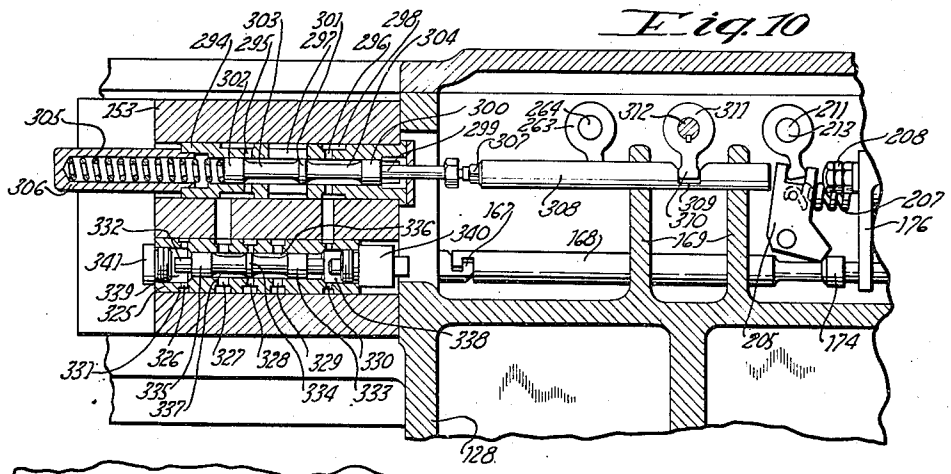
Attorney

Dec. 22, 1936. M. ROMAINE 2,065,100

GRINDING MACHINERY

Filed March 3, 1934 9 Sheets-Sheet 3

Fig. 10



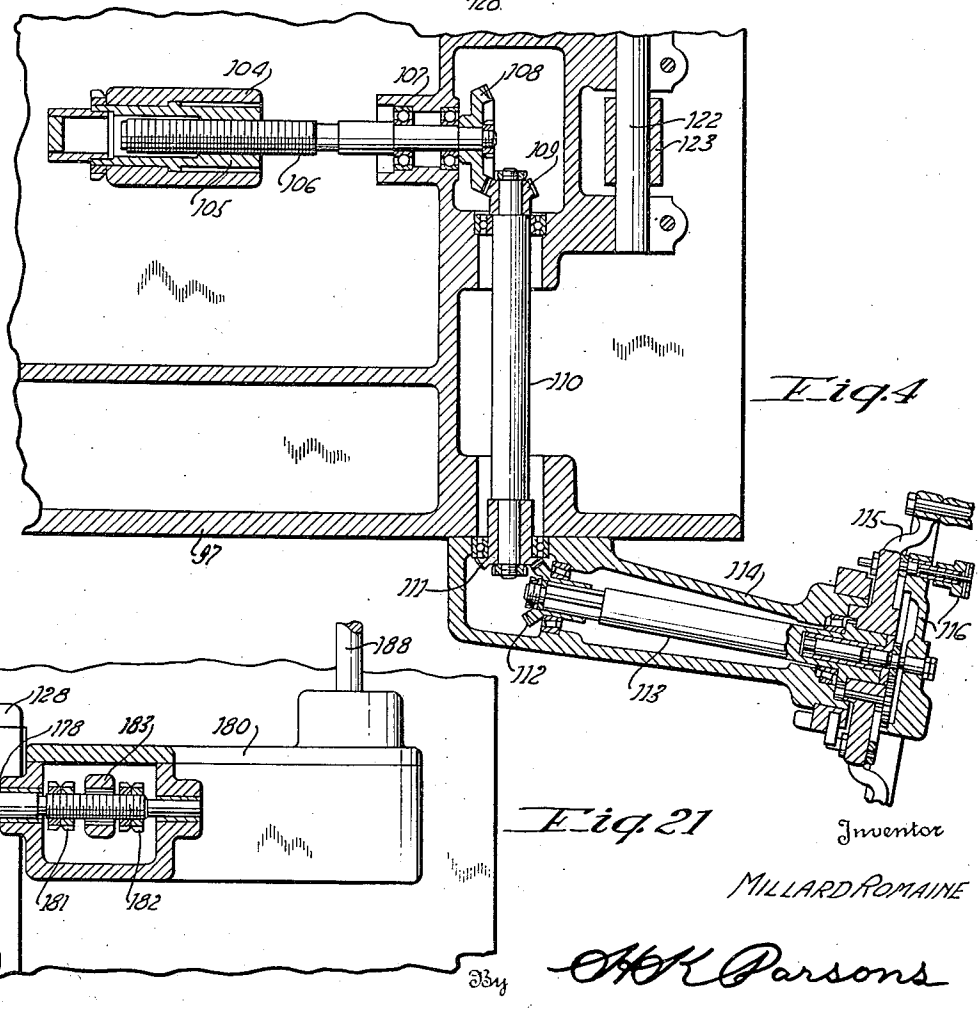


Fig. 4

Fig. 21

Inventor

MILLARD ROMAINE

By O'K Parsons

Attorney

Dec. 22, 1936. M. ROMAINE 2,065,100

GRINDING MACHINERY

Filed March 3, 1934 9 Sheets-Sheet 4

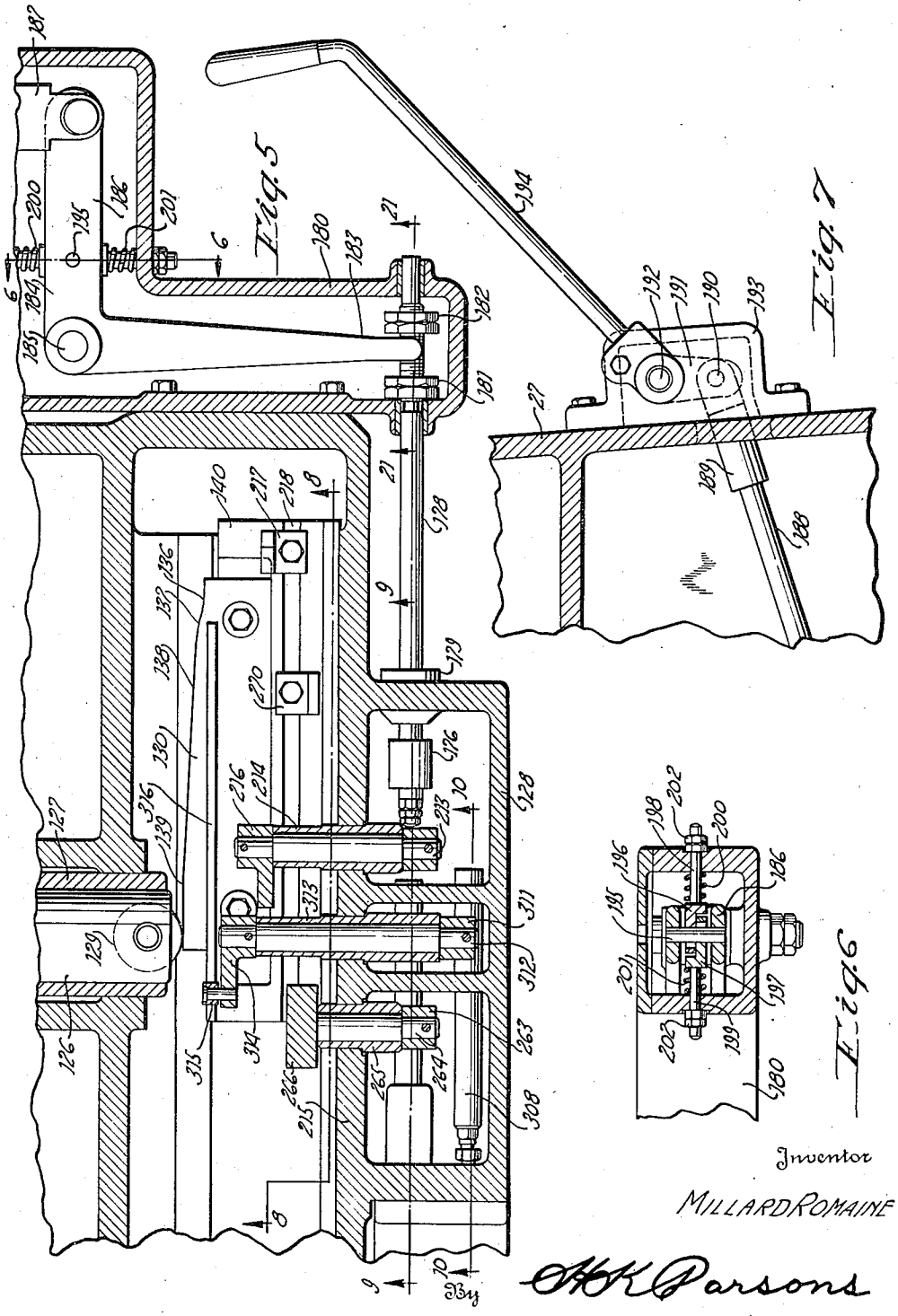


Fig. 5

Fig. 7

Fig. 9

Inventor

MILLARD ROMAINE

By H K Parsons

Attorney

Dec. 22, 1936. M. ROMAINE 2,065,100

GRINDING MACHINERY

Filed March 3, 1934 9 Sheets-Sheet 5

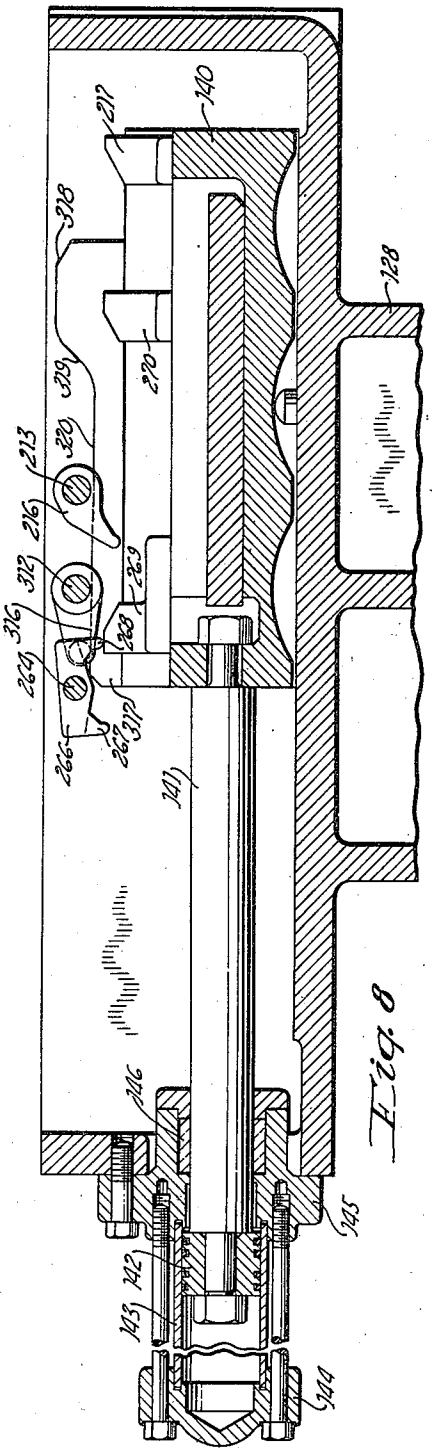


Fig. 8

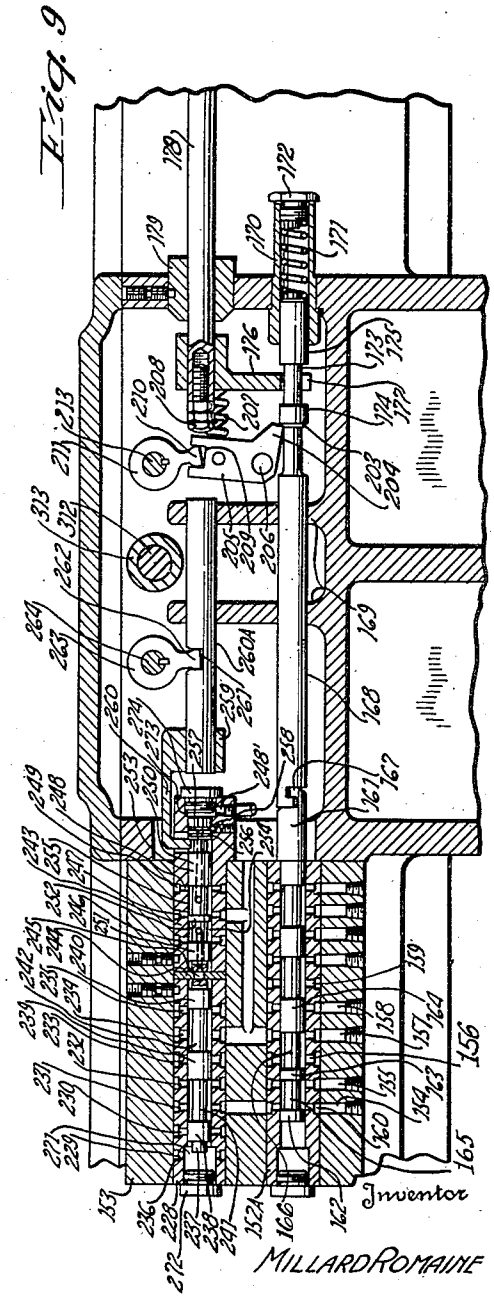


Fig. 9

Inventor

MILLARD ROMAINE

By H. K. Parsons

Attorney

Dec. 22, 1936. M. ROMAINE 2,065,100

GRINDING MACHINERY

Filed March 3, 1934 9 Sheets-Sheet 6

Fig. 11

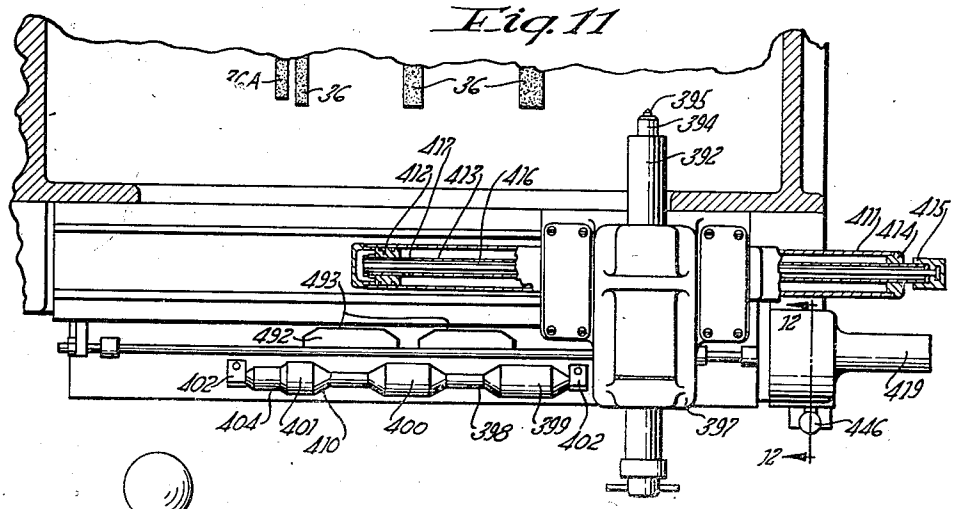
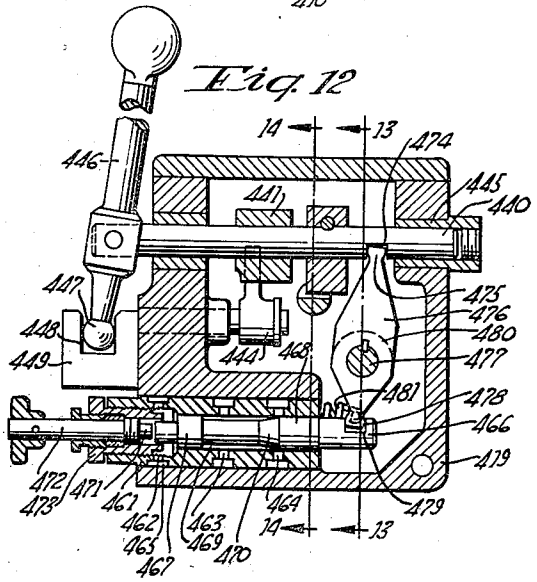


Fig. 12



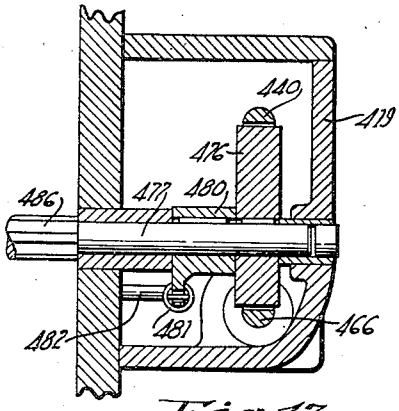


Fig. 13

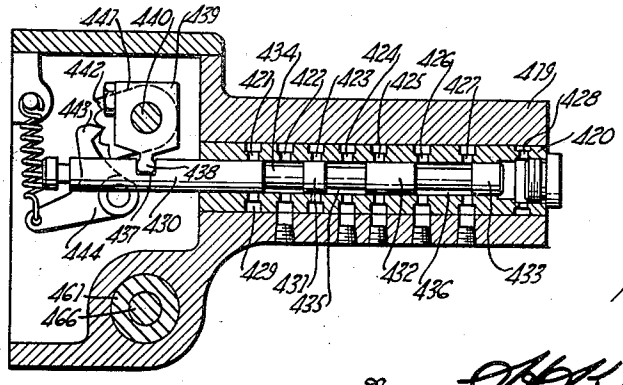


Fig. 14

Inventor

MILLARD ROMAINE

By H. K. Parsons

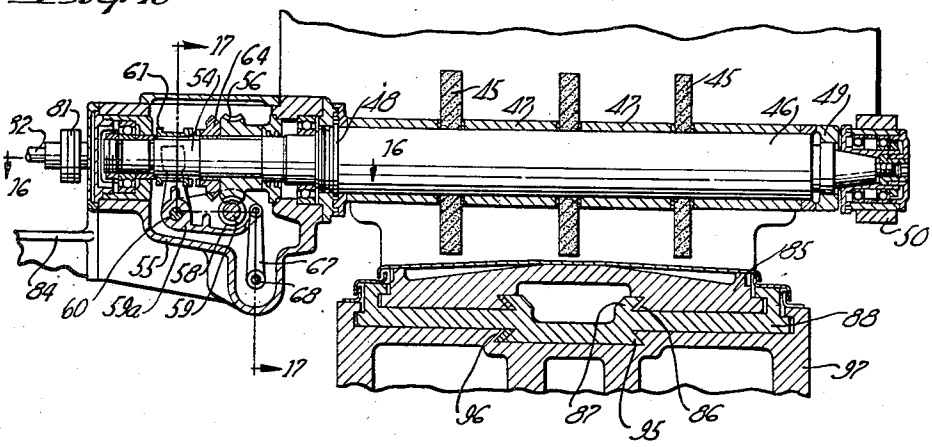
Attorney

Dec. 22, 1936. M. ROMAINE 2,065,100

GRINDING MACHINERY

Filed March 3, 1934 9 Sheets-Sheet 7

Fig. 15



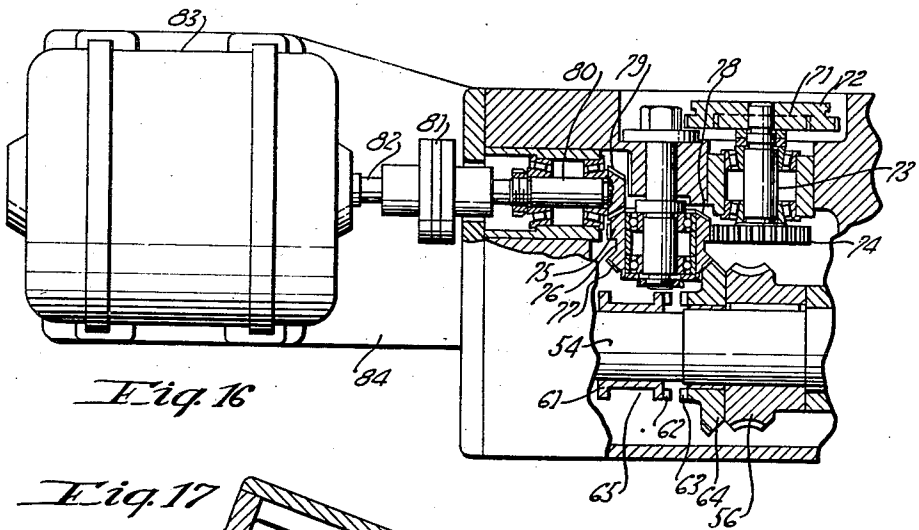
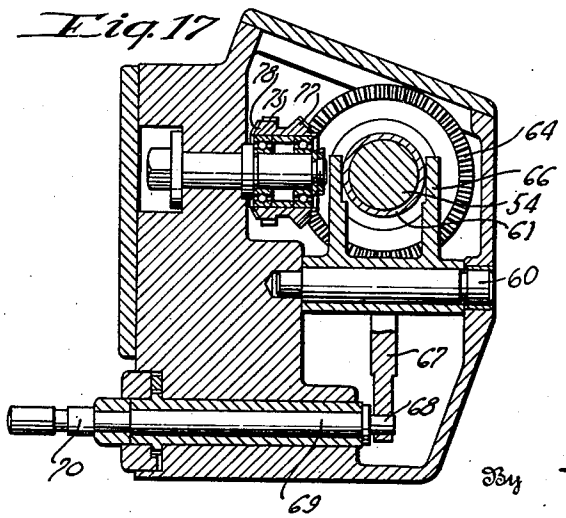


Fig. 16

Fig. 17



Inventor

MILLARD ROMAINE

By H. K. Parsons

Attorney

Dec. 22, 1936. M. ROMAINE 2,065,100

GRINDING MACHINERY

Filed March 3, 1934 9 Sheets-Sheet 8

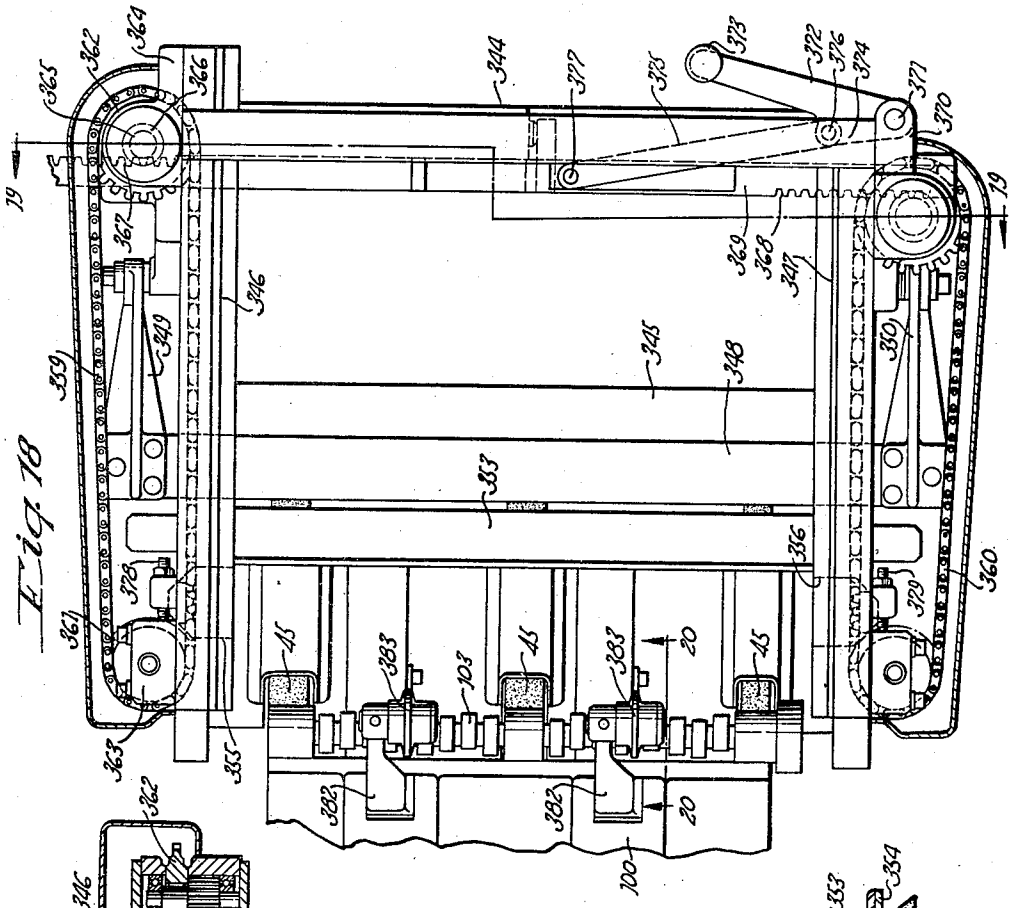


Fig. 18

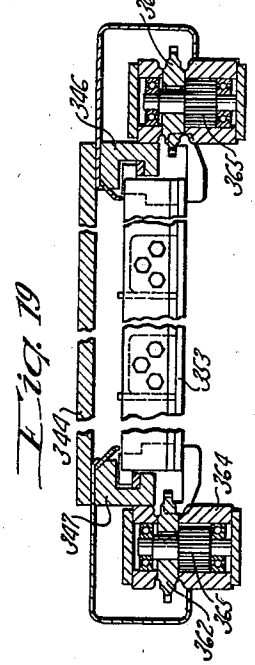


Fig. 19

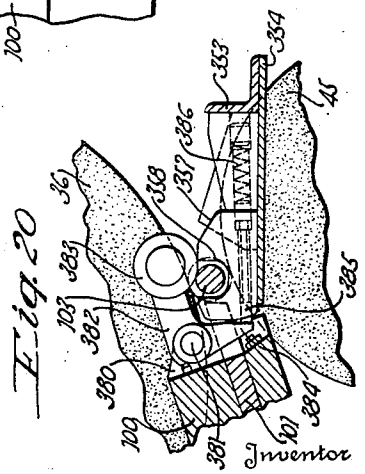


Fig. 20

Inventor
MILLARD ROMAINE

By H. K. Parsons
Attorney

Dec. 22, 1936. M. ROMAINE 2,065,100

GRINDING MACHINERY

Filed March 3, 1934 9 Sheets-Sheet 9

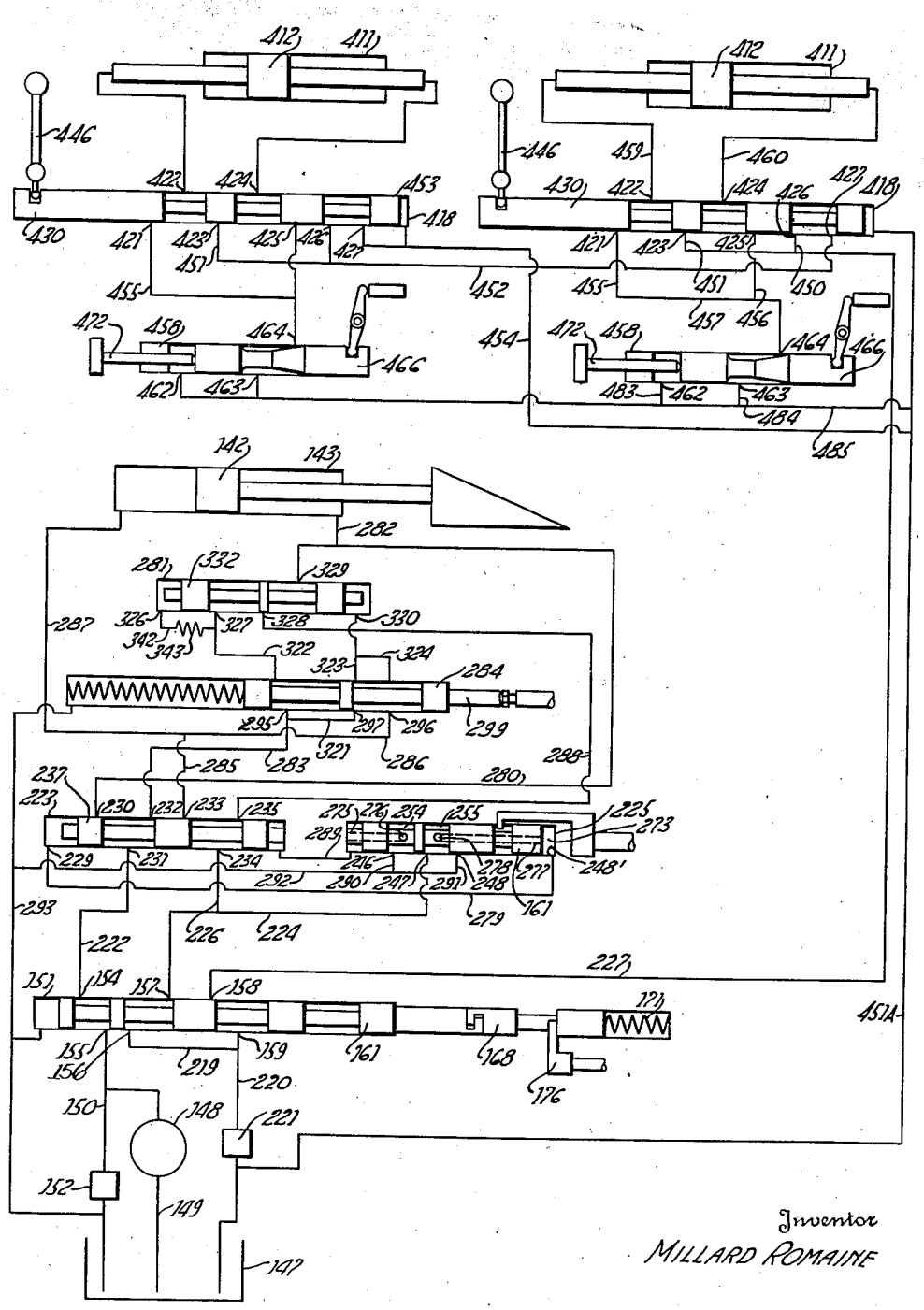


Fig. 22

Inventor
MILLARD ROMAINE

By H. K. Parsons
Attorney

Patented Dec. 22, 1936 2,065,100

UNITED STATES PATENT OFFICE

2,065,100

GRINDING MACHINERY

Millard Romaine, Cincinnati, Ohio, assignor to Cincinnati Grinders Incorporated, Cincinnati, Ohio, a corporation of Ohio

Application March 3, 1934, Serial No. 713,890

29 Claims. (Cl. 51—103)

This invention relates to improvements in machine tools and particularly to improvements in grinding machines of the centerless type.

An object of the invention is the provision of an improved centerless grinder particularly adapted for the production of large, heavy work pieces which require a plurality of grinding operations to be performed thereon.

Another object of the invention is the provision of an improved centerless grinder operable in a semi-automatic, cyclic manner for expeditiously producing such large work pieces.

A further object of the invention is the provision of improved means for effecting the operation of the machine and the control thereof which involves the use of hydraulically actuated means for expeditiously producing the work.

A further object of the invention is the provision of an improved centerless grinder of the vertical or substantially vertical type in which the parts thereof are of massive construction and requiring adjustments thereof in a vertical direction and whereby the said adjustments may be made with the expenditure of the least amount of effort.

A still further object of the invention is the provision of a centerless grinder of the kind above referred to wherein improved means are provided for operating the feed mechanism of the machine.

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 the improved centerless grinder of the present invention.

Figure 2 is a top plan view of the machine shown in Figure 1, certain overhead parts of Figure 1 being eliminated.

Figure 3 is a vertical sectional view through the machine and illustrating certain of the operative parts thereof.

Figure 4 is a fragmentary sectional view taken on line 4—4 of Figure 1.

Figure 5 is a fragmentary sectional view taken on line 5—5 of Figure 3.

Figure 6 is a sectional view on line 6—6 of Figure 5.

Figure 7 is a view partly in elevation and partly in section illustrating the control handle for the machine as seen on line 7—7 on Figure 1.

Figure 8 is a sectional view taken substantially on line 8—8 of Figure 5.

Figure 9 is a sectional view taken on line 9—9 of Figure 5.

Figure 10 is a sectional view taken on line 10—10 of Figure 5.

Figure 11 is a view, partly in section and partly in plan, as seen from line 11—11 of Figure 3.

Figure 12 is a sectional view taken on line 12—12 of Figure 11.

Figure 13 is a sectional view taken on line 13—13 of Figure 12.

Figure 14 is a sectional view taken on line 14—14 of Figure 12.

Figure 15 is a view taken substantially along the axis of the regulating wheel spindle and illustrating the change speed mechanism.

Figure 16 is a fragmentary view at right angles to Figure 15 as seen from line 16—16 on Figure 15.

Figure 17 is a sectional view taken on line 17—17 of Figure 15.

Figure 18 is a plan view of the work loading and ejecting mechanism as seen from line 18—18 on Figure 1.

Figure 19 is a sectional view taken on line 19—19 of Figure 18.

Figure 20 is a sectional view taken on line 20—20 of Figure 18.

Figure 21 is a sectional view taken on line 21—21 of Figure 5.

Figure 22 is a diagrammatic view illustrating the hydraulic circuit involved in the invention.

Figure 23 is a fragmentary sectional view taken on line 23—23 of Figure 3.

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

As was noted above, this invention pertains to a centerless grinder for operating on or producing large work pieces and for grinding a plurality or portions of a work piece concentrically. The machine is semi-automatically operated, requiring the operator to merely place a work piece in a work loading cradle and insert in the grinding throat and then throw a lever for initiating the cycle of the machine and upon completion of the cycle to withdraw the cradle and eject the work therefrom.

The machine comprises a bed or base 26 from which rises a column 27, see Figure 3. Mounted on top of the column 27 is the grinding wheel

head 28 having formed at opposite ends thereof supports 29 and 30 to which are clamped as by clamps 31 and 32 the journal bearings 33 and 34. The bearings 33 and 34 have rotatably mounted therein a spindle 35 to which are spaceably secured grinding wheels 36. Since the construction of the spindle and its supporting bearings form no part of the present invention it is not further illustrated or described.

The said spindle 35 is driven through a pin and slot connection 37 by a shaft 38 journaled in a bracket 39 secured to the side of the column and with the axis of the shaft substantially in line with the axis of the spindle. Secured to the spindle is a sheave or pulley 40 of the multiple groove type about which is trained multiple V belts 41. The belts 41 are in turn trained about a pulley or sheave on the motor shaft 42 of the prime mover or motor 43. The drive, including the belts 41, is suitably enclosed within a guard 44 secured to the side of the column.

Opposed to each of the grinding wheels is a regulating wheel 45 secured to a spindle 46 by means of spacing sleeves 47. The regulating wheels 45 and spacing sleeves 47 are clamped between a flange 48 integral with the spindle and a nut 49 threaded thereon. One end of the spindle is journaled in a bearing 50 integral with a head 51, the head 51 being in turn connected by a stud 52 to a bracket 53. The head 51 is therefore capable of being adjusted to dispose the axis of the spindle 46 in angular relation to the axis of the grinding wheel spindle 35.

The end of the spindle 46 projecting beyond the collar 48 is reduced as at 54 where it is journaled in a housing 55, also integral with the head 51. Keyed or otherwise secured to the reduced portion 54 of the spindle is a worm wheel 56 in mesh with a worm 58 on the worm shaft 59. The worm shaft 59 is rotatably journaled in a bracket 59A which is mounted within the housing 55 for oscillation about the pivot shaft 60. From this it will be seen that the worm 58 may be meshed with or disengaged from the worm wheel 56. Also, slidably keyed on the reduced portion 54 of the spindle is a clutch 61 having projecting from one face thereof clutch teeth 62 adapted to engage co-operating clutch teeth 63 on the adjacent face of a bevel gear 64 loosely mounted on the spindle portion 54. The clutch 61 is provided with a circumferential groove 65 in which is disposed a shifter fork 66 integral with the bracket 59A. From this it will be seen the relation of the shifter fork 66 to the worm 58 is such that when the said worm 58 is meshed with the worm wheel 56 the clutch teeth 62 and 63 are disengaged by shifting the clutch 61 to the position shown in Figures 15 and 16, while the reverse actuation of the bracket 59A to disengage the worm wheel 58 and worm 56 simultaneously engages the clutch teeth 62 and 63.

In order to effect the oscillation of the bracket 59A, it has depending therefrom an arm 67, the end of which engages an eccentric pin 68 associated with an oscillatable shaft 69. The shaft 69 is journaled for oscillation in a suitable bearing provided by the housing 55 and projects beyond the said housing to which projection is fastened the handle 70. From this it will be seen that through the operation of the handle 70 the bracket 59A may be actuated for either engaging the clutch teeth 62 and 63 or the worm and worm wheel 58 and 56.

Secured to the rear end of the worm shaft 59 is a gear 71 meshing with a gear 72 carried by a stub shaft 73 rotatably journaled in bearings carried by the housing 55 in a plane above the worm shaft 59. The stub shaft 73 has integral with or secured to its other end a gear 74 meshing with the spur gear 75 of a multiple gear unit 76. The multiple gear unit 76 has formed at one end thereof bevel gear 77 which meshes with the bevel gear 64 loosely journaled on the spindle and has formed at its other end the gear 78 meshing with bevel gear pinion 79. The pinion 79 is formed integral with or secured to drive shaft 80, also journaled in suitable bearings provided by the housing 55. The drive shaft 48 extends through and beyond the housing 55 where it is connected by a coupling 81 with the shaft 82 of the motor or prime mover 83. The motor or prime mover 83 is carried by a suitable shelf or the like 84 integral with the head 51.

From the foregoing it will now be seen that the regulating wheel unit is a self-contained one and includes means whereby its spindle and regulating wheels may be driven at a relatively slow rate of speed while controlling the rate of rotation of the work or at a faster rate of speed during the truing of the wheels.

The bracket 53 is integral with or secured to a slide 85 which has formed on its under surface a dovetailed guide way 86. Received in the guide way 86 is a correspondingly shaped guide 87 formed on the upper face of a lower slide 88. The slide 85 is adapted to be shifted relative to the slide 88 by means of a screw 89 having its rear end suitably journaled in a bracket 90 secured to the lower slide 88. The threaded end of the screw 89 is connected to a nut 91 rotatably journaled in suitable bearings provided by the upper slide 85. The nut 91 is held against any axial movement relative to the slide 85 and has formed integral therewith or secured thereto a spiral gear 92. The said spiral gear 92 is in mesh with a complementary gear 93 on one end of a shaft 94 and the said shaft 94 is journaled in suitable bearings in the bracket 53 and projects therebeyond where the projecting end is given an angular cross section for a wrench or the like.

The lower slide 88 is provided on its under surface with a second dovetailed guide 95 received in a correspondingly shaped guide way 96 formed in the upper surface of a bed plate 97. The slide 88 at its inner end is provided with a transverse guide way 98 receiving the tongue 99 of a block 100. The block 100 carries at its upper end the work support or work rest blade 101 which has an inclined operative surface 102 which peripherally supports the work 103 while being operated upon.

The work rest blade 101 is disposed within the grinding throat formed between the proximate portions of the grinding and regulating wheels. From this it will be seen that the work is peripherally supported while in contact with all of the grinding and regulating wheels, the former of which is rotated at a rapid rate of speed in a clockwise direction, while the latter are rotated at a relatively slow work controlling rate of speed also in a clockwise direction. From this it follows that the opposed surfaces of the grinding and regulating wheels travel in opposite directions with the grinding wheels operating toward the work rest blade 101 while the regulating wheels operate away from the said blade.

In practice the grinding wheels are subject to relatively rapid wear as is usual with wheels of this type wherefore the work rest blade and regulating wheels are periodically fed toward the

grinding wheel. For this purpose the lower slide 88 has secured to its under surface a housing 104 in which is clamped a nut 105. In threaded engagement with the nut 105 is an adjusting screw 106 which has one end thereof journaled in bearings 107 provided by the bed plate 97. The screw 106 projects beyond the bearings 107 and has secured to its projecting end a bevel gear 108 in mesh with a second bevel gear or pinion 109, see Figure 4, which bevel pinion 109 is keyed or otherwise secured to a shaft 110 rotatably journaled in suitable bearings provided by the bed plate 97. The other end of the shaft 110 has also keyed or otherwise secured to it a bevel pinion 111 meshing with a bevel gear 112 on the inner end of a shaft 113. The shaft 113 is journaled in bearings provided by a housing 114 which also encloses the bevel gears 111 and 112 and is secured to the side of the base plate 97. The shaft 113 extends beyond the housing 114 to receive the coarse infeed hand wheel 115 and the fine feed or micrometer mechanism under the control of the hand wheel and handle 116. The mechanisms operated by the hand wheels 115 and 116 are of a well known form and it is therefore deemed that further description thereof is unnecessary.

In practice the actual feed of the work and wheel is affected by oscillating the base plate 97 and parts carried thereby toward the grinding wheel. For this purpose the said base plate is provided at a point beneath the grinding wheels with lugs 117 through which pass a pivoted shaft 118. The shaft 118 also extends through a lug 119 integral with and depending from a bracket 120. The bracket 120 in turn is pivotally connected as by stud 121 with the grinding wheel head 28. The pivot 121 and bracket 120 are utilized for correcting misalignment of the axes of the grinding and regulating wheel spindles whereby the said spindles may be accurately adjusted to dispose same in parallelism. From the foregoing it will now be seen that the regulating wheels are adapted to have their axes disposed at an angle to the axis of the grinding wheel spindle to effect a feed component on the work. At the same time the said axes may be accurately adjusted as respects parallelism thereof.

To effect the oscillation of the plate 97 and parts carried thereby toward the grinding wheel the said plate has pivotally connected to it at 122 one end of link portion 123, the link portion 123 being in turn connected with link portion 124 pivotally connected at 125 with a plunger 126. The plunger is mounted for axial movement through a sleeve 127 carried by bracket or housing 128 secured to the rear of the column 27. The plunger 126 has rotatably mounted in its rear end a roller 129 which contacts with the face of a cam 130. The cam 130 is adapted to be hydraulically actuated as will be later described. In order to counterbalance the enormous weight of the base plate 97 and parts carried thereby there is provided interiorly of the column 27 a weight 131 connected by a flexible member or cable 132 with the said base plate 97 as at 133. The strap 132 passes over the periphery of a wheel or roller 134 idly rotatably supported in brackets 135 carried by the column 27.

The infeed cam 130 is shown in plan in Figure 5 and comprises a low portion 136 followed by a rapid rise 137, a slow rise 138 and a plane or flat portion 139. The cam 130, while effecting the relative feed, travels toward the right as seen in Figure 5 and therefore effects a relatively rapid movement of the parts through the portion 137, a slow infeed through the portion 138 and a dwell through the portion 139 to permit a sparking out of the work and the wheel. The cam 130 is secured to a carrier 140, see Figure 8, which is in turn connected to the free end of a piston rod 141 which carries at its other end a piston 142. The piston 142 is enclosed by a cylinder 143 which has at opposite ends piston heads 144 and 145, piston head 145 being provided with a stuffing box 146 through which the piston rod passes and prevents the escape of the medium from within the cylinder.

The piston 142 is adapted to be actuated relative to the cylinder by an hydraulic medium, preferably oil, and the circuit for controlling the flow of the medium is shown most clearly in Figure 22. As there shown, the hydraulic system includes a sump or tank 147 which contains the oil. This tank 147 may be a separate independent unit attached to the machine or it may form a part of the supporting bed or column as is usual practice. Disposed above the tank 147 is a power driven pump 148 connected with the tank by a suction line or pipe 149. The pump 148 discharges the medium under pressure into a conduit or pipe 150 which terminates in the starting and stopping valve indicated generally by the numeral 151 and the conduit has extending therefrom a branch conduit connected with the relief valve 152.

The starting and stopping valve 151 is shown structurally in Figure 9 and as there shown comprises a valve bushing 152A pressed into a bore in a valve casing 153 carried by the housing 128. The bushing 152A has formed therethrough a plurality of sets of radial ports including ports 154, 155, 156, 157, 158 and 159. Each set of ports is encircled by a similar circumferential groove 160 formed in the exterior of the bushing 152A. Disposed within the bore in the bushing 152A is a valve member 161 having a plurality of piston portions including piston portions 162, 163 and 164 forming between them cannelures 165 and 166, which in different positions of adjustment of the valve connect the several sets of radial ports in different combinations.

The valve member 161 is connected by a hook connection 167 to a stem 168. The stem 168 is mounted in support ribs 169 integral with the housing 128 for axial movement relative thereto and to effect the movement of the valve member 161. The free end of the stem 168 is mounted in a guide sleeve 170 carried by the housing 128. The sleeve 170, in addition, encloses a spring 171 which abuts on one end with the stem 168 and on the other end with a plug 172 which closes one end of the sleeve 170. The spring 171 is utilized for shifting the valve 161 in one direction, namely, to a stop position while the said valve is manually shifted to its second or open position and latched therein by means to be later described.

As was just noted, the valve member 161 is shifted to a right hand or running position by manual means which effects the starting of the cycle of operation of the machine and for this purpose the stem 168 is provided with a reduced portion 173 formed between a collar 174 and the stem guide portion 175 which guide portion is disposed within the guide sleeve 170. A valve shifter member 176 is provided, having a bifurcated end 177 whose arms straddle the reduced portion 173 of the stem and are adapted on opposite sides thereof to engage the shoulders pro-

vided by the stem collar 174 and guide portion 175. In other words, the valve shifter member 176 is actuated to the right, as seen in Figure 9, against the yielding resistance of spring 171 for correspondingly shifting the valve to its open or starting position. To effect this shifting the shifter member 176 is pinned or otherwise secured to the end of a rod 178 mounted for sliding movement through a bearing sleeve 179 provided by housing 128 and additional bearings provided by a supplemental housing 180. Within the supplemental housing 180 the rod 178, see Figure 5, is provided with nuts 181 and 182 which form abutments for the long arm 183 of a bell crank lever 184. The lever 184 is pivotally mounted at 185 within the supplemental housing 180 for oscillating movement relative thereto and the said lever has projecting on the other side of the pivot 185 its short arm 186. Pivotally connected to the free end of the short arm 186 is a clevis 187 secured to the end of an angularly disposed rod or bar 188, see Figure 7. The rod 188 carries at its upper end a second clevis 189 which is pivotally connected at 190 to a short lever 191 keyed or otherwise secured to an oscillatable shaft 192. The shaft 192 is oscillatably journaled in a bracket 193 secured to the outer face of the supplemental housing 180 and the said shaft extends beyond the said housing to which extending portion is secured the operating lever 194.

From the foregoing it will be noted that the lever 194 may be actuated for effecting the counterclockwise oscillation of the bell crank 184 as seen in Figure 5 for causing a shifting of the valve stem 178 to the right as seen in Figures 5 and 9. This movement of the rod 178 through the valve shifter 176 correspondingly shifts the valve stem 168 and valve 161 to an open or starting position. The handle 194 and bell crank 184, upon release thereof by the operator, when actuated in either direction, is returned to a neutral or central position. The mechanism for effecting this return is illustrated in Figures 5 and 6 and comprises a pin 195 extending transversely of one of the arms of the bell crank 184. As shown in the drawings the pin passes through the short arm 186 of the bell crank and the pin extends through elongated perforations or slots formed in angle members 196 and 197 which have respectively projecting therefrom studs 198 and 199. Respectively encircling the said studs are coil springs 200 and 201 which contact on one end with their angle brackets 196 and 197 and on the other ends with the lateral walls of the housing 180. The studs 198 and 199 are each provided with nuts 202 for initially positioning the lever 184 and determining between them the central position thereof. Since when in this position the transverse pin 195 engages the opposite limits of the elongated perforations or slots in the members 196 and 187 it is believed that the operation of this structure is evident from the drawings without a further description thereof.

The valve member 161 and valve stem 168 are locked in the open position or during the cycle of operation of the machine and for this purpose the collar 174 on the stem 168 has a shoulder 203 which co-operates with the nose 204 of a latch member 205. The latch 205 is pivotally mounted at 206 within the housing 128. In order to shift the latch 205 to its latching position it has connected therewith one end of a spring 207 which has its other end anchored to a fixed part of the housing 128 interiorly thereof, as seen for example in Figure 9.

The latch is adapted to be automatically released at the end of a given cycle by means to be later described, and additionally the latch may be released by the handle 194 in case of an emergency. For this purpose the rod 178 terminates closely adjacent the upper end of the latch 205 and is provided with an adjustable abutment 208 here shown as a headed bolt or screw threaded into the end of said rod 178 and provided with suitable lock nuts for locking the bolt in adjusted positions. It should also be noted at this time that should the valve member 161 not be shifted by the spring 171 due to sticking of certain of the parts the valve shifter 176 may be actuated through the handle 194 to engage the adjacent shoulder of the collar 174 and thereby manually shift the valve to its closed position. It should be understood that in the normal operation of the machine the valve will automatically shift to its closed position and the latch will be automatically tripped, the manual tripping and shifting of the valve just described being resorted to only in the case of an emergency.

In order to automatically trip the latch it is provided in its upper end with a cross slot or notch 209 receiving the ball end 210 of a lever 211 keyed or otherwise secured to one end of a shaft 213. The shaft 213 is journaled for oscillation in a bearing sleeve 214 carried by a wall 215 of the housing 128. The shaft 213 projects beyond the inner end of the sleeve 214 and has keyed or otherwise secured thereto a flipper dog 216. The flipper dog 216 overlies a stop dog 217 secured in a slot 218 formed in the upper surface of the carrier 140. The dog 217 is located at the right hand end of the said carrier and since the carrier makes one reciprocation to the right for effecting the oscillation of the bed plate and parts carried thereby to reduce a work piece to the desired size and then a return reciprocation to its initial position the latch will be released at the conclusion of a complete cycle. In other words, the starting and stopping valve is manually opened to initiate a machine cycle and automatically shifted to stop the machine at the conclusion of this cycle.

When the stop valve is shifted from the right hand or running position to a position to the left of that indicated in Figures 9 and 22, pressure line 155 will then be connected by way of the cannelure 166 of the valve to port 156 and thence through line 219, port 159 and the adjacent valve cannelure to port 158 and line 227. It will thus be evident that when the valve device has been moved to a stop position, preventing flow of the hydraulic actuating medium for effecting cyclic shifting of the machine, that the fluid is then connectible by way of the lines and portings just referred to to conduit 227 leading to the truing mechanism for actuation thereof. Accordingly the one valve serves alternatively to direct pressure either to the feed controlling mechanism or to the truing device, depending on the position adjustment thereof.

Continuing now the description of the hydraulic circuit as shown in Figure 22, it will be seen that the pressure conduit 150 terminates at the ports 155 of the starting and stopping valve bushing 152A, while the ports 156 and 159 have connected therewith one end of branch conduits 219 and 220, the latter of which empties into the tank or sump 147. Included in the conduit

220 is a valve 221 of any well known or acceptable construction which will maintain a definite back pressure in the system. The ports 154 have connected therewith one end of a pipe or conduit 222 that terminates at its other end in a reversing valve mechanism indicated generally by the numeral 223, while the ports 157 have connected therewith one end of a pipe or conduit 224, which terminates at its other end in the pilot reversing valve mechanism indicated generally by the numeral 225 and the said conduit 224 also terminates through a branch conduit or pipe 226 in the reversing valve mechanism 223. The ports 158 of the starting and stopping valve 151 have connected therewith one end of a pipe or conduit 227 which terminates at its other end in the control mechanism for operating the truing mechanisms for the grinding and regulating wheels as will be described in detail later.

The pilot and reversing valve mechanisms are in practice mounted in axial alignment in the valve casing 153 and for convenience are disposed above the starting and stopping valve mechanism 151 as shown in Figure 9. These valves are independent mechanisms, the reversing valve being operated by pressure under the control of the pilot valve which in turn is controlled by suitable dogs. As shown in Figure 9, the reversing valve mechanism 223 comprises a valve bushing 228 through which is formed a plurality of sets of radial ports 229, 230, 231, 232, 233, 234 and 235, each set being encircled by a similar circumferential groove 236 formed in the exterior of the bushing 228. Within the bore in the bushing 228 is the reversing valve member 237 having formed thereon piston portions 238, 239 and 240 forming between them cannelures 241 and 242 which connect the sets of radial ports in different combinations depending upon the position of the valve member.

The pilot valve mechanism 225 comprises a valve bushing 243 mounted in the same bore in the valve block 153 in which the valve bushing 228 is disposed. The said bushings 228 and 243 are separated by a disc 244 through which is formed a port 245, the port 245 being utilized for connecting the chambers formed at the adjacent ends of the bushings 243 and 228. The pilot valve bushing 243 has formed therethrough a plurality of sets of radial ports 246, 247, 248 and 248', each set being encircled by a similar circumferential groove 249 formed in the exterior of the bushing 243. Disposed within the bore through the bushing 243 is a pilot valve member 250 which has formed thereon piston portions 251, 252 and 253, forming between them cannelures 254 and 255 for connecting the pilot valve bushing radial ports in different combinations.

As stated above, the reversing valve bushing 228 and pilot valve bushing 243 are each provided with a chamber at their inner adjacent ends, being respectively formed on opposite sides of the disc 244. At the same time the bushing 228 has a chamber 271 formed at its other end which is closed by a plug 272 threaded into the outer end thereof. Also the pilot valve bushing 243 is likewise provided with a chamber 273 formed at its outer end, which chamber is closed by a plug 274. The inner chamber of the pilot valve bushing communicates with the cannelure 254, see Figure 22, by way of a port 275 formed centrally through the pilot valve member from the left hand end thereof as seen in the said Figure 22 and a transverse port 276 formed through the reduced portion of the valve member which forms the cannelure 254. Likewise the chamber 273 at the outer end of the pilot valve bushing communicates with the cannelure 255 by way of a port 277 formed centrally of the pilot valve member from the left hand end thereof and a transverse port 278 formed through the reduced portion of the valve member which forms the cannelure 255.

The pilot valve member has two operative positions determined by circumferential grooves 256 and 257 formed circumferentially of the valve member 250 which co-operate with a spring loaded detent 258. In order to shift the valve there is provided a valve shifter member 259 having a nose 260 disposed in a circumferential groove associated with the valve member and forming shoulders at each end thereof against which the nose engages for shifting the same. The shifter member 259 is pinned or otherwise secured to a rod 260A mounted for sliding movement in bearings provided by the support ribs 169 of the housing 128. Intermediate its ends the rod 260A has formed therein a notch 261 receiving the ball end 262 of an arm 263, keyed or otherwise secured to an oscillatable shaft 264. The shaft 264 is journaled for oscillation in a bearing sleeve 265 supported by the housing rib 215 and the shaft 264 projects beyond the sleeve 265 to which is secured a flipper member 266 having depending fingers 267 and 268.

The pilot valve member 250 is adapted to be shifted to its different positions at each end of the stroke of the carrier 140 for effecting the reverse operation of the carrier piston 142. For this purpose the flipper 266 overlies a pair of reversing dogs 269 and 270 adjustably secured in the slot 218 of the carrier 140. The operating portions of the dogs 269 and 270, however, are offset with respect to the operating portion of the stop dog 217. Therefore, no interference is had between the said reversing and stop dogs and the flippers 266 and 216. From the foregoing it is believed now evident that the reverse reciprocations of the carrier 140 are effected at each end of the travel of the carrier and since, as above described, the carrier is stopped at the completion of each complete cycle the mechanism is a semi-automatic one or fully automatic when once set in motion.

Referring again to Figure 22 and continuing the description of the hydraulic circuit the ports 229 of the reversing valve bushing have connected therewith one end of a conduit 279 which terminates at its other end in the ports 248' of the pilot valve bushing. The ports 230 of the reversing valve bushing have connected therewith one terminus of a pipe or conduit 280 which terminates at its other end in a pressure balancing valve mechanism indicated generally by the numeral 281 and the conduit 280 through the branch conduit 282 terminates at the right hand end of the wedge actuating cylinder 143. The ports 231 have connected therewith the other end of the pressure conduit 222, which extends from the start and stop valve mechanism 151 while the ports 234 have connected therewith the other end of the branch discharge conduit 226 which likewise extends from the valve mechanism 151. The ports 232 have connected therewith one end of a pipe or conduit 283 which terminates in the feed rate control valve mechanism indicated generally by the reference numeral 284, while the ports 233 have connected therewith one end of a conduit 285 which in turn connects with conduits 286 and 287 respectively terminating in the feed

rate control valve mechanism and the left hand end of the wedge cylinder 143. The ports 235 have connected therewith one end of a conduit 288 which terminates at its other end in the pressure balancing valve mechanism 281. The inner chamber of the reversing valve bushing and the adjacent or inner chamber of the pilot valve bushing are shown diagrammatically in Figure 22 as connected by a line or conduit 289, but in practice this connection is made by way of the port 245 through the separator disc as above described.

Referring now to the remaining connections of the pilot valve bushing ports, it will be seen that the ports 246 and 248 have respectively connected therewith one end of conduits 290 and 291 which empty into a conduit 292, in turn emptying into a conduit 293 which terminates in the sump or tank 147. The ports 247 have connected therewith the other terminus of the return conduit 224 extending from the starting and stopping valve mechanism 151.

The feed rate control valve mechanism is shown structurally in Figure 10 and is supported by the valve block 153 in which the starting and stopping valve, reversing valve and pilot valve are disposed. This feed rate control valve mechanism comprises a valve bushing 294 through which is formed a plurality of sets of ports 295, 296 and 297, the latter being considerably elongated as compared to the others, each set, however, being encircled by a similar circumferential groove 298 formed in the exterior of the bushing 294. Disposed in the bore through the bushing 294 is a piston type valve 299 having formed thereon piston portions 300, 301 and 302, forming between them cannelures 303 and 304. The central or piston portion 301 is utilized, depending upon its position relative to the elongated ports 297, to determine the rate of flow of the medium from the cylinder 143 and thereby determine and control the rate of movement of the piston therein and rate of movement of the work toward the wheel.

The valve member 299 is constantly urged to move toward the right, as seen in Figures 10 and 22, by a spring 305 which abuts on the rear end of the valve member 299 and on the base of an enclosing sleeve 306 carried by the valve bushing 294. The movement of the valve 300 by the spring 305 is limited by an adjustable abutment 307 carried by the end of a rod 308 lying in axial alignment with the valve member 300. The rod 308 is mounted for sliding movement through bearings provided by the transverse supporting ribs 169. The rod 308, and consequently the valve member 300, are shifted automatically during the operation of the machine.

To effect this axial shifting of the rod 308 it is provided intermediate its ends with a transverse slot 309 receiving the ball end 310 of a lever 311 keyed or otherwise secured to a shaft 312. The shaft 312 is disposed transversely of the housing 128 and is journaled for oscillation in a sleeve 313 supported by the wall 215 of said housing. The shaft 312 extends beyond the rear end of this supporting sleeve 313 and to the said projection is pinned or otherwise secured a lever 314 which carries at its outer end a roller 315. The roller 315 rides on the cam face 316 of a cam plate 317 which is secured to the carrier 140.

As seen in Figure 8 the cam face 316 of the cam plate 317 has a high portion 318 at its right hand end followed by a relatively rapid inclined portion 319 and a low flat portion 320. When the roller 315 is on the high portion 318 the valve member 299 is in such a position to permit a rapid flow therethrough. When the stop valve is open, and with the feed rate valve member 299 in this position a rapid movement of the work toward the wheel ensues. As soon as the roller 315 starts to ride down the incline 319 the valve shifts under influence of the spring 305 to slow down the rate of movement of the work and when the roller reaches the low level 320 this rate of movement is reduced to the usual rate of infeed or plunge cut grinding. The parts are so related to one another that the roller 314 reaches the junction of the inclinations 319 and 320 at substantially the same instant that the work initially contacts with the grinding wheel. From then on the rate of movement of the work relative to the wheel is at a constant grinding rate as above indicated. It is understood that this rate of movement refers to the infeed cam member 130 which acts through the plunger 126 and connecting links for oscillating the bed plate 97.

As seen in Figure 22 the feed rate valve bushing ports 295 have connected therewith the other end of the conduit 283 which extends from the reversing valve mechanism 223, while the ports 297 are also connected with the said conduit 283 by means of a branch conduit 321. The ports 295, in addition, have connected therewith one end of a conduit 322 which terminates in the balanced pressure valve mechanism 281, while the ports 297 and 296 are additionally respectively connected by conduits 323 and 324 which also terminate in the balanced pressure valve 281.

The balanced pressure valve is shown structurally in Figure 10 and is utilized, as above noted, for maintaining a definite back pressure in the exhaust side of the system. This back pressure valve mechanism is actuated and controlled by the forward and exhaust pressures in the system and acts in conjunction with the feed rate control valve for maintaining the rate of feed in accordance with the setting of the feed rate valve. As shown in Figure 10, the balanced pressure valve is mounted in the same valve block 153 and for convenience is disposed beneath the feed rate valve mechanism. This balanced valve mechanism comprises a valve bushing 325 having formed therethrough a plurality of sets of radial ports 326, 327, 328, 329 and 330, each set being connected by a similar circumferential groove 331. Disposed within the bore through the bushing 325 is the balanced valve member 332 having formed thereon piston portions 333, 334 and 335 between which is formed cannelures 336 and 337. The ends of the bushing bore are enlarged to form the chambers 338 and 339 into which the ends of the valve member 332 project. The said chambers are closed by means of plugs 340 and 341 threaded into the ends of the bushing. It is into the chambers 338 and 339 that the ports 330 and 326 empty.

As seen in Figure 22 it is with the ports 327 that the conduit 322 connects at its other end, while the conduits 323 and 324 connect with the ports 330. The ports 326 are connected through a conduit 342 and a choke coil 343 with the conduit 322. The ports 328 are connected with the other terminus of the conduit 288 while the ports 329 are connected to the other end of the conduit 280 which, together with the conduit 288, extend from the reversing valve mechanism 223.

The foregoing description completes the hydraulic circuit, the various valves in said circuit and the means for actuating said valves which effect and control the movement of the infeed

wedge piston 142 which effects the actual movement of the work as respects the grinding wheels. The complete operation of this circuit is as follows:

The work piece is inserted within the grinding throat by means to be subsequently described into engagement with the work rest blade 101 and the lever 194 actuated to shift the starting and stopping valve member 151 to its open position, that shown in Figure 22. The valve is held in this position manually until the latch 205 drops into locking position behind the collar 203. At this time the pilot reversing valve member 205 is in the position opposite to that shown in Figures 9 and 22, thereby in effect causing the bed plate to be further retracted from the grinding wheels, this for a reason which will be explained later. This retracting movement, however, takes place only for an instant when the reversing dog 270, which at this time is adjacent the arm 267 of the flipper 266, engages said arm 267 for actuating the flipper 266 in a clockwise direction as seen in Figure 8, and thereby shifting the pilot valve member 250 to the position shown in the drawings.

The flow of the hydraulic medium when the valve member 161 is first shifted is through the conduit 150, starting and stopping valve mechanism 151, conduit 222, reversing valve 223, and conduit 280 to the right hand end of the cylinder 143 as seen in Figure 22 for actuating the piston 142 to the left thereof. The medium ahead of the piston 142 is exhausted through conduits 287 and 285, reversing valve mechanism 223, conduits 226 and 224, starting and stopping valve 151 and conduits 219 and 220 to the sump 147. A definite back pressure is maintained in the exhaust side of the circuit by the valve mechanism 221, this back pressure, for example, being in the neighborhood of 125 pounds to the square inch. As mentioned above, the movement of the piston 142 for retracting the work from the wheel continues only for a very short space of time when the dog 270 shifts the pilot valve mechanism 225 to the position shown in the drawings. The shifting of the pilot valve opens up the chamber 248' at the right hand end thereof, thereby permitting a flow of the exhaust medium under pressure through the conduit 224, radial port 278 in the pilot valve member 250 and axial port 277 into the chamber 248'. The flow from the chamber 248' is through the conduit 279 to the chamber 271 at the left hand end of the reversing valve member for shifting it to the position shown in Figures 9 and 22. The shifting of the reversing valve therefor disconnects the conduits 222 and 280 and connects instead the conduits 222 and 283, causing the flow of the medium to the feed rate valve mechanism 284.

At this time the feed rate valve member is to the opposite extreme position from that shown in Figures 10 and 22 due to the fact that the roller 315 of the arm 314, which controls the position of the valve member 299, is riding on the high portion 318 of the cam 317. As explained above, this permits a relatively free rate of flow in the system wherefore the piston 142 travels at a rapid rate to effect the rapid approach of the work and grinding wheel. The continued movement of the piston 142 shifts the cam 317 whereupon the roller 268 rides down the inclined portion 319 to gradually shift the feed rate valve member 299 to the position shown in the drawings for thereby slowing down the rate of approach of the work and the grinding wheels. The flow of the hydraulic medium when actuating the work toward the grinding wheel is through the conduits 283 and 321 to the valve 284 where it is connected with the conduit 286 to the left hand end of the cylinder 143. The medium ahead of the piston 142 is exhausted through conduits 282, balance pressure valve mechanism 281, conduit 288, reversing valve mechanism 223, conduits 226 and 224, starting and stopping valve 151 and conduits 219 and 220 to the sump 147. With the feed rate valve member 299 in its extreme left hand position from that shown in Figure 22 the port 297 is relatively wide open so that the full flow is through the said port 297 to the port 296 and conduit 286, thereby obtaining the rapid approach of the work and wheel. As the piston portion 301 on the valve member 299 approaches the closing off position shown in the drawings, as above described, the flow through the port 297 is gradually decreased, thereby gradually slowing down the movement of the piston. The unused and wasted medium passes through the port 297 on the left hand side of the piston portion 301 of the valve member 299 where it is connected by the conduit 322 with the balanced pressure valve mechanism 281.

In order to maintain the feed or rate of movement of the work with respect to the wheel as determined by the position of the feed rate valve member 299 the balanced pressure valve mechanism 281 is employed as above indicated. It will be noted that the forward pressure through the conduit 283 is connected by way of conduits 322 and 326 including the choke 343 with the chamber 339 at the left hand end of the balanced pressure valve member 332 and by way of conduits 321 and 323 with the chamber 338 at the right hand end of balanced valve member 332. Since there is normally no outlet from these chambers the pressures therein will be in accordance with the divided flow from the pressure conduit 283 as effected by the piston portion 301 of the balanced pressure member 299 with relation to its port 297. This causes the balanced pressure valve member 332 to take a position relative to the port 328 to permit the flow of the exhaust medium through the conduits 282 and 280 through the balanced pressure valve member 332 and the conduit 288. During a grinding or tooling operation the piston portion 301 of the feed control valve member 299 will be nearer the right hand end of the port 297. Since the feed is necessarily a low one the greatest flow of the medium from the conduit 283 will be through the port on the left hand side of said piston portion 301. In the event of an increased flow through the system or an increased pressure due to any of a number of well known reasons encountered in hydraulic circuits of machine tools, the increased flow would tend to accelerate the feed above that established by the feed rate valve mechanism 284. This acceleration would be substantially instantly checked because the increased flow would be through the conduits 322 and 342 into the chamber 339 and thereby shift the balanced valve member to the right for cutting down the exhaust flow from the cylinder through the said balanced pressure valve mechanism, thereby setting up a higher back pressure and effectively counteracting the attempted accelerated movement of the piston.

From the foregoing it is believed that the operation of the hydraulic system is now clear and that the rate of feed between a tool and its work may be accurately controlled. The work and

tool would be actuated relative to one another until the dog 269 engages the second arm 268 on the flipper 266 for shifting the pilot valve member 161 to its second position which is, as above noted, opposite to that shown in the drawings. This, of course, disconnects the conduits 224 from the radial port 278 and axial port 277 and instead connects the said conduit 224 with the radial port 276 and axial port 275 for thereby placing the chamber at the inner end of the pilot valve member under pressure. This pressure is immediately communicated through the port 245 of the disc 244, as shown in Figure 9, or the conduit 289, as shown in Figure 22, with the inner chamber of the reversing valve member 237 and thereby shifting said valve member to its second or reversing position which is opposite to that shown in the drawings. At this time the flow of the hydraulic medium is that as first described.

This, of course, causes the piston 142 to travel to the left as seen in the drawings. The movement of the piston 142 in a retracting direction or to the left continues until the work is fully retracted to its initial position. As will be appreciated, this movement could be automatically reversed by the reversing dog 270 engaging the arm 267 of the flipper 266, but before this occurs the cycle is stopped. This stopping is effected by the dog 217 which is set to engage the flipper dog 216 before the reversing dog 270 actuated the flipper 266. The actuation of the flipper dog 216 in a clockwise direction correspondingly shifts the lever 211 on the other end of the shaft to which the flipper dog is secured. This movement of the lever 211 actuated the latch 205 in a counterclockwise direction for lifting the nose 204 thereof above the collar 174 on the starting and stopping valve stem 168. Upon release of the stem 168 the spring 171 expands and shifts the starting and stopping valve to the stop position which is at the other end of its movement from that shown in Figures 9 and 22.

Upon stopping of the machine cycle the work piece is removed and an unfinished one substituted therefor, whereupon the lever 194 is again engaged for initiating the cycle of the machine.

The means for inserting and withdrawing the work into and from the grinding throat is illustrated in Figures 3, 18, 19 and 20. As there shown, this means comprises a frame member consisting of a front bar 344, a rear bar 345 and a pair of side bars 346 and 347 connected to one another to form a rectangular frame. The said frame is supported on the upper edge of the regulating wheel head 51 where the said head is provided with an enlarged rib 348 to which is secured at opposite ends thereof brackets 349 and 350 connected at their free ends to the side bars 346 and 347. The said brackets 349 and 350 are each provided with an elongated aperture 351 through which passes attachment bolts or studs 352 into said side bars.

The work is adapted to be shifted relative to the work supporting frame for which purpose there is provided a transverse member 353 conveniently taking the form of an angle iron secured in any desirable manner to end plate members 354. The angle iron 353 and plates 354 are shifted below the supporting frame and have secured thereto at opposite ends thereof brackets 355 and 356. Intermediate the ends of the angle iron 353 it carries a plurality of cradle blocks 357 having formed therein slots 358 in which the work is disposed and whereby the said work is moved with the plates 354 and angle iron 353.

In order to effect the movement of the angle iron 353, and therefore, the work, the brackets 355 and 356 at the opposite ends of the said angle iron are respectively secured to endless sprocket chains 359 and 360. The said chains 359 and 360 are each trained about a pair of sprockets 361 and 362 located at opposite ends of the side bars 346 and 347. The sprockets 361 are each journaled in a block 363 disposed at the inner ends of the side bars 346, while the sprockets 362 are each journaled in blocks 364 disposed at the outer ends of the said side bars 346 and 347. In practice, the outer sprockets 362 are keyed or otherwise secured to a shaft 365 which is in turn rotatably journaled in the blocks 364.

Additionally, each of the shafts 365 have secured to them a small rack pinion 366 respectively in mesh with rack teeth 367 and 368 of a rack bar 369. The rack bar 369 is mounted in suitable bearings provided by the forward frame bar 344 for sliding movement relative thereto and the teeth thereof upon sliding movement effect a rotation of the rack pinions 366 for actuating the endless sprocket chains 358 and 359 in the same direction, which causes the angle bar 353 and its plates 354 to move toward or from the grinding throat.

In order to effect the sliding movement of the bar 369 the outer frame member 344 is provided with a lug 370 in which is journaled at 371 one end of a lever 372. The outer end of the lever 372 is provided with an operating handle or knob 373 and between the said handle a pivot point 371 with a lug 374. A link 375 has one end pivoted at 376 to the lever lug 374 and has its other end pivoted at 377 to the rack bar 369 intermediate the ends of said bar. The coupling of the link 375 with the lever 372 is such as to provide a toggle joint for locking the bar 369 in its inner position, namely, that shown in Figure 18. It is believed that the operation of the bar 369 is self-evident since by grasping the handle 373 of the lever 372 and actuating same in a clockwise direction will shift the link 375 and therefore the rack bar 369 to the right causing a clockwise rotation of the right hand outer sprocket 362 and a counterclockwise rotation of the left hand outer sprocket 362, thereby causing the angle iron 353 to be withdrawn from the grinding throat. Naturally an opposite actuation of the parts would reversely shift the work cradles and work carried thereby.

In order to limit the inward movement of the work and insure that the same is positioned properly within the grinding throat the brackets 355 and 356 are each provided with an adjustable abutment screw 378 and 379 which engage with the wall of the sprocket supporting blocks 363. The work is held yieldably against the work rest blade 101 during the grinding operation, for which purpose the work rest blade block 100 has secured hereto at several points and along its length a bracket 380 to which is pivotally mounted at 381 a bell crank 382. The bell crank 382 has rotatably journaled at one end of one of its arms a pressure roller 383 and at the outer end of its second arm an abutment lug 384. The abutment lug 384 is adapted to be engaged by a spring actuated plunger 385 yieldably urged relative to a bracket 386 carried by the angle iron 353 and disposed at points along said angle iron intermediate the work cradles 357. From the foregoing it will be noted that when the work is inserted within the grinding throat the carriage therefor through the spring plunger carried

thereby will yieldably hold the work against the work rest blade during the grinding operation.

The grinding and regulating wheels must periodically be trued in order to produce accurate work pieces having the desired quality of finish. The means for truing the grinding wheels and the regulating wheels are independent of one another, but since they are substantially identical in construction but one of the truing mechanisms will be described in detail. The truing mechanism for the grinding wheels is shown in Figures 3, 11, 12, 13, 14 and 22, the latter figure showing the hydraulic circuit and its connection with the machine circuit.

The truing mechanism comprises a housing 387 provided with a dovetail guideway 388 receiving a correspondingly shaped tongue 389 formed on the under surface of a slide or carriage 390 which supports the truing mechanism indicated generally by the numeral 391. The truing mechanism 391 comprises a sleeve 392 mounted in a cylindrical boss 393 integral with a second slide 397 mounted on and transversely shiftable relative to the slide 390. Mounted in the sleeve 392 is the truing tool or diamond bar 394 carrying at its inner end the diamond or truing tool 395. The outer end of the bar 392 has a threaded bore therein receiving the threaded end of a screw 396 whereby the said bar is axially adjusted relative to the surface of the wheels for effecting the inward movement thereof.

As will be noted from the left hand end of Figure 11 one of the grinding wheels, 36A, is of a smaller diameter than the other wheels, however, each of the wheels have a plane face. In order to insure the wheels being trued with a plane face the upper slide 397 of the truing mechanism has its position controlled by a cam. The cam is shown in Figure 11 and comprises a cylindrical bar 398 having secured thereto or formed integral therewith a plurality of cylindrical spools 399, 400 and 401 which are respectively disposed in alignment with one of the grinding wheels. The bar 398, together with the cam portions thereon, is mounted in brackets 402 secured to a ledge or shelf 403 projecting outwardly from the main supporting bracket 387. In order to true the face of the smaller wheel 36A the cam sleeve 401 is provided with a reduced portion or second cam face 404. Secured to the outer end of the upper slide 397 is a stud 405 rotatably carrying a roller 406 which contacts with the periphery of the cam portions on the bar 398. In order to maintain engagement of the roller 406 and the controlling cam portions the traversing or lower slide 390 is formed with a lug 407 forming one abutment for a spring 408 which abuts at its other end with the lug 409, depending from the upper slide 397. The said spring 408 tends to shift the said upper carriage toward the face of the wheels and thereby maintains contact between the follower roller 406 and cam portions 399, 400, 401 and 404. From this it will follow that the said cams absolutely determine the operative position of the truing tool or diamond 395 while cutting across the faces of the wheels and that in between the cam portions the diamond may shift inwardly of the faces of the wheels. To facilitate this movement of the diamond and its supporting slide the cam portions are provided at their opposite ends with tapers 410, facilitating the roller in riding onto the operative surfaces thereof.

To effect the traverse of the truing tool or diamond relative to the wheels the lower slide 390 has secured thereto a cylinder 411 enclosing a piston 412. The piston 412 is secured to the inner end of a hollow piston rod 413 which passes out through a head 414 on one end of the said cylinder 411. The outer end of the hollow piston rod 413 is secured in a block 415 carried by the bracket 387. Extending through the hollow piston rod 413 is a pipe or tube 416 likewise having its outer end anchored in the block 415. The piston rod 413 communicates with the cylinder on one side of the piston 412 through suitable ports 417 formed therein, while the pipe or tube within the piston rod communicates with the cylinder on the other side of the piston 412. The anchoring block 415 communicates with the reversing valve mechanism illustrated in Figure 14 for alternately connecting the hydraulic medium under pressure with the opposite sides of the piston and thereby effecting reverse reciprocations of the truing tool relative to the wheels.

The hydraulic circuit is shown in Figure 22 and as there shown illustrates similar mechanism for each of the truing mechanisms, that is, the mechanism for the grinding wheels and the mechanism for the regulating wheels. It will further be seen that when one of the truing mechanisms is being used the other is inoperative since the idle position of the first truing mechanism connects the pressure medium with the second truing mechanism. Since, however, the control mechanisms for these truing mechanisms are otherwise identical but one of them will be described in detail as will the coupling between the two. Accordingly the supply line 227 which extends from the starting and stopping valve mechanism 151 terminates at the reversing valve mechanism 418, diagrammatically shown in Figure 22 and structurally shown in Figure 14. The valve mechanism as shown in Figure 14 comprises a casing 419 in which is pressed a valve bushing 420 having formed therethrough a plurality of sets of radial ports 421, 422, 423, 424, 425, 426, 427 and 428, each set being encircled by a similar circumferential groove 429 formed in the exterior of the bushing 420. Disposed within the bore in the bushing 420 is a valve of the sliding piston type 430, having formed thereon piston portions 431, 432 and 433, forming between them cannelures 434, 435 and 436 for connecting in different combinations the radial ports in the bushing 420, depending upon the position of the valve member 430.

The valve member 430 has three operative positions and in order to shift the valve to said positions it is provided therein with a transverse slot 437 in which is received the ball end 438 of a valve shifter 439 pinned or otherwise secured to an oscillatable, slidable shaft 440. To determine the operative positions of the valve member 430, the shaft 440 has fastened to it a dog 441 provided in its outer periphery with notches 442. Co-operating with the said notches is the nose 443 of a spring pressed detent 444.

The shaft 440 is mounted for sliding and oscillatory movement in bearings 445 provided by the valve housing 419. The outer end of the shaft 440 projects beyond the housing 419 to which is pivotally secured a handle 446. The lower end of the handle 446 is provided with a ball 447 disposed in a slot 448 formed in a block 449 secured to the housing 419. The handle 446 is oscillated toward and from the housing 419 about the horizontal axis of its ball 447 in order to effect the sliding movement of the shaft 419, while it is oscillated about the axis of the shaft 440 to effect the oscillation thereof.

As seen in Figure 22 the supply conduit 227 connects through branch conduits 450 and 451 with the ports 423 and 426 of the reversing valve mechanism 418. The ports 428 have connected therewith one end of a discharge conduit 451A which terminates at its other end in the discharge conduit 220 below the back pressure valve 221. The port 427 by one truing mechanism has connected therewith one end of a conduit 452 which terminates at its other end in the reversing valve mechanism 453 of the second truing mechanism and thereby supplies pressure to said mechanism when desired. At the same time the reversing valve mechanism 453, when neither of the truing mechanisms are in use, connects the conduit 452 with a conduit 454 which has its one end terminating in the said reversing mechanism, and its other end terminating in the discharge conduit 451A and thereby shorts the system on itself. The ports 421 and 425 of the reversing valve bushing 420 have respectively connected with them one end of conduits 455 and 456 which in turn empty into a conduit 457 that terminates in a rate control valve indicated generally by the numeral 458. The remaining ports 422 and 423 have respectively connected therewith one end of conduits 459 and 460, which respectively connect at their opposite ends with the hollow piston rod and the pipe extending therethrough for alternately supplying the pressure to opposite sides of the piston 412 and connecting the remaining side to the sump or tank.

The rate control valve is illustrated structurally in Figure 12 and comprises a valve bushing 461 having formed therethrough a plurality of sets of radial ports 462, 463 and 464, each set being connected by a similar circumferential groove 465 formed in the exterior of the bushing 461. Mounted within the bushing 461 is the rate control valve member 466 having formed substantially at opposite ends piston portions 467 and 468, forming between them the cannelure 469. The piston portion 468 is provided at its inner end with a conical portion 470 which acts as an hydraulic resistance to more or less limit the flow of the hydraulic medium through the ports 464. The minimum amount of flow through the ports 464 as effected by the conical portion 470 may be adjusted by limiting the movement of the valve member 466 to the left as seen in Figure 12. This adjustment is effected by an abutment 471 formed on the inner end of a stem 472 threaded into a bonnet 473 in the end of the valve bushing 461.

The valve member 466 may be manually positioned with respect to its bushing 461 by means of the handle 446 and axial shifting of the shaft 440. For this purpose the shaft 440 has formed therein a transverse notch 474 receiving the upper ball end 475 of a lever 476 keyed or otherwise secured to a shaft 477. The lower end of the lever 476 is also provided with a ball end 478 received in a notch 479 formed in the valve member 466. By reference to Figure 12 it will, therefore, be seen that actuation of the shaft 440 in an axial direction will oppositely shift the valve member 466. The valve member 466 is normally shifted to its closed position, that illustrated in Figure 12, for which purpose the shaft 477 has keyed or otherwise secured to it an arm 480 to the free end of which is secured a spring 481 having its other end anchored in a fixed part of the valve housing 419, such as the pin 482 projecting from a wall thereof. From this it is seen that the rate control valve member 466 is manually operated or actuated through the handle 446 and shaft 440 for opening the ports 464 and permitting a greater flow through the ports 464.

Referring again to Figure 22 it will now be appreciated that the conduit 457 from the reverse valve mechanism 418 is the exhaust conduit and is connected with the ports 464 of the rate control valve 458. The remaining ports 463 and 462 of this rate control valve 458 are respectively connected with one end of conduits 483 and 484 which in turn empty into a conduit 485 discharging into the main return conduit 451A.

The stem 472 which controls the closing off position of the rate control valve 466 is set to determine the rate of movement of the truing tool past the wheels. By reference to the drawings, it will be seen that the wheels are spaced a considerable distance apart and if the rate of travel of the truing tools between the said wheels were maintained at the truing speed a considerable amount of lost time would ensue. For this reason the valve member 466 is automatically, axially positioned to increase the rate of travel of the tool between the wheels. To effect this increase in this rate of travel and to automatically adjust the position of the rate valve member 466, the shaft 477 extends beyond the housing 419 as a spline shaft 486. This shaft 486 extends entirely across the machine and the wheels thereof. Secured to the underside of the lower slide 390 is an arm 487, see Figure 3, having oscillatably mounted therein a sleeve 488. The sleeve 488 has a splined bore therethrough complementary to the spline shaft 486 and slides along said shaft as the truing tool is moved relative thereto. Depending from the bushing 488 is an arm 490 to which is secured a cam follower 491. The follower 491 conveniently takes the form of a roller and rides on the cam face of a bar 492 secured to the shelf or ledge 403 projecting from the housing 387. The cam bar 492 is provided with a plurality of enlarged cam portions 493 which act on the cam follower for shifting the arm 490 in a counterclockwise direction as seen in Figure 3, thereby correspondingly oscillating or rotating the shaft 486—477. The oscillation of the shaft correspondingly actuates the lever 476 for shifting the rate control valve to a position for opening the exhaust ports 464 and permitting an increase in rate of travel of the truing tool. As will be seen from Figure 11, the cam portions 493 are located intermediate the grinding wheels 36 so as to increase the speed of travel of the truing tools between said wheels.

It is believed that with the foregoing description the complete operation of the improved grinding machine will be understood.

What is claimed is:

1. In a grinding machine of the class described the combination of a bed, a grinding wheel rotatably mounted on said bed, a work supporting and rotating unit, means for pivotally mounting said unit on the bed for adjustment transversely thereof, additional means for pivotally mounting the unit on the bed for oscillation toward and from the grinding wheel, hydraulically actuated means for effecting the oscillation of the unit, and control means for the hydraulic actuating means for cyclically oscillating the unit at a rapid rate and a slow rate toward the grinding wheel, and at a rapid rate from the grinding wheel and stopping said oscillation in the retracted position.

2. In a centerless grinding machine the combination of a bed, a grinding wheel rotatably mounted on said bed, an opposed regulating wheel

forming with the grinding wheel a grinding throat, a head rotatably supporting the regulating wheel, a slide for the head, a supporting plate pivotally mounted on the bed for the slide, and means pivotally connecting the slide pivot means to the bed whereby the plate may be adjusted transversely of the bed for aligning the axes of the grinding and regulating wheels and whereby the plate may be oscillated to effect a relative approach and retraction of the grinding and regulating wheel axes.

3. In a centerless grinding machine the combination of a bed, a grinding wheel rotatably mounted on said bed, an opposed regulating wheel forming with the grinding wheel a grinding throat, a head rotatably supporting the regulating wheel, a slide for the head, a supporting plate pivotally mounted on the bed for the slide, means pivotally connecting the slide pivot means to the bed whereby the plate may be adjusted transversely of the bed for aligning the axes of the grinding and regulating wheels and whereby the plate may be oscillated to effect a relative approach and retraction of the grinding and regulating wheel axes, and power actuated means for effecting the oscillation of the plate toward and from the grinding wheel.

4. In a centerless grinding machine the combination of a bed, a grinding wheel rotatably mounted on said bed, an opposed regulating wheel forming with the grinding wheel a grinding throat, a head rotatably supporting the regulating wheel, a slide for the head, a supporting plate pivotally mounted on the bed for the slide, means pivotally connecting the slide pivot means to the bed whereby the plate may be adjusted transversely of the bed for aligning the axes of the grinding and regulating wheels and whereby the plate may be oscillated to effect a relative approach and retraction of the grinding and regulating wheel axes, power actuated means for effecting the oscillation of the plate toward and from the grinding wheel, means within the grinding throat for peripherally supporting a work piece, a second slide on the plate for supporting the work supporting means, and independent means for effecting the adjustment of the said slides for varying the grinding throat and the position of the work support relative thereto.

5. In a machine tool organization the combination of a bed, a plate pivotally secured to the bed, a slide member mounted on the plate for movement relative thereto, a wedge shaped cam for effecting the oscillation of the plate, an hydraulic piston and cylinder mechanism for actuating the cam, and control means for sequentially shifting the cam at rapid and slow rates in one direction and at a rapid rate in the reverse direction.

6. In a machine tool organization the combination of a bed, a plate pivotally secured to the bed, a slide member mounted on the plate for movement relative thereto, a wedge shaped cam for effecting the oscillation of the plate, an hydraulic piston and cylinder mechanism for actuating the cam, control means for sequentially shifting the cam at rapid and slow rates in one direction and at a rapid rate in the reverse direction, and manual means for initiating the operation of the piston and cylinder mechanism.

7. In a machine tool organization the combination of a bed, a plate pivotally secured to the bed, a slide member mounted on the plate for movement relative thereto, a wedge shaped cam for effecting the oscillation of the plate, an hydraulic piston and cylinder mechanism for actuating the cam, control means for sequentially shifting the cam at rapid and slow rates in one direction and at a rapid rate in the reverse direction, manual means for initiating the operation of the piston and cylinder mechanism, and automatic means for stopping the operation of the piston and cylinder mechanism at the end of the reverse rapid movement.

8. In a machine tool organization the combination of a bed, a tool support, a work support, means pivotally connecting one of said supports to the bed for oscillation relative thereto toward and from the tool, cam means for effecting the oscillation of the said support, an hydraulic motor for actuating the cam, an hydraulic circuit for controlling the movement of the motor including a start and stop valve, manual means for shifting the start and stop valve in one direction, yielding means for shifting the said start and stop valve in the other direction, means for latching the valve in the position effected by the manual means, automatically operable means for unlatching the valve to permit its operation by the yielding means, a pressure actuated reversing valve between the starting and stopping valve and motor, and a pilot valve operated by the motor for connecting the hydraulic pressure with the reversing valve to effect its operation.

9. In a grinding machine the combination of a bed, a grinding wheel head mounted thereon, a work head mounted on the bed, a support for one of said heads pivotally secured to the bed for oscillation toward and from the other head, a wedge cam for effecting the oscillation of said head support, a connection between the cam and support whereby movement of the cam effects the oscillation of the support, an hydraulic motor for actuating the cam, an hydraulic circuit for effecting the operation of the motor, a starting and stopping valve in said circuit for initiating and stopping the operation of the motor, a rate control valve in the circuit for determining the rate of movement of the motor and rate of oscillation of the support, and means operable by said motor for automatically positioning the rate control valve to automatically determine and vary the rate of operation of the motor.

10. In a grinding machine the combination of a bed, a grinding wheel head mounted thereon, a work head mounted on the bed, a support for one of said heads pivotally secured to the bed for oscillation toward and from the other head, a wedge cam for effecting the oscillation of said head support, a connection between the cam and support whereby movement of the cam effects the oscillation of the support, an hydraulic motor for actuating the cam, an hydraulic circuit for effecting the operation of the motor, a starting and stopping valve in said circuit for initiating and stopping the operation of the motor, a rate control valve in the circuit for determining the rate of movement of the motor and rate of oscillation of the support, means operable by said motor for automatically positioning the rate control valve to automatically determine and vary the rate of operation of the motor, and manual means for shifting the starting and stopping valve to initiate the operation of the motor.

11. In a grinding machine the combination of a bed, a grinding wheel head mounted thereon, a work head mounted on the bed, a support for one of said heads pivotally secured to the bed for oscillation toward and from the other head, a wedge cam for effecting the oscillation of said

head support, a connection between the cam and support whereby movement of the cam effects the oscillation of the support, an hydraulic motor for actuating the cam, an hydraulic circuit for effecting the operation of the motor, a starting and stopping valve in said circuit for initiating and stopping the operation of the motor, a rate control valve in the circuit for determining the rate of movement of the motor and rate of oscillation of the support, means operable by said motor for automatically positioning the rate control valve to automatically determine and vary the rate of operation of the motor, manual means for shifting the starting and stopping valve to initiate the operation of the motor, and means operable by the motor for shifting the starting and stopping valve to a second position for stopping the operation of the motor.

12. In a grinding machine the combination of a bed, a grinding wheel head mounted thereon, a work head mounted on the bed, a support for one of said heads pivotally secured to the bed for oscillation toward and from the other head, a wedge cam for effecting the oscillation of said head support, a connection between the cam and support whereby movement of the cam effects the oscillation of the support, an hydraulic motor for actuating the cam, an hydraulic circuit for effecting the operation of the motor, a starting and stopping valve in said circuit for initiating and stopping the operation of the motor, a rate control valve in the circuit for determining the rate of movement of the motor and rate of oscillation of the support, means operable by said motor for automatically positioning the rate control valve to automatically determine and vary the rate of operation of the motor, manual means for shifting the starting and stopping valve to initiate the operation of the motor, and a reversing valve between the starting and stopping valve and motor for determining the direction of operation of the motor.

13. In a grinding machine the combination of a bed, a grinding wheel head mounted thereon, a work head mounted on the bed, a support for one of said heads pivotally secured to the bed for oscillation toward and from the other head, a wedge cam for effecting the oscillation of said head support, a connection between the cam and support whereby movement of the cam effects the oscillation of the support, an hydraulic motor for actuating the cam, an hydraulic circuit for effecting the operation of the motor, a starting and stopping valve in said circuit for initiating and stopping the operation of the motor, a rate control valve in the circuit for determining the rate of movement of the motor and rate of oscillation of the support, means operable by said motor for automatically positioning the rate control valve to automatically determine and vary the rate of operation of the motor, manual means for shifting the starting and stopping valve to initiate the operation of the motor, a reversing valve between the starting and stopping valve and motor for determining the direction of operation of the motor, and means operable by the motor for actuating the reversing valve.

14. In a grinding machine the combination of a bed, a grinding wheel head mounted thereon, a work head mounted on the bed, a support for one of said neads pivotally secured to the bed for oscillation toward and from the other head, a wedge cam for effecting the oscillation of said head support, a connection between the cam and support whereby movement of the cam effects the oscillation of the support, an hydraulic motor for actuating the cam, an hydraulic circuit for effecting the operation of the motor, a starting and stopping valve in said circuit for initiating and stopping the operation of the motor, a rate control valve in the circuit for determining the rate of movement of the motor and rate of oscillation of the support, means operable by said motor for automatically positioning the rate control valve to automatically determine and vary the rate of operation of the motor, a pressure actuated reversing valve between the starting and stopping valve and motor for determining the direction of operation of the motor, a pilot valve for directing the pressure to the reversing valve and effecting its operation, and means operable by the motor for reversing the position of the pilot valve and therefore the reversing valve to reverse the operation of the motor.

15. In a grinding machine the combination of a bed, a grinding wheel head mounted thereon, a work head mounted on the bed, a support for one of said heads pivotally secured to the bed for oscillation toward and from the other head, a wedge cam for effecting the oscillation of said head support, a connection between the cam and support whereby movement of the cam effects the oscillation of the support, an hydraulic motor for actuating the cam, an hydraulic circuit for effecting the operation of the motor, a starting and stopping valve in said circuit for initiating and stopping the operation of the motor, a rate control valve in the circuit for determining the rate of movement of the motor and rate of oscillation of the support, means operable by said motor for automatically positioning the rate control valve to automatically determine and vary the rate of operation of the motor, a pressure actuated reversing valve between the starting and stopping valve and motor for determining the direction of operation of the motor, a pilot valve for directing the pressure to the reversing valve and effecting its operation, means operable by the motor for reversing the position of the pilot valve and therefore the reversing valve to reverse the operation of the motor, manual means for shifting the starting and stopping valve to its starting position and initiating the operation of the motor, and means for latching the starting and stopping valve in its operative position.

16. In a grinding machine the combination of a bed, a grinding wheel head mounted thereon, a work head mounted on the bed, a support for one of said heads pivotally secured to the bed for oscillation toward and from the other head, a wedge cam for effecting the oscillation of said head support, a connection between the cam and support whereby movement of the cam effects the oscillation of the support, an hydraulic motor for actuating the cam, an hydraulic circuit for effecting the operation of the motor, a starting and stopping valve in said circuit for initiating and stopping the operation of the motor, a rate control valve in the circuit for determining the rate of movement of the motor and rate of oscillation of the support, means operable by said motor for automatically positioning the rate control valve to automatically determine and vary the rate of operation of the motor, a pressure actuated reversing valve between the starting and stopping valve and motor for determining the direction of operation of the motor, a pilot valve for directing the pressure to the reversing valve and effecting its operation, means operable by the motor for reversing the position of the

pilot valve and therefore the reversing valve to reverse the operation of the motor, manual means for shifting the starting and stopping valve to its starting position and initiating the operation of the motor, means for latching the starting and stopping valve in its operation position, yielding means for shifting the starting and stopping valve to its inoperative position, and means operable by the motor for rendering the locking means inoperative to effect the operation thereof by the yielding means.

17. In a grinding machine the combination of a bed, a grinding wheel head mounted thereon, a work head mounted on the bed, a support for one of said heads pivotally secured to the bed for oscillation toward and from the other head, a wedge cam for effecting the oscillation of said head support, a connection between the cam and support whereby movement of the cam effects the oscillation of the support, an hydraulic motor for actuating the cam, an hydraulic circuit for effecting the operation of the motor, a starting and stopping valve in said circuit for initiating and stopping the operation of the motor, a rate control valve in the circuit for determining the rate of movement of the motor and rate of oscillation of the support, means operable by said motor for automatically positioning the rate control valve to automatically determine and vary the rate of operation of the motor, and additional rate control means in said circuit to insure the rate of operation of the motor as determined by the rate control valve.

18. In a grinding machine the combination of a bed, a grinding wheel head mounted thereon, a work head mounted on the bed, a support for one of said heads pivotally secured to the bed for oscillation toward and from the other head, a wedge cam for effecting the oscillation of said head support, a connection between the cam and support whereby movement of the cam effects the oscillation of the support, an hydraulic motor for actuating the cam, an hydraulic circuit for effecting the operation of the motor, a starting and stopping valve in said circuit for initiating and stopping the operation of the motor, a rate control valve in the circuit for determining the rate of movement of the motor and rate of oscillation of the support, means operable by said motor for automatically positioning the rate control valve to automatically determine and vary the rate of operation of the motor, and additional rate control means in said circuit to insure the rate of operation of the motor as determined by the rate control valve, said means being in the nature of a balanced pressure valve located in the exhaust side of the system.

19. A grinding machine including a grinding wheel and an opposed work support, means pivotally supporting one of said parts for oscillatory movement with respect to the other for effecting a relative feeding movement, a shiftable wedge engaging the oscillatable part for imparting oscillations thereto, and means for effecting a controlled variable rate of movement of the wedge.

20. A grinding machine including a grinding wheel and an opposed work support, means pivotally supporting one of said parts for oscillatory movement with respect to the other for effecting a relative feeding movement, a shiftable wedge engaging the oscillatable part for imparting oscillations thereto, and means for effecting a rapid initial and subsequent slower operative advance of the wedge whereby a variable rate of oscillation is effected.

21. A machine of the character described including a grinding wheel and a work support disposed in opposition one to the other, means supporting one of said parts for movement relative to the other, a cam operatively related to the movable member and having a variable contour for successively effecting rapid and slow relative movements of predetermined amount between the two first named members and means for variably controlling the rate of movement of the cam, said means comprising a hydraulic actuating motor, a throttling device for determining the rate of operation of the motor and means actuated by movement of the motor for varying the effect of the throttling means.

22. A machine of the character described including a grinding wheel and a work support disposed in opposition one to the other, means supporting one of said parts for movement relative to the other, a cam operatively related to the movable member and having a variable contour for successively effecting rapid and slow relative movements of predetermined amount between the two first named members, power means for effecting a continuous shifting movement of the cam during a prescribed operating cycle and additional means for varying the rate of movement of the power means.

23. A machine of the character described, including a grinding wheel and a work support, one of said parts being mounted for oscillation relative to the other to control the rate of approach and feed of the work and grinding wheel, a cam having a contoured portion reacting on the pivoted member to effect a predetermined cycle of relative movement of the parts, means for effecting a continuous movement of the cam to produce the prescribed cycle of movement, means for varying the rate of movement of the cam to vary the time of the cycle, adjustable means to vary the limits of the cycle within the maximum range capacity of the cam, said cycle being effected by forward and retracting movements of the cam, and means to interrupt the retraction of the cam at a point within the established cycle limits.

24. A machine of the character described, including a grinding wheel and a work support, one of said parts being mounted for oscillation relative to the other to control the rate of approach and feed of the work and grinding wheel, a cam having a contoured portion reacting on the pivoted member to effect a predetermined cycle of relative movement of the parts, means for moving the cam to produce the prescribed cycle of movement, means for varying the rate of movement of the cam to vary the time of the cycle, adjustable means to vary the limits of the cycle within the maximum range capacity of the cam, said cycle being effected by forward and retracting movements of the cam, means to interrupt the retraction of the cam at a point within the established cycle limits, and additional means to reestablish the retracting movement of the cam.

25. A machine of the character described, including a grinding wheel and a work support, one of said parts being mounted for oscillation relative to the other to control the rate of approach and feed of the work and grinding wheel, a cam having a contoured portion reacting on the pivoted member to effect a predetermined cycle of relative movement of the parts, means for moving the cam to produce the prescribed cycle of movement, means for varying the rate of movement of the cam to vary the time of the cycle, ad-

justable means to vary the limits of the cycle within the maximum range capacity of the cam, said cycle being effected by forward and retracting movements of the cam, means to interrupt the retraction of the cam at a point within the established cycle limits, and additional means to reestablish the retracting movement of the cam, said means for varying the limits of the cycle including automatic means to initiate the forward movement of the cam for effecting relative approach of the grinding wheel and work support.

26. In a machine for grinding of articles of circular form in cross section, the combination with a grinding wheel support carrying a grinding wheel and work supporting means for supporting and rotating a work piece in opposition to the grinding wheel, one of said supports being mounted for oscillation toward the other, of a movable cam for controlling the relative oscillation of the parts, means for imparting a continuous movement to the cam said cam having a contoured portion reacting on the oscillatable support including a portion for effecting a rapid advance or retraction of the supports, one toward the other and an additional portion of less pitch for effecting a controlled relative feeding oscillation of prescribed amount of the supports one toward the other, and means for varying the rate of movement of the cam during a single operative movement thereof whereby the rate of rapid advance or feeding oscillation of the controlled support may be accelerated or decelerated as desired.

27. In a grinding machine for the production of surfaces of revolution, the combination with a grinding wheel support and a work support, one of said supports being mounted for oscillatory movement with respect to the other, of a cam having a contoured face cooperating with the oscillatable support, means supporting the cam and oscillatable support for shifting movement, one with respect to the other, whereby said movement will effect an oscillation of the support as determined by the cam, said cam having a sharp rise designed to effect a rapid oscillation and a less steep portion adapted to effect a gradual oscillation as for relative feeding movement of the wheel and work supports one toward the other, the contour of the cam determining the maximum amount of relative movement impartable to the supports, a motor for effecting the said relative movement of the oscillatable member and the cam, and means for automatically varying said rate of relative movement during a single cycle of operation whereby the ultimate movement effected by the cam is the resultant of its predetermined contour as modified by the reaction of the varying rate of actuation thereof by a motor.

28. A precision grinding machine of the character described, including opposed grinding and regulating wheels forming a work receiving throat therebetween, means supporting one of said wheels for movement in a direction toward and from the other to effect a grinding operation on a work piece disposed therebetween, power means including an hydraulic motor for determining the relative feeding movement of the wheels, truing mechanisms associated with the respective wheels for maintaining their surfaces in condition for precision grinding work, hydraulically actuable motors for operating said truing devices, a source of hydraulic fluid under pressure for actuation of said several hydraulic motors, and a control valve for selectively coupling the hydraulic fluid with the wheel feeding or wheel truing motors.

29. A precision grinding machine of the character described, including opposed grinding and regulating wheels forming a work receiving throat therebetween, means supporting one of said wheels for movement in a direction toward and from the other to effect a grinding operation on a work piece disposed therebetween, power means including an hydraulic motor for determining the relative feeding movement of the wheels, truing mechanisms associated with the respective wheels for maintaining their surfaces in condition for precision grinding work, hydraulically actuable motors for operating said truing devices, a source of hydraulic fluid under pressure for actuation of said several hydraulic motors, and a starting and stopping valve for controlling the flow of actuating fluid to the feed motor, said valve having a portion effective in stop position for coupling the hydraulic actuating fluid with the truing motors.

MILLARD ROMAINE.