Aug. 20, 1935. F. S. HAAS ET AL 2,012,065

GRINDING MACHINE

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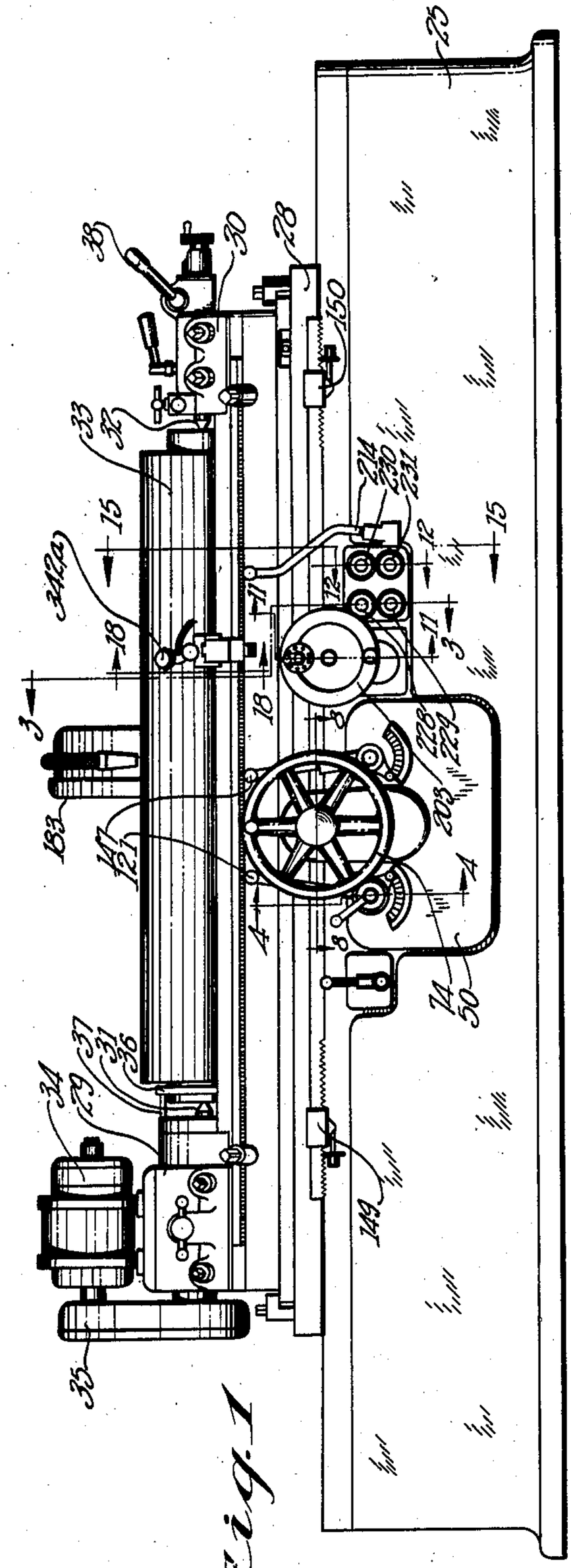

Fig. 1

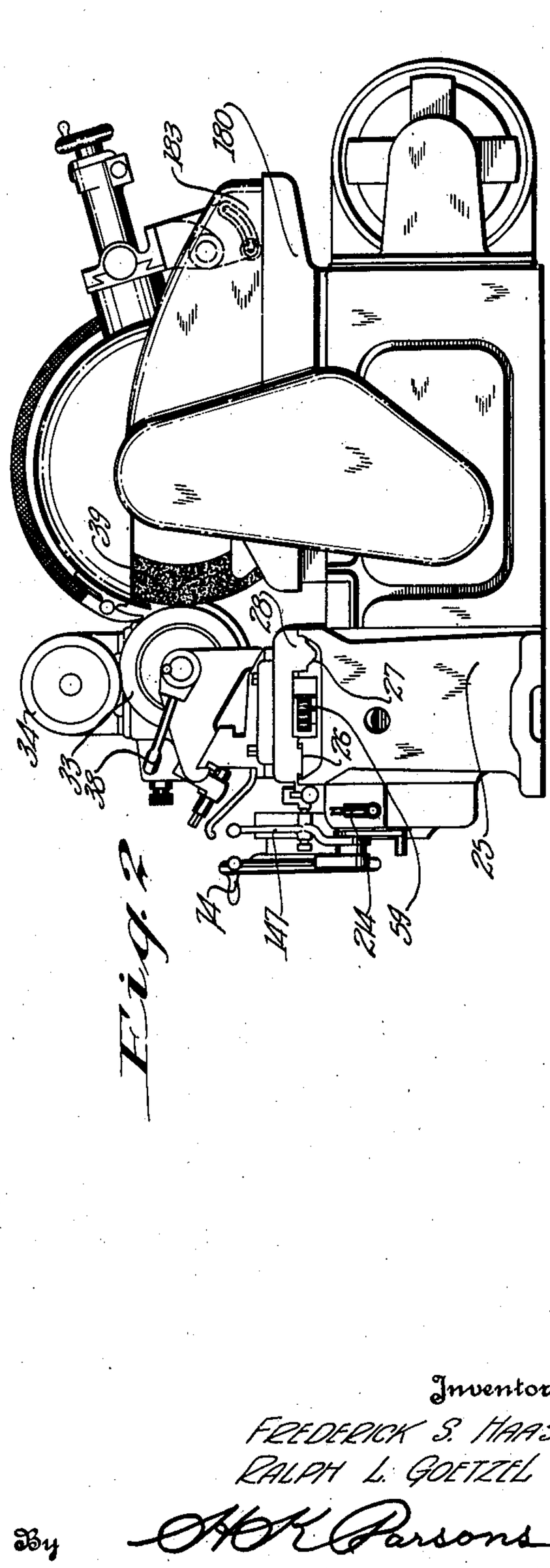

Fig. 2

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GRINDING MACHINE

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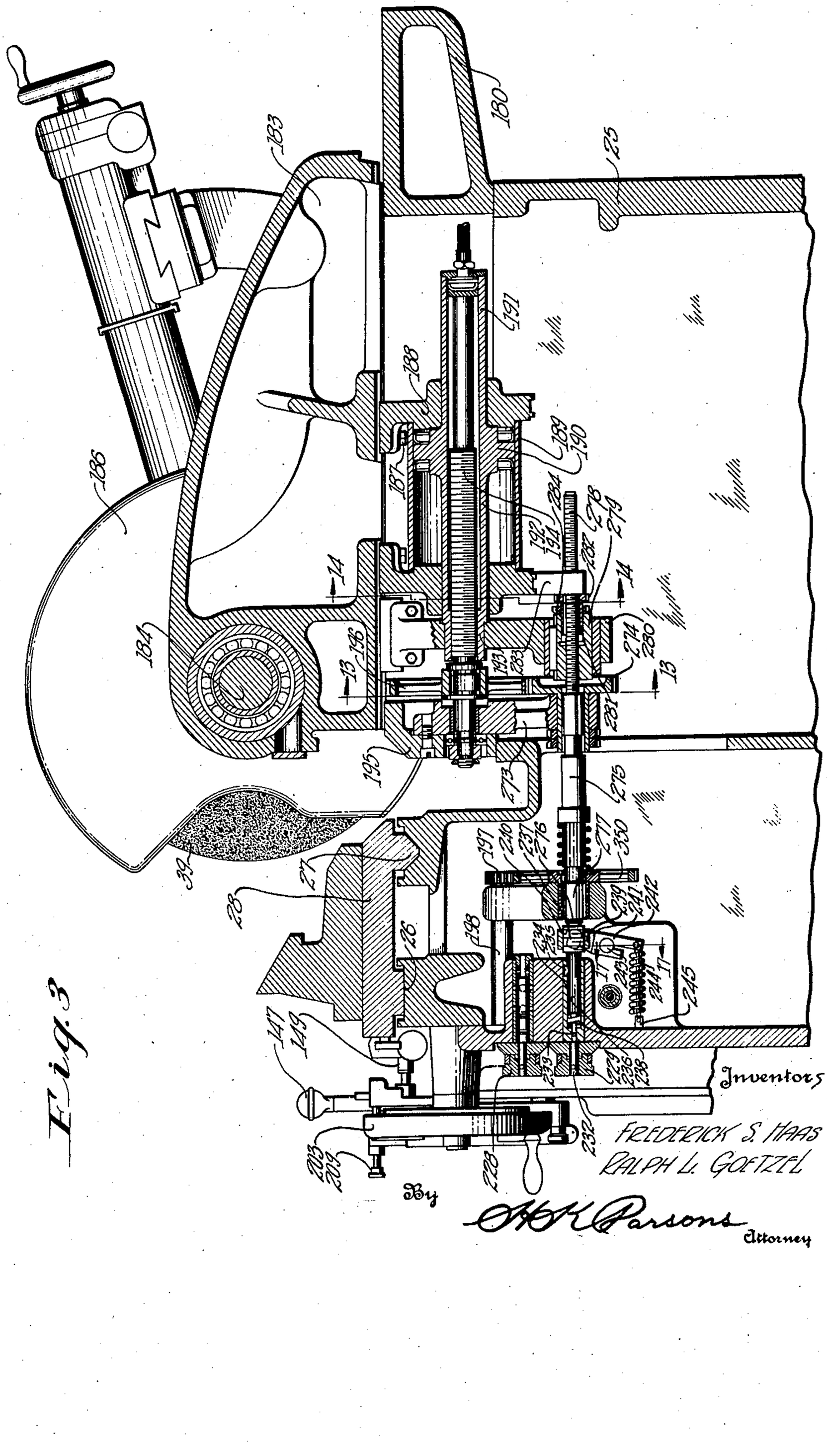

Fig. 3

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GRINDING MACHINE

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Fig. 4

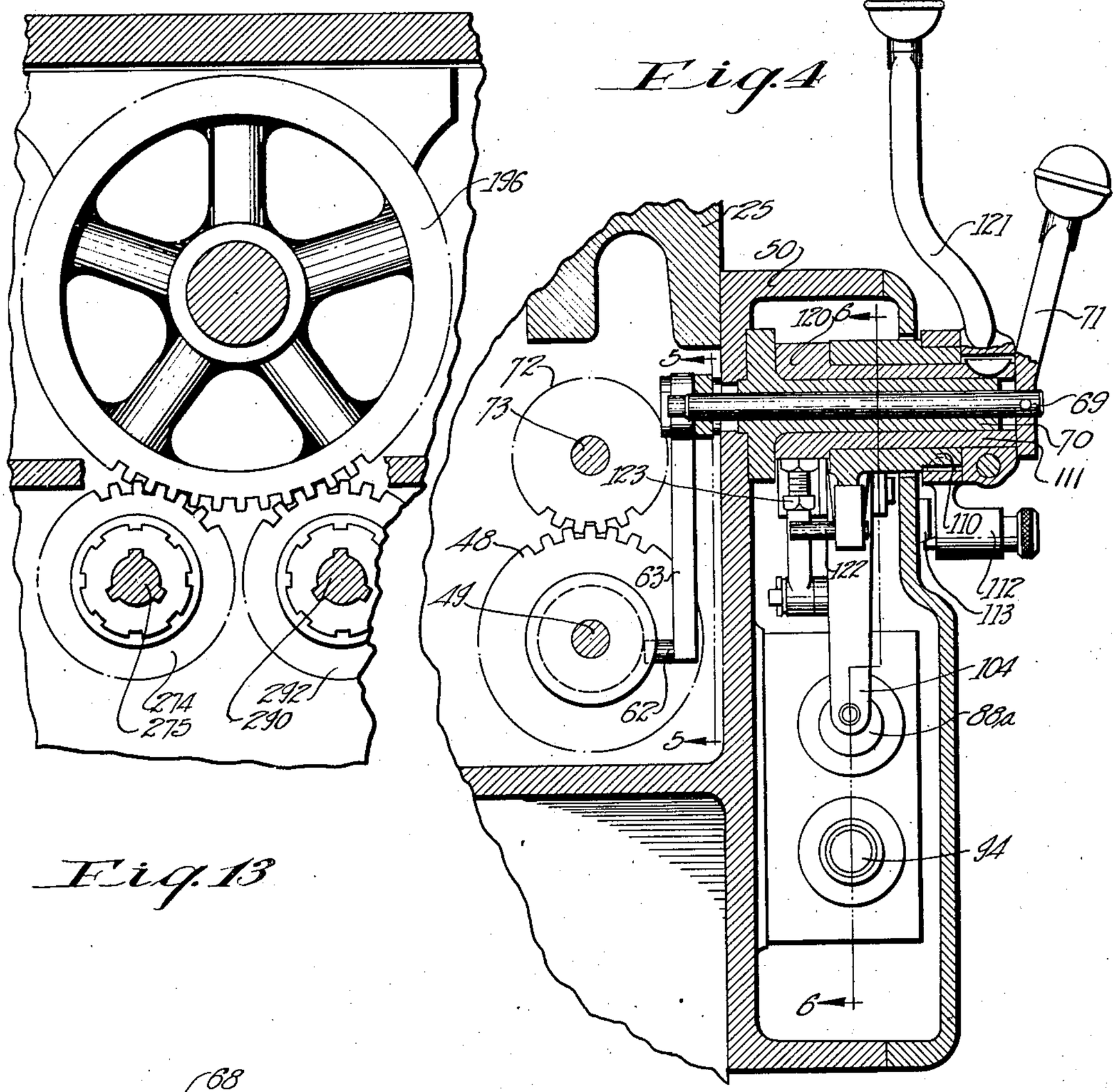

Fig. 13

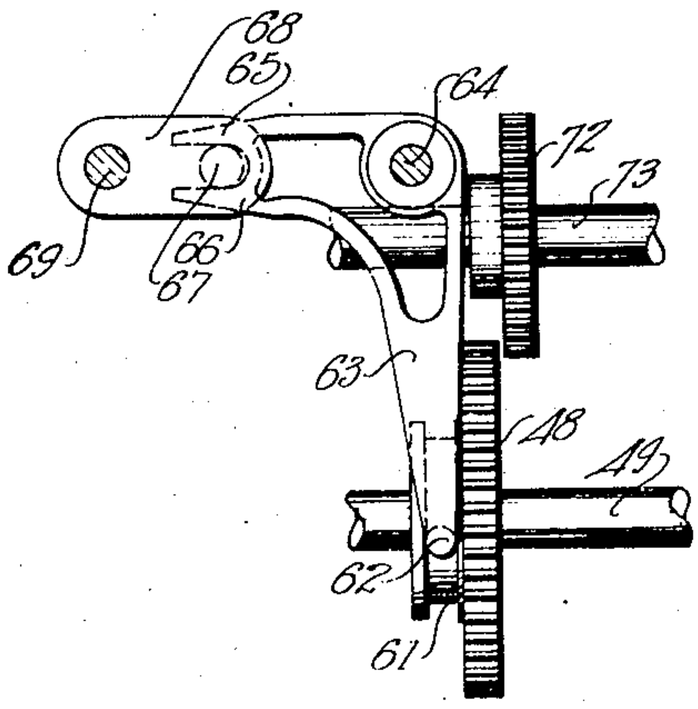

Fig. 5

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GRINDING MACHINE

Filed May 31, 1930 10 Sheets-Sheet 4

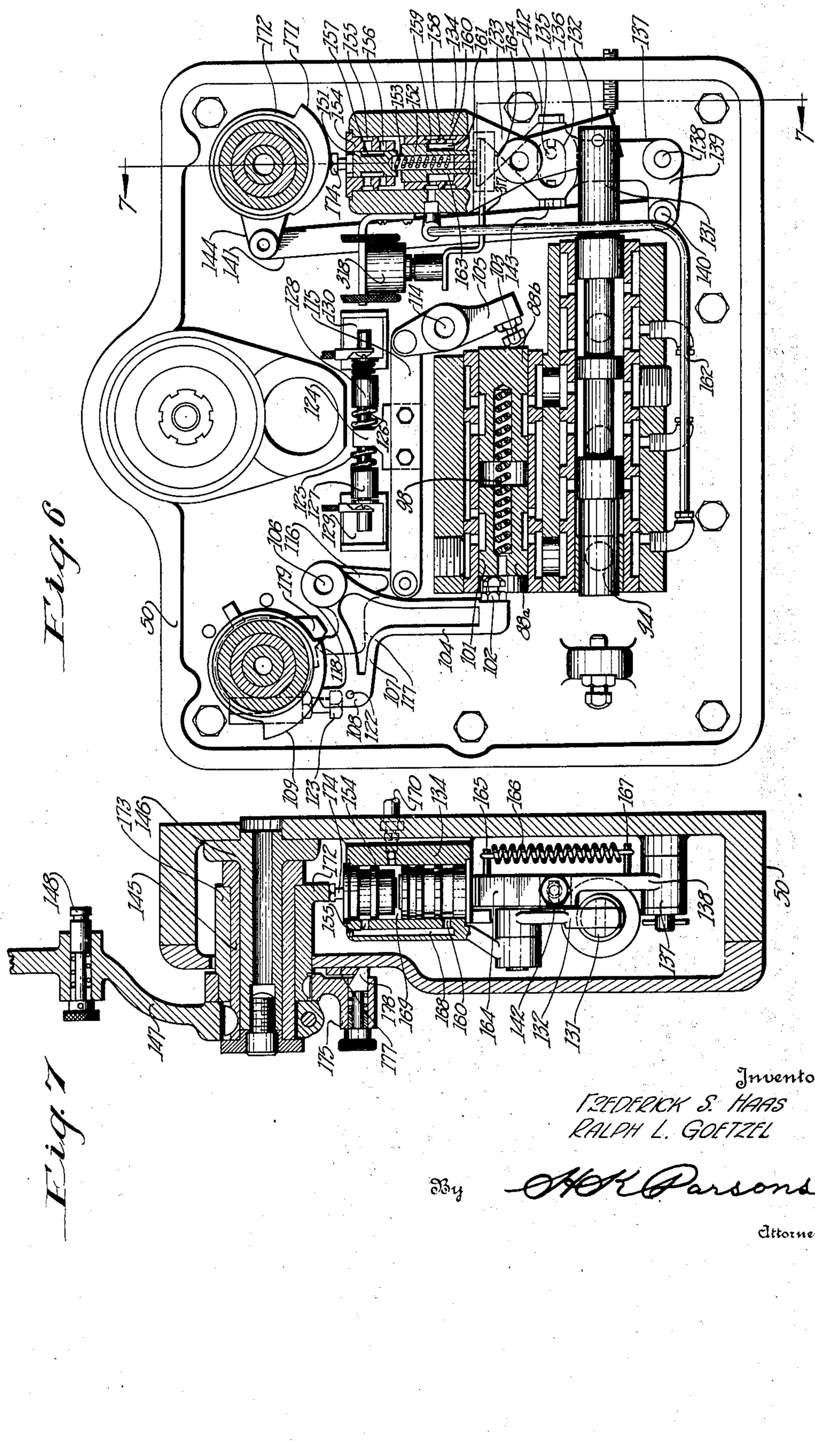

Fig. 6

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GRINDING MACHINE

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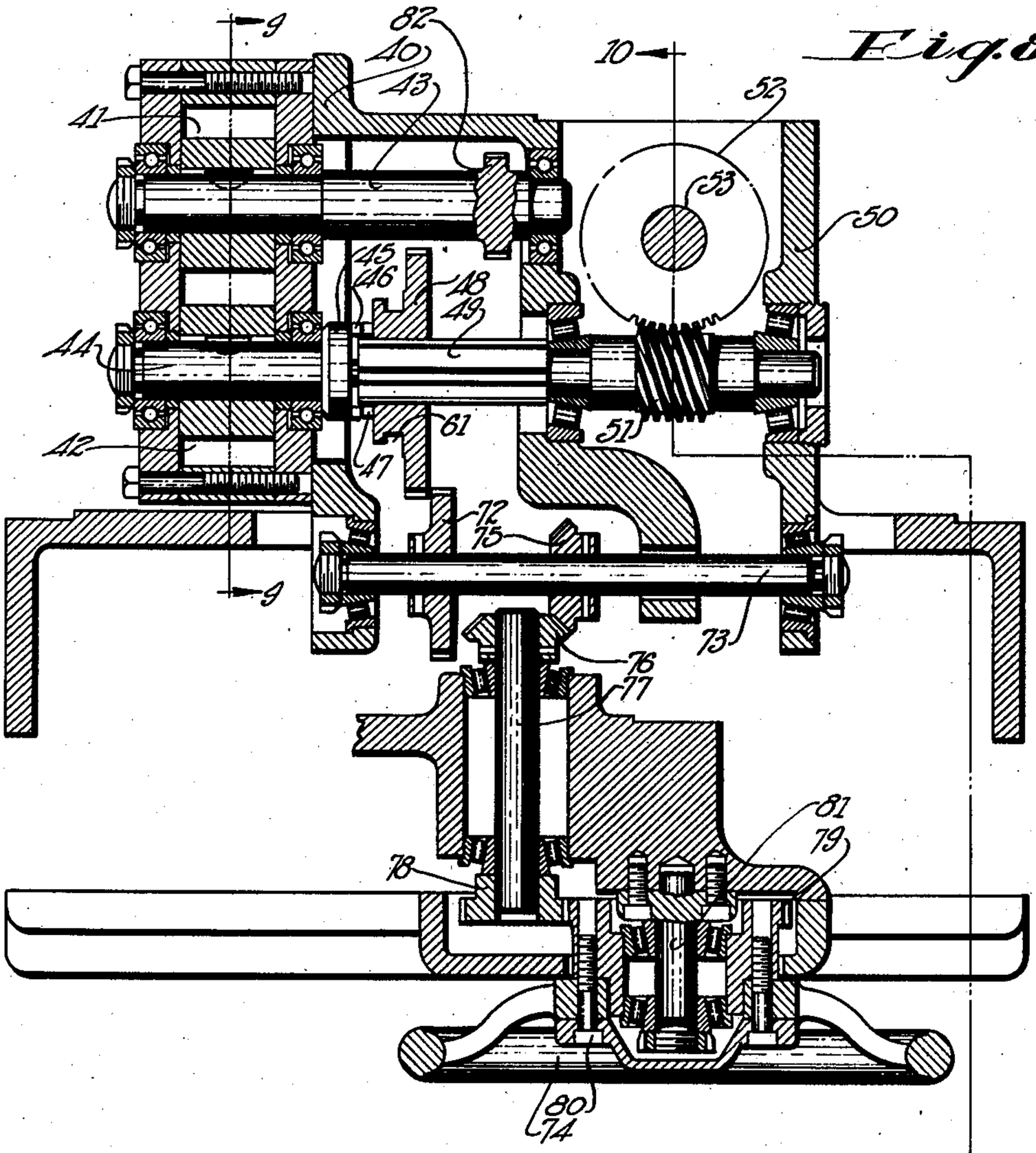
Fig. 8



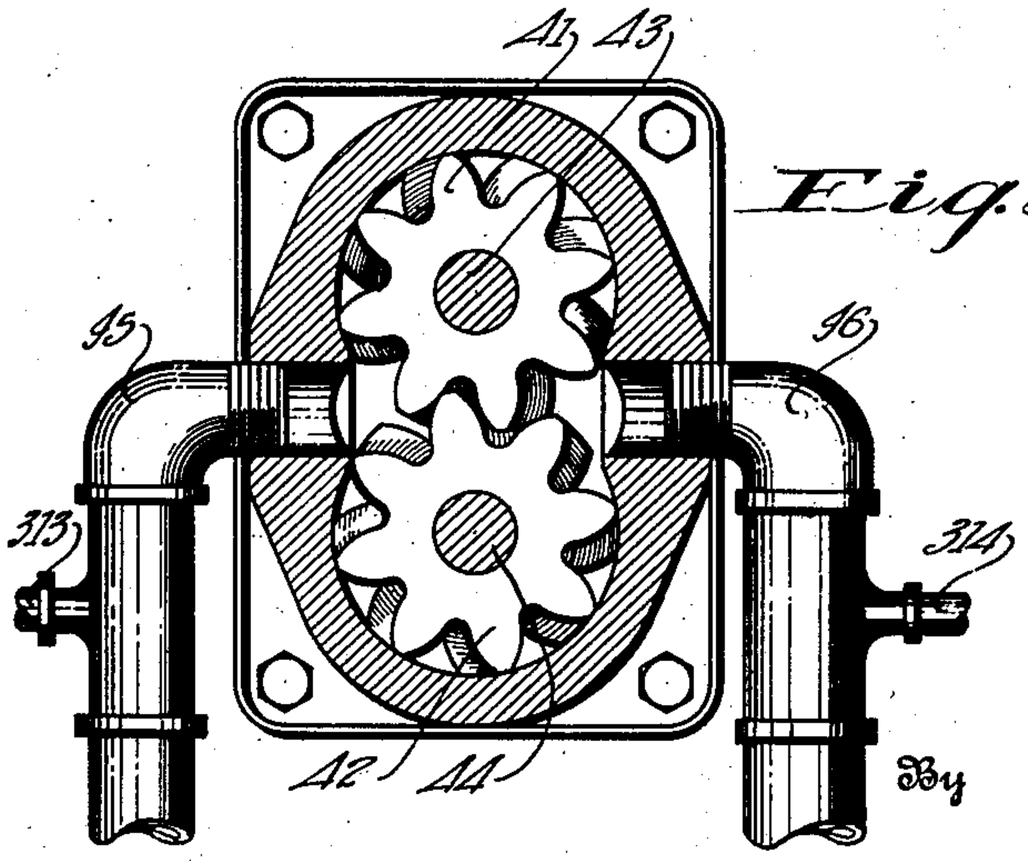


Fig. 9

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GRINDING MACHINE

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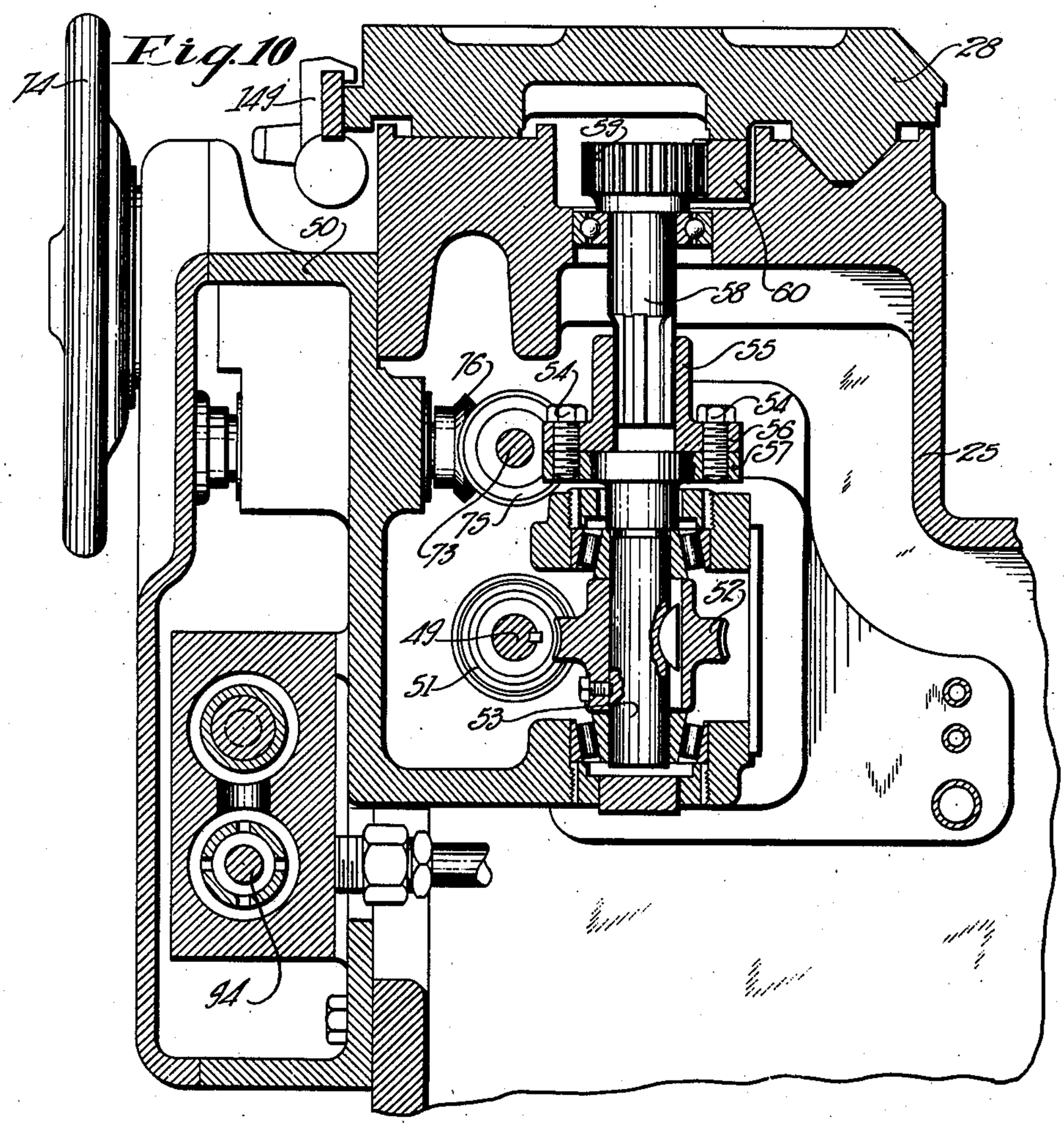
Fig. 10



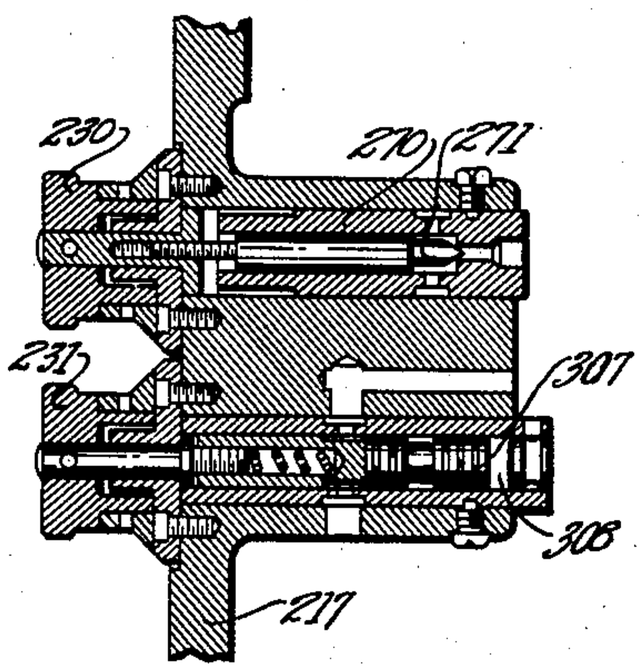


Fig. 12

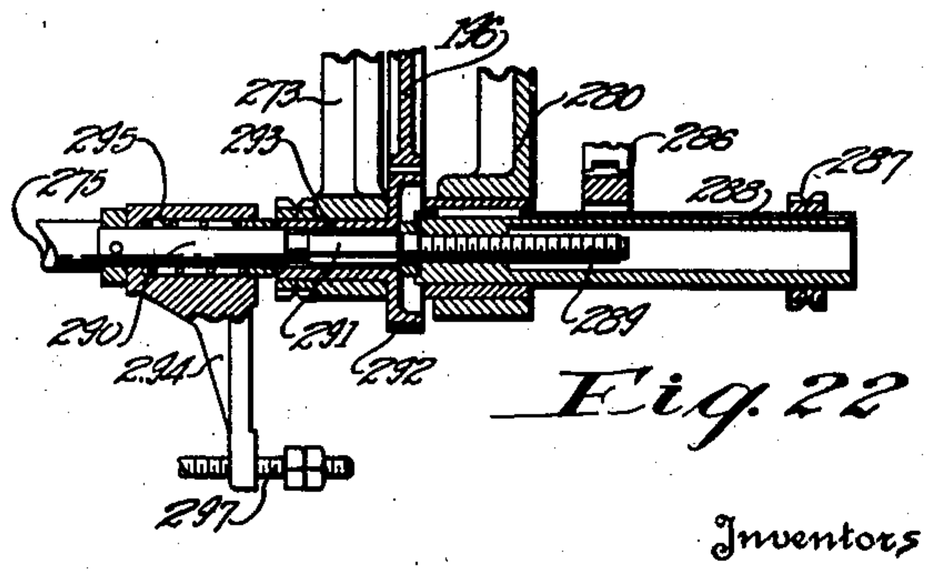


Fig. 22

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GRINDING MACHINE

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Fig. 11

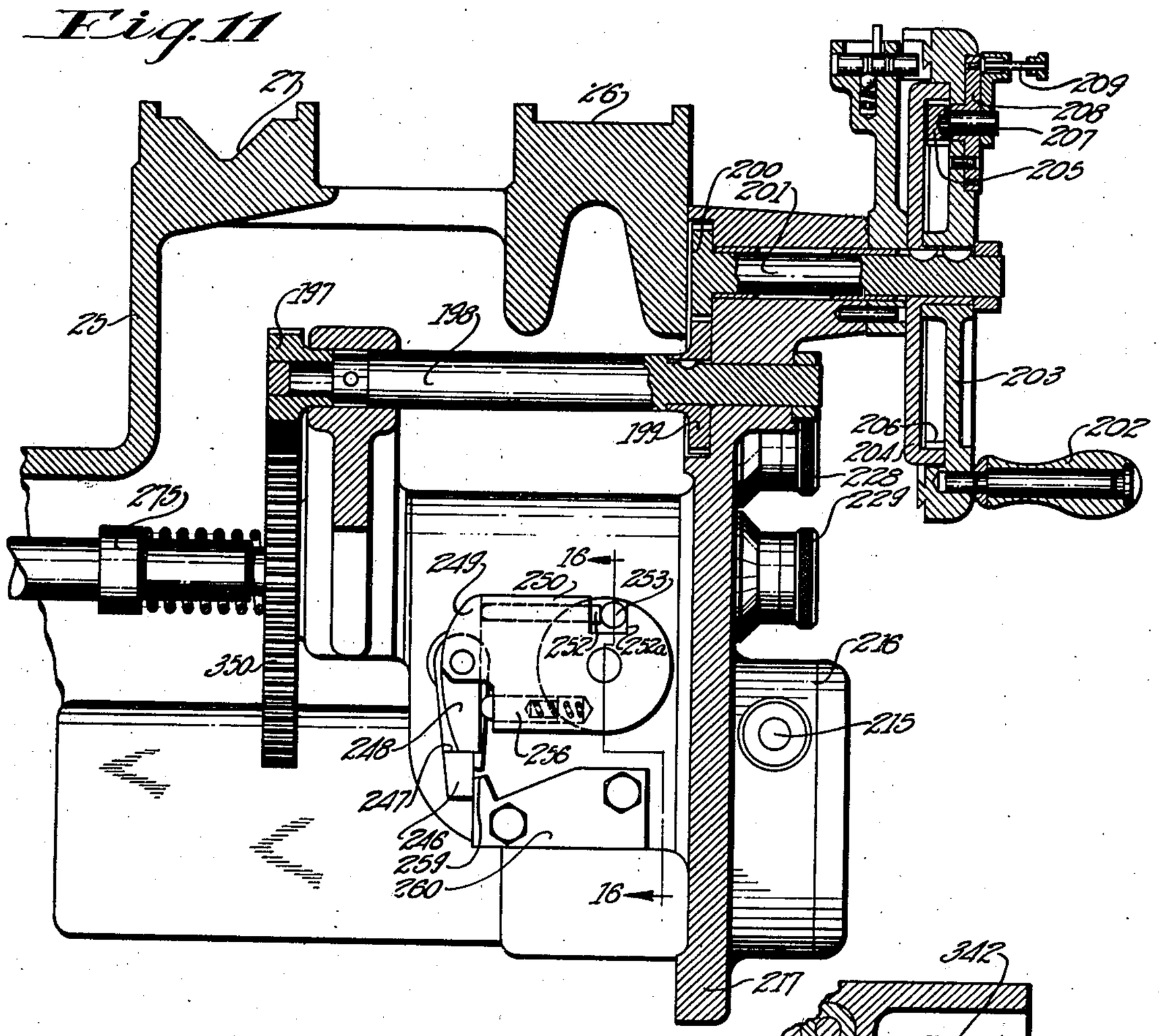


Fig. 17

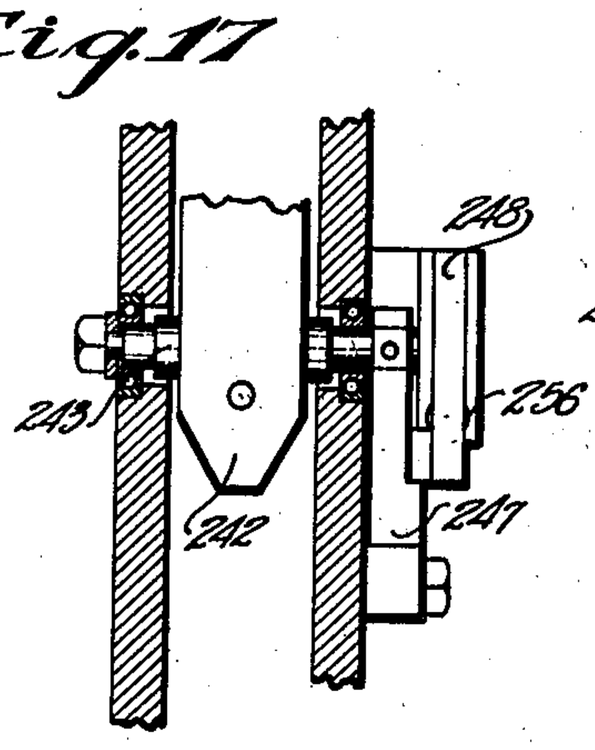
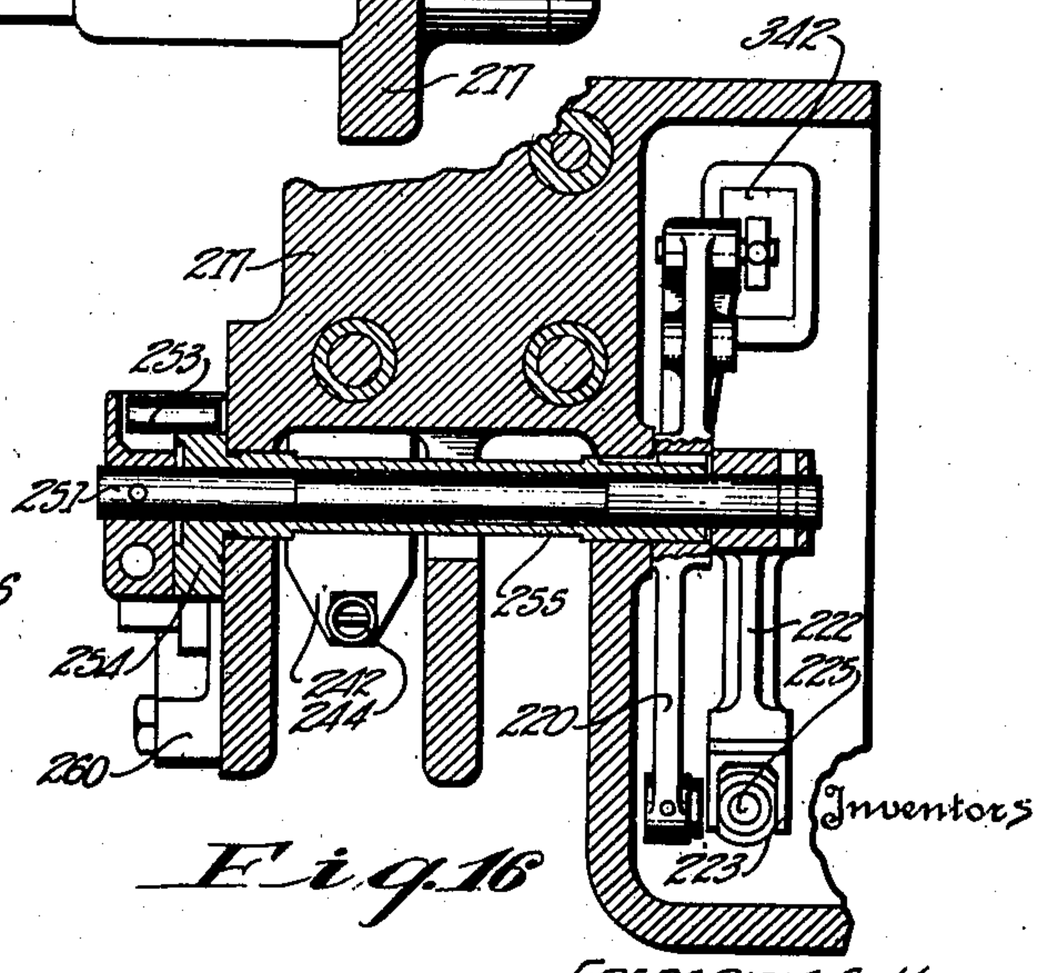


Fig. 16



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GRINDING MACHINE

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Fig. 15

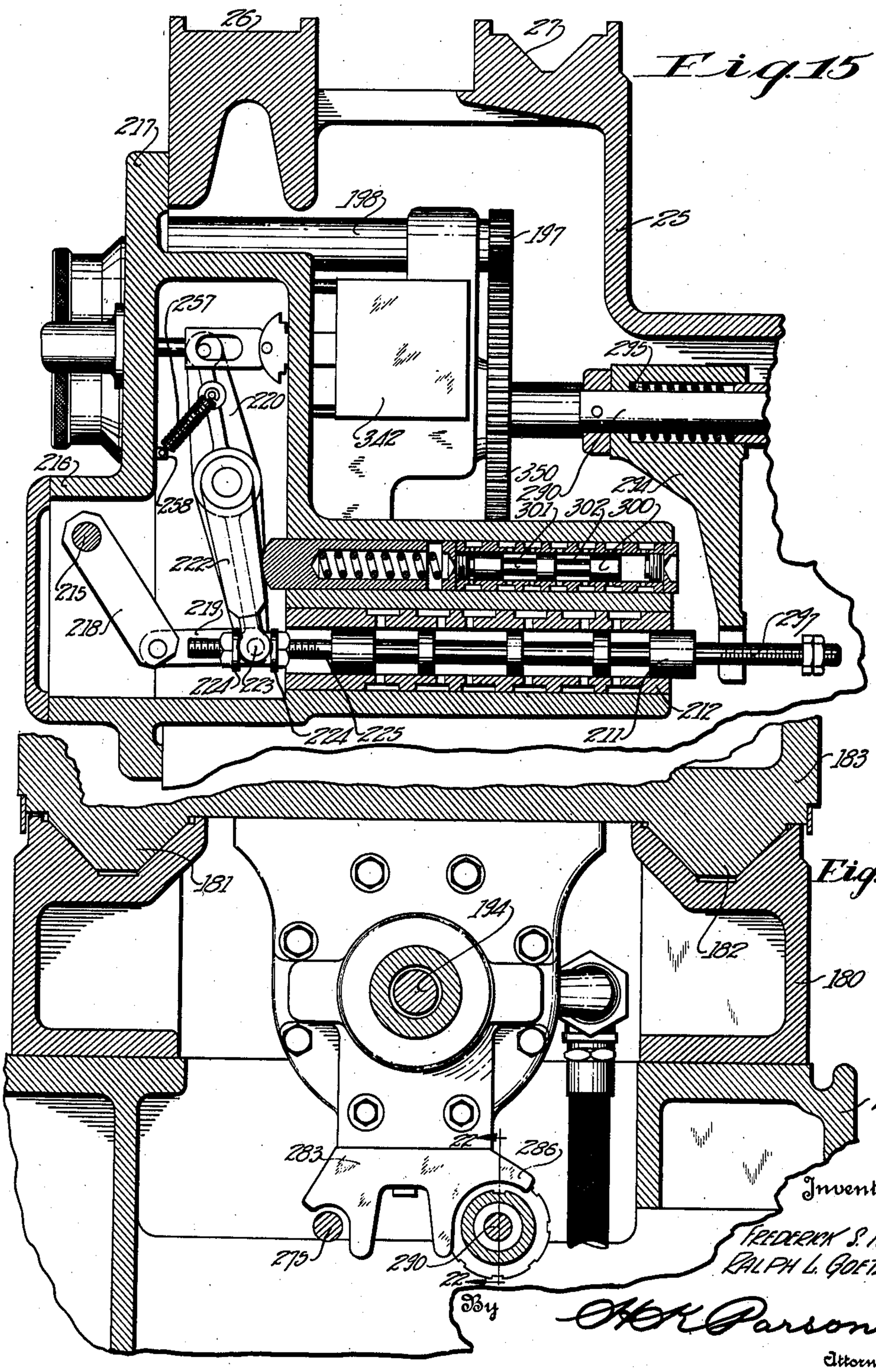

Fig. 14

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GRINDING MACHINE

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Fig. 18

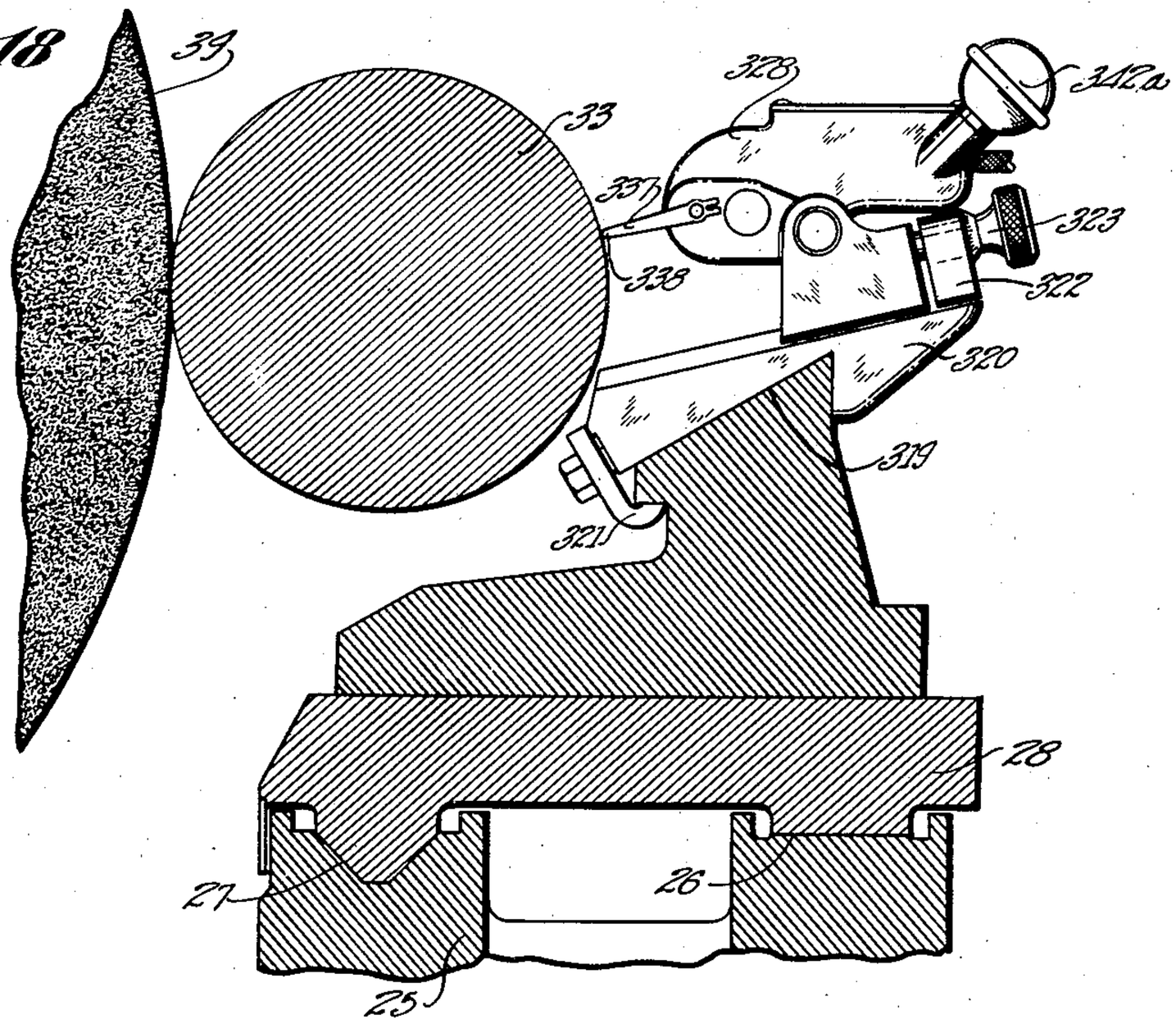


Fig. 20

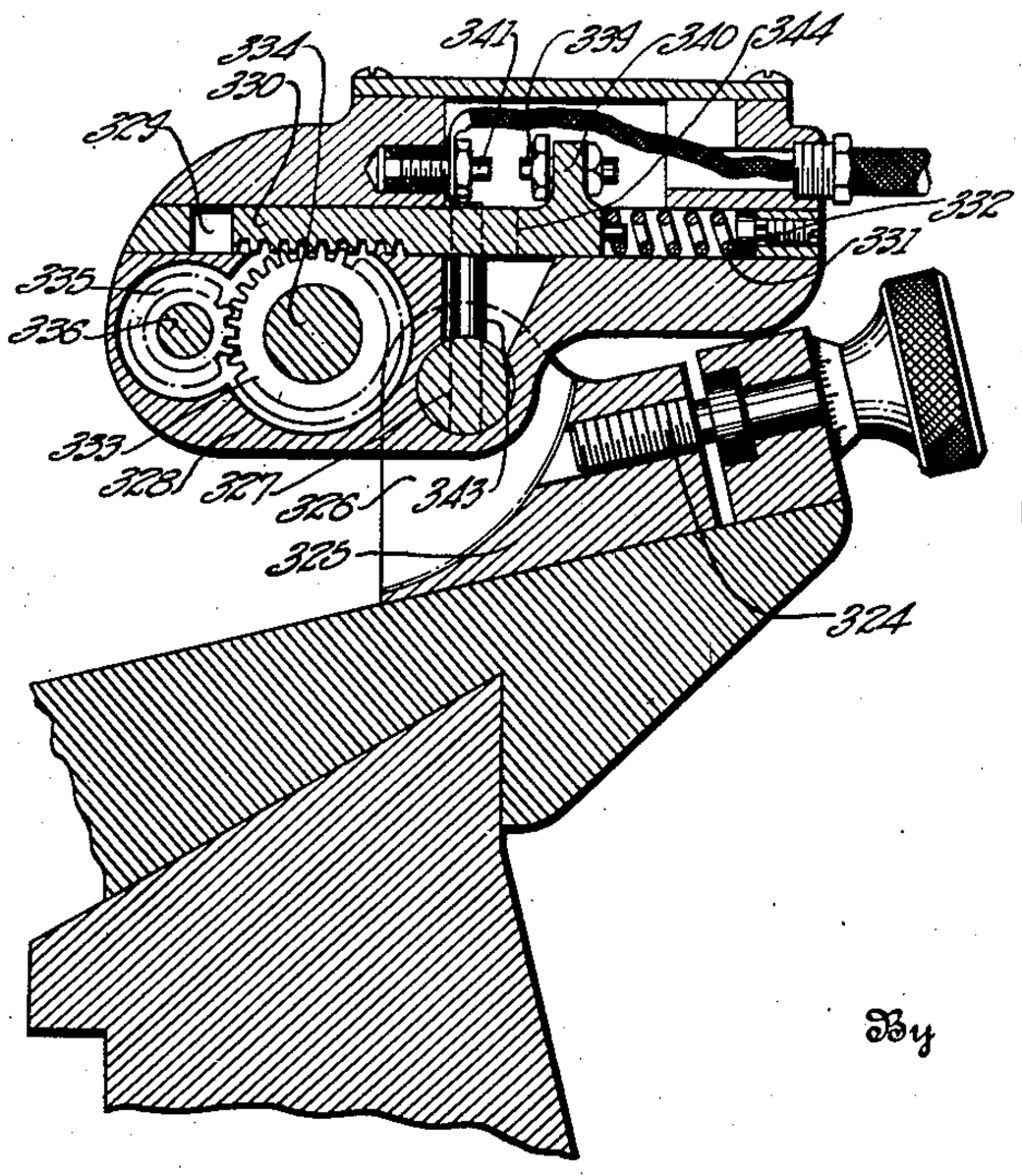
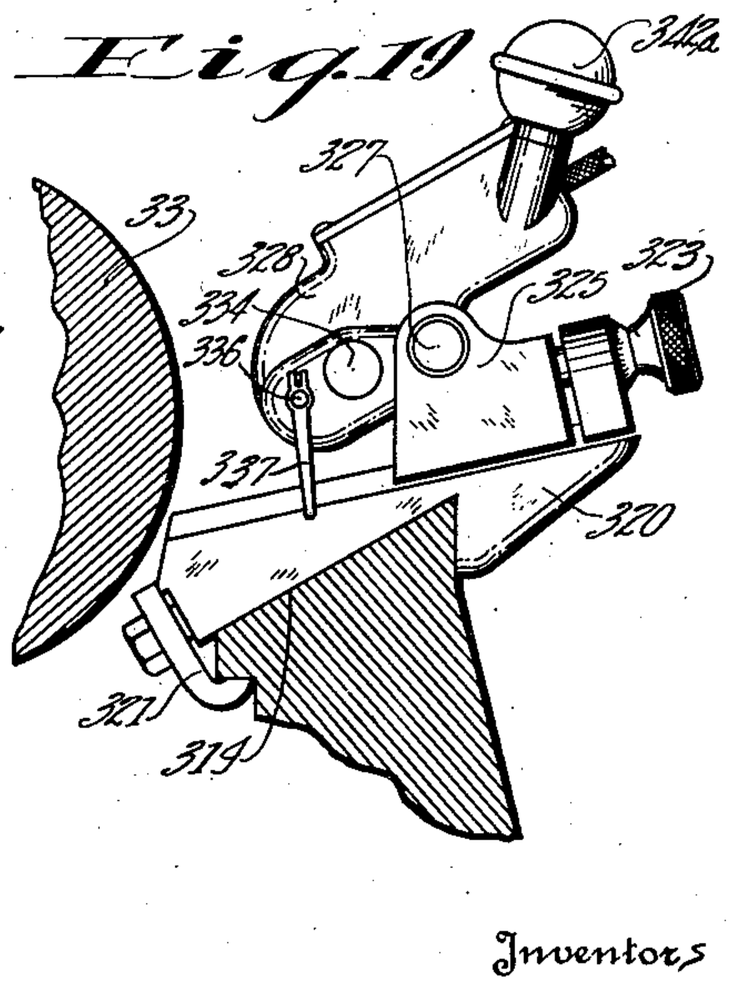


Fig. 19



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GRINDING MACHINE

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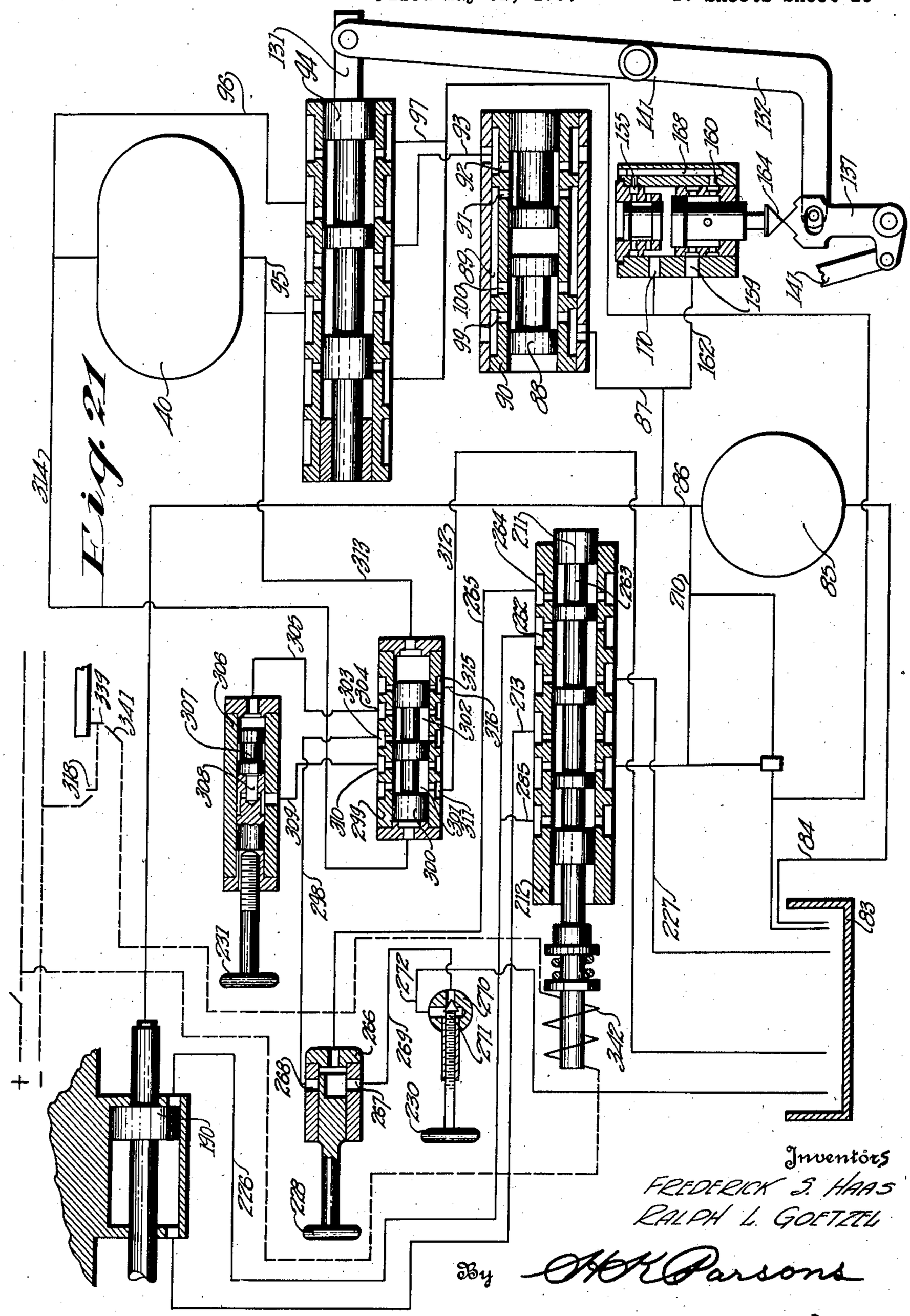
Fig. 21.



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Patented Aug. 20, 1935 2,012,065

UNITED STATES PATENT OFFICE

2,012,065

GRINDING MACHINE

Frederick S. Haas, Cincinnati, and Ralph L. Goetzel, Norwood, Ohio, assignors to Cincinnati Grinders Incorporated, Cincinnati, Ohio, a corporation of Ohio

Application May 31, 1930, Serial No. 458,558

18 Claims. (Cl. 51—95)

This invention relates to improvements in grinding machines and especially to improvements in such machines for operation on work pieces held between centers.

In the performance of grinding operations on work pieces held between centers there are two methods generally employed, in the first method the work piece is held between the centers on the table or supporting member which is then traversed across the face of the grinding wheel to reduce the work piece throughout its length to the same size while in the second method the supporting member, centers and work piece carried thereby are held stationary as respects this traversing movement and the grinding wheel fed into the work piece for effecting a stock removal therefrom. In the former method of grinding the grinding wheel or tool is fed into the work piece at the end of each reciprocating stroke until the work piece is reduced to the desired size and the table is traversed between the increments of feeding.

It is, therefore, one of the principal objects of the present invention to provide a universal grinding machine that may be satisfactorily employed for performing either of the above mentioned methods of grinding.

Another object of the invention is the provision of improved means for actuating the several moveable members of the improved grinding machine in the most expeditious manner to eliminate all unnecessary movements and increase the production of the machine to the maximum.

Another object of the invention is the provision of improved means for effecting the translation of the work supporting member while performing the grinding operation by traversing the work supporting table and work across the face of the grinding wheel together with improved means for feeding the said grinding wheel or tool into the work at each end of the stroke of the table.

A further object of the invention is the provision of improved means for actuating the grinding wheel or tool carriage relative to the bed and feed the tool into the work while the said work is being held stationary on its supporting table as respects the longitudinal movement thereof.

A still further and specific object of the invention is the provision of an improved grinding machine capable of performing universal grinding operations having the control and adjusting members within convenient reach of the operator so that the machine may be adjusted in a minimum of time and with the least inconvenience for the performing of the several methods of grinding.

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 within the exact structural details 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 elevational view of a grinding machine embodying the improvements of this invention.

Figure 2 is an elevational view of the machine as seen from the right hand side thereof in Figure 1.

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

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

Figure 5 is a view of several parts shown in Figure 4, as seen from line 5—5 thereon.

Figure 6 is a sectional view taken on line 6—6 of Figure 4.

Figure 7 is a sectional view taken on line 7—7 of Figure 6.

Figure 8 is a developed view showing the several positions of the actuating parts which effect the reciprocation of the work table as seen substantially from line 8—8 of Figure 1.

Figure 9 is a sectional view taken on line 9—9 of Figure 8.

Figure 10 is a sectional view taken on line 10—10 of Figure 8.

Figure 11 is a sectional view through the manual tool slide feeding means as seen from line 11—11 of Figure 1.

Figure 12 is a sectional view taken on line 12—12 of Figure 1.

Figure 13 is a sectional view as seen from line 13—13 of Figure 3.

Figure 14 is a sectional view taken on line 14—14 of Figure 3.

Figure 15 is a sectional view as seen from line 15—15 of Figure 1.

Figure 16 is a sectional view taken on line 16—16 of Figure 11.

Figure 17 is a sectional view taken on line 17—17 of Figure 3 showing certain details of the operating structure.

Figure 18 is a view taken on line 18—18 of Figure 1 showing the size control mechanism in

elevation in operative engagement with the work piece.

Figure 19 is a view similar to Figure 18 showing the size controlling mechanism in an inoperative position.

Figure 20 is a longitudinal sectional view through the size controlling mechanism illustrating the internal mechanism thereof.

Figure 21 is a diagrammatic view illustrating the hydraulic and electric circuits involved in the control of the several moveable parts of this invention.

Figure 22 is a fragmentary sectional view taken on line 22—22 of Figure 14.

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

In general the improved grinding machine of this invention is semi-automatic in performance and includes hydraulic and electric means for controlling the various movements of the machine. The machine includes the usual bed or support having mounted thereon a work supporting table reciprocable longitudinally of the length of the bed or support. Improved novel means for controlling and effecting the said reciprocation of the table are employed. In addition a tool slide operable transversely of the bed or support is controlled by improved novel electric and hydraulic means. The hydraulic and electric means for effecting the reciprocation of the table are interlocked with the movement of the tool slide toward and from the said table through an improved work piece size mechanism. The several movements of the table and tool slide are also under control of suitable handles or levers within convenient reach of the operator from his normal working position at the forward end of the machine. All of the foregoing mechanisms are clearly illustrated in the drawings and will be described in detail later.

Referring to the drawings and specifically to Figures 1, 2 and 3 there is disclosed a bed or support 25 having formed longitudinally thereof at its forward end ways 26 and 27 for guiding during its reciprocating movement a work supporting table 28. Adjustably carried by the table at opposite ends thereof is the headstock 29 and tailstock 30 from which centers 31 and 32 respectively project. The centers 31 and 32 support a work piece 33 between them. The headstock 29 has a motor or prime mover 34 connected through suitable transmission means enclosed within casing 35 with the spindle which carries the live center 31. To effect rotation of the work piece 33 from the spindle or center 31 a dog 36 is secured to the work piece and bridged over by driving pin 37 to the said spindle. The work piece 33 is removed from between the centers 31 and 32 by retracting the said center 32 through the medium or handle 38 carried by the tailstock 30.

The table 28 and work 33 are reciprocated longitudinally of the bed while effecting a stock removal from the surface of the work throughout its length by a suitable tool or grinding wheel 39 supported by the bed for this purpose. To effect the said movement of the table 28 use is made of an hydraulic motor 40 disclosed in Figures 8 and 9. The motor 40 is rotated by an hydraulic medium in an hydraulic circuit which will be explained in detail later. The said motor 40 comprises gears 41 and 42 secured respectively to back gear shaft 43 and stub shaft 44. The stub shaft 44 is formed on its inner end with an enlarged head 45 having clutch teeth 46 for engagement with similar clutch teeth 47 on driving gear 48. The driving gear 48 is keyed or splined to driving shaft 49 and the said gear is slidable relative to the said shaft 49 but rotatable therewith. The driving shaft 49 is journaled in anti-friction bearings mounted in the walls of gear box or bracket member 50 and has secured thereto or formed integral therewith intermediate to said anti-friction bearings a worm 51. The worm 51 meshes with and drives a worm wheel 52 keyed or otherwise secured to vertical pinion shaft 53. This shaft 53 is journaled in anti-friction bearings carried by the bracket or housing 50 and is connected by cap screws or the like 54 with a driving coupling 55. The driving coupling 55 is provided with a flange 56 through which the said cap screws 54 extend into a collar or flange 57 formed on the upper end of shaft 53 and the coupling 55 is splined to a pinion shaft 58 co-axial with the shaft 53. The pinion shaft 58 has integral therewith a pinion 59 having its teeth in mesh with the teeth of a rack 60 secured to the under surface of the table 28.

From the foregoing it will be noted that if gear 48 were shifted to engage its clutch teeth 47 with the clutch teeth 46 a direct driving connection between the hydraulic motor 40 and table 28 would be established to actuate the said table at its maximum rate. To effect the shifting of the gear 48 it is provided with a circumferential groove 61 receiving shifter pin 62 carried by one end of bell crank 63 pivoted at 64 to the bracket or housing 50. The other end of the bell crank 63 is bifurcated to provide arms 65 and 66 receiving therebetween a pin 67 extending from a link 68. The link 68 is pinned or otherwise secured to a shaft 69 journaled in a sleeve 70 carried by the bracket 50. Secured to the outer end of the shaft 69 exterior of the housing 50 and within convenient reach of an operator is a handle 71 whereby the shaft 69 may be rocked.

The handle 71 has four positions, the first of which is the shifting of the gear 48 to engage the clutch teeth 47 and 46 for effecting a rotation of pinion shaft 58 and pinion 59 and actuate the table at its maximum speed. The second position of the handle shifts the gear 48 to the position shown in Figure 8 at which time the clutch teeth 46 and 47 are out of engagement, and the gear 48 is in a neutral position to effect a complete stopping or non-movement of the said table 28. Continued movement of the handle 71 in a clockwise direction to its third position would mesh the teeth of the gear 48 with the teeth of a gear 72 pinned or otherwise secured to a shaft 73 journaled in anti-friction bearings carried by the walls of the bracket or housing 50. In this position the worm shaft 49 is rotated by manual means such as the hand wheel 74 mounted on the forward face of the bed or support 25. This rotation of the shaft 73 is effected through a pair of bevel gears 75 and 76, the former being keyed or otherwise secured on the shafts 73, while the latter is pinned to a stud 77 journaled in the walls of the bracket or housing 50. Similarly pinned to the outer end of the stud 77 is a pinion 78 in mesh with a gear 79 secured by cap screws or the like 80 to the hand wheel 74, the hand wheel 74 and gear 79 being mounted for rotation about a stud 81 carried by the bracket 50. The fourth or last position of the handle or lever 71 meshes the teeth of the gear 48 with a pinion 82 integral with or secured to the shaft 43 of motor gear 41 of hydraulic motor 40 to ef-

fect the rotation of worm shaft 49 at a slower rate from the said hydraulic motor 40.

From this it will be seen that the table 28 may be longitudinally actuated at differential speeds under power or the said table may be manually reciprocated.

As was noted above the motor 40 has the gears thereof rotated by an hydraulic medium under pressure. This hydraulic medium is normally contained within a tank 83 from which it is drawn through a conduit 84 by a pump 85 and discharged from the pump under pressure through a conduit 86. The medium then passes through a conduit 87 to starting and stopping valve 88 from which it passes through port 89 formed along the exterior valve sleeve 90 to a port 91 for direction to the interior of the sleeve 90 passing then through port 92 to conduit 93 for conveyance to the directional control or reverse valve 94 which directs the medium to one side or the other of hydraulic motor 40. As shown in Figure 21, the medium passes through the conduit 95 from the valve 94 to the lower side of motor 40. The spent medium discharged on the other side of the motor is directed through a conduit 96 back to the valve 94 for discharge through a conduit 97 to the sump or tank 83. The valve 88 in addition to being used as a starting and stopping valve controls the velocity or rate at which the table 28 is being reciprocated and is of a unique, novel construction. This valve comprises a pair of spools 88*a* and 88*b*, each having a bore therein in axial alignment to receive a spring 98 which tends to actuate the spools in opposite directions. The cannelure formed in spool 88*b* is utilized for connecting ports 91 and 92 formed in the sleeve 90 while the cannelure of spool 88*a* connects a pair of similar ports 99 and 100 formed in the said sleeve 90. The velocity or rate of movement of the table by the hydraulic motor is controlled more or less by closing off the port 99 by the shoulder 101 formed by the cannelure in valve spool 88*a*.

As was noted above, the spring 98 tends to actuate the spools 88*a* and 88*b* in opposite directions or away from one another and thereby holds the said spools in engagement with adjustable stops 102 and 103 respectively, carried by a pivotally mounted bell crank 104 and by an arm 105. The crank 104 is pivotally mounted at 106 to the bracket or housing 50 and has a second arm 107 extending therefrom. The arm 107 of bell crank 104 is provided with a nose 108 contacting at all times with cam face 109 formed on a flange of sleeve 110 journaled for rotation about a sleeve 111. Secured to the outer end of the sleeve 110 is a handle 112 having a spring pressed locking pawl cooperating with a serrated or toothed plate 113 secured to the cover of the bracket or housing 50 positioned on the forward face of the bed 25 within convenient reach of the operator. Adjustment of the handle 112 rotates the sleeve 110 for adjusting the position of cam 109 to thereby shift the spool 88*a* and vary the opening of port 100 to control the flow of the hydraulic medium therethrough. As shown in Figure 6, the port 100 is partly open to permit a normal shifting of the table so that the removal of stock from the work piece 33 takes place at the desired rate.

While the flow of the medium through the port 100 is restricted during actual operation of the machine, the flow from the port 89 formed longitudinally of the sleeve 90 is shut off by the spool valve 88*b* to stop the reciprocation of the table but an unrestricted flow is permitted during actual operation. As shown in Figure 6, ports 91 and 92 are connected permitting, as noted above, an unrestricted flow of the medium therethrough. This spool 88*b* is shifted by the arm 105 pivoted about pivot 114 carried by the rear wall of the bracket or housing 50. The upper end of arm 105 is pivotally connected to a longitudinally shiftable link 115 which has its opposite end pivotally connected to smaller crank arm 116 pivotally carried by pivot 106. The other arm 117 of bell crank 116 is provided with a cam follower 118 at all times held in engagement with the stepped cam 119 formed on a flange 120 carried by the sleeve 111. Pivotally secured to the outer end of the sleeve 111 is the main starting and stopping lever 121 which may be rocked in a clockwise direction to shift the valve spool 88*b* and open port 91 to permit the table 28 to be actuated at a normal work feeding rate.

From the foregoing it will be noted that handle 112 may be adjusted for positioning valve spool 88*a* to determine the rate of speed at which the work supporting table will be reciprocated. It will also be noted that with starting and stopping lever in its neutral or central position the flow of the hydraulic medium is restricted to stop the movement of the table while a shifting thereof to the right or in a clockwise direction will open port 91 and permit a flow of the medium therethrough determined by the setting of the valve spool 88*a*.

There are times when it is desirable to reciprocate the work table 28 at a high or rapid traverse rate, such as when grinding bearing portions at opposite ends of a shaft, for example, to thereby materially reduce the time involved in completing a given grinding operation. To this end the arm 107 of bell crank 104 is provided with a pin 122 in the path of movement of an abutment 123, shown in Figure 4 as an adjustable screw, carried by a projection on flange 120 of sleeve 111. Rotation of main starting and stopping lever 121 in a counter clockwise direction will cause the abutment 123 to engage the pin 122 and actuate the bell crank 104 about its pivot 106 to shift the valve spool 88*a* to the right as seen in Figure 6 thereby completely uncovering port 100 and permitting an unrestricted flow of the hydraulic medium therethrough. This unrestricted flow of the medium through port 100 effects a corresponding speeding up of rotation of the pump gears to correspondingly rapidly rotate the pinion shaft 58 and reciprocate the table at a rapid rate.

The longitudinally shiftable bar 115 has secured thereto a projection 124 abutting on opposite sides with adjacent ends of springs 125 and 126 through which depressible plungers 127 and 128 of stopping and starting switches 129 and 130 are actuated to stop and start the headstock rotating motor 34 with which the said switches are electrically connected. From this it will be noted that actuation of the lever 121 to effect reciprocation of the table 28 simultaneously effects the rotation of the motor 34 and work piece 33 rotated thereby.

The directional control or reversing valve 94 is shifted at each end of the stroke of the table 28 to thereby reverse the movement of the table. To this end the valve 94 is provided with a shifter rod 131 having a forked end and receiving between its arms a pivotally mounted lever 132. The lever 132 is pivoted to a projection 133 depending from a casing 134 carried by the housing or bracket 50. A pin 135 projects from the lever

132 into an elongated perforation 136 formed in the upper end of one arm of bell crank 137. This bell crank 137 is pivoted at 138 and has its other arm 139 pivoted at 140 with one end of a link 141. Carried by the bell crank 137 and projecting into the perforation 136 therein and from opposite sides thereof is a pair of set screws 142 and 143 adapted to engage with the pin 135 of lever 132. The upper end of the link 141 is pivotally connected to a crank arm 144 integral with a sleeve 145 journaled about a hollow shaft 146 supported by the bracket or housing 50. Keyed or otherwise secured to the outer end of sleeve 145 is a reversing lever 147 extending upwardly above the bed 25 and having a projection 148 extending therefrom toward the said bed 25. The table 28 has secured to its forward edge on opposite ends thereof dogs 149 and 150 adapted to engage the projection 148 for oscillating same about its axial center or hollow shaft 146.

At each end of the stroke of the table a slight pause is effected followed by a gradual increase in speed of movement of the table in the opposite direction. This pause is effected by an hydraulic tarry valve enclosed within the casing 134. Vertically shiftable through the casing 134 is a pair of spool valves 151 and 152 having co-axial bores therein for a spring 153. The spool valve 151 is enclosed within a sleeve 154 through which ports 155 and 156 are formed. A cannelure 157 formed in the spool valve 151 connects the ports 155 and 156. The spool valve 152 is likewise enclosed in a sleeve 158 having ports 159 and 160 connected together by the passage 161 formed on the spool 152. The hydraulic medium under pressure is conveyed to the casing 134 through a conduit 162 coupled into the casing containing the reversing valve 94 and is in direct communication with the main pressure line 87. The spool valve 152 is provided with a reduced portion 163 having formed at the end thereof a wedge shape head 164 having cam faces on opposite sides thereof. These cam faces cooperate with similar cam faces formed on the end of valve shifter lever 132. A pin 165 projects from the valve spool head 164 to which is attached one end of a spring 166 the other end of which spring is secured to a pin 167 projecting from the rear face of bell crank 137. Referring to Figure 7, it will be noted that port 155 of sleeve 154 is connected with port 160 of sleeve 158 by a longitudinal port 168. The chamber 169 formed between valve spools 151 and 152 and their containing sleeves 154 and 158 is drained through a port 170 formed in the valve casing 134.

Assuming the table to be traveling to the left as seen in Figure 1, the dog 150, upon engagement with the projection 148 would rotate lever 147 and sleeve 145 which through the crank 144 would depress link 141. This depression of link 141 actuates the bell crank 137 in a counter clockwise direction to take up the lost motion between the pin 135 and abutment set screw 142 and at the same time through the interengagement of the contacting cam faces on the upper end of the bell crank with the cam face on head 164 forces upwardly the said head 164 and spool valve 152 permitting the hydraulic medium flowing through the conduit 162 to fill the passage 161. By oscillating the bell crank 137 until the lost motion between the ends of set screws 142 and 143 is taken up the apex of the cam faces on the bell crank 137 is beyond the point of head 164. At this time the spring 166 which was tensioned by the raising of the head 164 tends to actuate the said head downwardly thereby bringing into engagement the opposite cam faces. This downward movement of the head and valve spool while freely moved upward is now restricted in its descent since it must force outwardly from the passage 161 the hydraulic medium therein. The medium is discharged through port 160 to port 168 to the upper port 155 in sleeve 154. The flow of the medium through the port 155 is restricted by the shoulder on the valve 151 so that the descent of the head 164 and valve spool 152 is restricted and the shifting of the valve 94 takes place only at the rate of movement of the head. This movement gradually uncovers the port through which the hydraulic medium is passing to the hydraulic motor thereby slowly picking up speed to correspondingly slowly accelerate the speed of movement of the table 28.

The adjustment of spool valve 151 is obtained through cam face 171 formed on flange 172 of a sleeve 173 mounted for rotary movement about the sleeve 145. A cam follower 174 projects from the spool valve 151 in engagement with the cam 171 being held in this engagement by the spring 153. The sleeve 173 is adjusted by a handle 175 keyed or otherwise secured thereto and locked in position by the interengagement of a spring pressed pawl 176 cooperating with a serrated or toothed plate 177. From this it will be seen that the amount of tarry and rate of acceleration of movement of the table 28 after reversal may be adjusted to any desired limit.

The bed 25 has secured thereto behind the table 28 a plate or support 180 having formed thereon ways 181 and 182 extending transversely of the bed for guiding a tool carriage 183 for movement toward and from the table 28 and work carried thereby. Journaled in the tool carriage 183 is a spindle 184 supporting for rotation therewith a grinding wheel 39. The grinding wheel is substantially enclosed with a guard or housing 186 carried by the carriage 183 and moveable therewith. Depending from the carriage 183 and secured thereto by cap screws or the like 187 is a bracket 188 for a cylinder 189. Within the cylinder for movement relative thereto is a piston 190 having extending from opposite sides thereof hollow piston rods 191 and 192. The outer end 193 of the piston rod 192 is provided with internal threads meshing with the threads of adjusting screw 194 journaled for rotative but not translative movement in the forward end 195 of intermediate plate or bracket 180. Keyed or otherwise secured to the screw 194 is a large gear 196 meshing with a pinion 274 keyed to rotate with a trigger or trip shaft 275 to be later described in detail. A relatively large gear 350 is keyed for rotation with the trigger or trip shaft 275 near its forward end and meshes with a pinion 197 pinned or otherwise secured to one end of pinion shaft 198. A second pinion 199 is keyed to the shaft 198 near its other end and meshes with a similar pinion 200 on the end of shaft 201 rotatable through handle 202 carried by crank 203. A hand wheel 204 is journaled within a central boss of the crank 203 and keyed to the shaft 201 for movement therewith and has a driving connection with and relative to the crank 203 through a pinion 205 carried by the said crank 203. The teeth of the pinion 205 mesh with similar internal teeth 206 of an internal gear carried by the hand wheel 204. The pinion 205 has integral therewith a stud 207 journaled in a relatively small plate 208 pinned or otherwise secured in the crank 203 for movement therewith. To the outer end of the stud 207 is a spring pressed locking pin 209 engage-

able in a plurality of holes formed around the plate 208.

From the foregoing it will be noted that by grasping handle 202 and rotating the crank 203 movement will be imparted to the hand wheel 204 which in turn rotates the pinion shaft 201 and through the transmission gearing, above noted, rotation is imparted to the screw 194 for adjusting the tool carriage 183, cylinder 189, piston 190 and parts associated therewith relative to the intermediate plate or support and relative to the adjusting screw 194. It will also be noted that by withdrawing the plunger 209 from the particular locking bore then engaged and advancing same to a different locking bore the stud 207 and pinion 205 will be rotated. The rotation of the pinion 205 will through the interengagement of its teeth with teeth of internal gear 206 additionally rotate the hand wheel 204 and pinion shaft 201 to further adjust the parts as above noted. The foregoing description deals with the manual means for initially setting up the machine for operation on a plurality of similar work pieces and for further adjusting the machine to take up for wheel wear to insure successive work pieces being reduced to the same size.

In the normal operation of the machine the tool carriage 183 is advanced toward and retracted from the work piece by an hydraulic medium under pressure. Means are provided for varying the rate of movement of the carriage at a fast or rapid rate in both directions and additionally at a slow rate in one direction. This slow movement of the carriage in the one direction may be either continuous as when performing a grinding operation by the plunge method or the said slow movement of the carriage may occur intermittently as at the opposite ends of movement of the work table 28. Means are also provided for determining whether the carriage will be actuated for plunge cut grinding or for intermittent feeding movement when operating on a cylindrical bar or shaft, for example.

In utilizing the power or hydraulic means for actuating the slide the hydraulic medium passes through a conduit 210 from the main pressure conduit 86 to a slide valve 211 from which it is directed to one side or the other of piston 190. As shown in Figure 21, the medium passes from the valve sleeve 212 through a conduit 213 to the left hand side of the piston 190 for actuating the carriage 183 toward the work supporting table. The valve 211 is initially shifted through its sleeve to initiate a movement of the grinding wheel carriage by a manually shiftable lever 214 pinned or otherwise secured on the end of the shaft 215. The shaft 215 is journaled in the wall of a projection 216 of bracket or housing member 217. On the inner end of the shaft 215 interiorly of the projection 216 is a link 218 pivotally connected to a second link 219 having its other end pivotally connected to lever 220. The lever 220 is keyed to a hollow shaft 255 having an operable connection through a pin 253 projecting from a flange 254 on the hollow shaft 255 and an oscillatable plate 250 with a solid shaft 251 journaled for rotation within the said hollow shaft whereby said solid shaft is actuated. Depending from the solid shaft 251 is a short lever 222 having a forked end 223 received between adjustable abutments 224 fixed on the end of valve shifter rod 225.

By actuating the lever 214 in a counter clockwise direction or toward the operator the valve 211 is shifted to the position shown in Figure 21, to permit the hydraulic medium to pass through conduit 213 and actuate the grinding wheel carriage toward the work supporting table. This movement is at a rapid rate and the medium in the cylinder on the right hand side of piston 190 is being discharged through an unrestricted conduit 226 to the valve sleeve 212 at which point the medium flows through a conduit 227 to the tank or sump 83. The movement of the carriage continues until the flow of the medium is interrupted either by being completely cut off or by being forced to pass through a restricted orifice. As was noted above, the movement of the carriage either continues in a direct line into the work at a relatively slow rate or it is fed toward the work at the completion of each longitudinal stroke of the work carrier. Considering first the continuous movement of the carriage in a straight line, as when performing a plunge cut grinding operation, the following mechanism is employed.

Mounted on the forward face of the bed 25 in the housing 217 are various valves and control members each having a knob or control element positioned on the outside face of the box or bracket 217. Referring now to Figure 1, the knob or control element in the upper left hand corner indicated by the numeral 228 determines whether the carriage will be actuated toward the work piece at a continuous rate or intermittently at the end of each movement of the table. The knob or control element 229 directly beneath the knob 228 is for determining the point at which the rapid movement of the carriage is changed to a slow feeding movement. The knob or control element 230 in the upper right hand corner of the box or housing 217 controls the rate at which the the grinding wheel and carriage will be fed toward the work supporting table after its speed has been changed from a rapid movement to a slow feeding movement, and the knob 231 directly beneath the knob 230 adjusts the amount of feed of the wheel toward the table at the completion of each stroke of the reciprocating work table 28.

The knob 229 is pinned to a shaft 232 which shaft is in turn pinned at 233 to a sleeve 234. The sleeve 234 has a sliding keyed connection as at 235 with a stud 236 of a worm screw 237. The stud 236 is adapted to be slidably actuated through the interior of the sleeve 234 without breaking the driving connection therebetween. A spring 238 is interposed between the face of the sleeve 234 and the end of the stud 236 tending to actuate the stud toward the right, as seen in Figure 3. This movement of the stud is restricted however, by a worm nut 239 threaded on the worm screw 237 having shoulders 240 formed at its opposite ends receiving therebetween the forked end 241 of lever 242. The lever is pivotally mounted on a shaft 243 and restrained against movement by a spring 244 having one end connected to the lower end of the lever 242 and its other end secured to a lug 245 formed on the inner face of the bracket or housing 217. A latch 246, see Figures 11 and 17, is secured to the shaft 243 having a ledge or step 247 thereon for a trigger 248. By actuating the knob or control member 229 in the proper direction the worm nut 239 may be actuated toward the front of the machine to thereby rotate the shaft 243 and actuate the trigger 248, as seen in Figure 11, in a counter clockwise direction thereby shifting the ledge or seat 247 of the latch 246 relative to the end of trigger 248 so that the said trigger and latch overlap one another a predetermined amount,

the function of which will be explained in detail later.

The latch 246 is pivotally mounted between the forked end 249 of the oscillatable plate 250 pinned or otherwise secured to the end of the shaft 251. A spring pressed plunger 252 is carried by the plate 250 and bears against the latch 246 tending to rotate same in a counter clockwise direction about its pivot, as seen in Figure 11, for holding the rear edge of the said latch against the seat formed by the forked end 249 of the plate 250. The plate 250 is further formed with a notch 252*a* receiving the pin 253 projecting from the flange 254 of the hollow shaft 255 in which the shaft 251 is rotatably journaled as above mentioned. Shiftable through the plate 250 adjacent the upper end thereof is a pin 256 abutting on one end the trigger 248 at a point on the other side of the pivot from the abutment of the plunger 252. The pin 252 on its other end engages the driving pin 253. The other end of the hollow shaft 255 has secured to it the arm 220 while the same end of the shaft 251 carries the arm 222 connected with the valve stem 225 for actuating the valve 211. A spring 257 is secured to the arm 220 and to a lug 258 extending inwardly from the front wall of bracket or housing 217.

From the foregoing it will be noted that a push on the end of the worm screw 237 will cause stud 236 to be telescoped within the sleeve 234 carrying with it the worm nut 239 and through the shoulders or abutments 240 thereon a movement of lever 242 and shaft 243 in a counter clockwise direction. This rotation of shaft 243 moves the latch 246 away from the trigger 248 whereupon spring 257 will rock the arm 220 together with hollow shaft 255. Movement of the hollow shaft 255 carries with it the flange 254, and through the pin 253 shifts the pin 256 to actuate plate 250 causing the trigger 248 to rest on the ledge or step 259 of plate 260 secured to the bracket 217. At the same time the movement of the plate 250 rocks the shaft 251 and valve shifter arm 222 connected thereto for shifting the valve 211 to the left, as seen in Figure 21, connecting the discharge port 262 in sleeve 212 through the cannelure 263 of valve 211 with the port 264 of a conduit 265. The conduit 265 extends to a valve chamber 266 controlled by the knob 228.

As was noted above the knob or control member 228 is adapted to be adjusted or set to effect a continuous movement of the tool carriage 183 toward the work supporting table 28 or it may be set to permit an intermittent movement of the tool carriage toward the table, namely, at each end of the stroke of the table. As shown diagrammatically in Figure 21, the knob 228 is connected to a valve adjustable within the valve casing 266 to direct the flow of the medium through either of two ports 267 or 268 formed therein. The setting of the valve here shown directs the flow of the medium through a conduit 269 to a needle valve casing 270. This casing contains an adjustable needle valve 271 under the control of the knob or control member 230. The needle valve will regulate the rate of flow of the medium into and through the casing 270 to conduit 272 for returning the medium to the tank or sump 83.

From the foregoing description it will be noted that with the valve 211 adjusted to the position shown in Figure 21, the tool slide 183 will be actuated at a high or rapid rate of speed toward the work supporting table 28 until the grinding wheel 39 is positioned a predetermined amount from the work piece, which is controlled by the setting of the trigger 248 relative to the ledge or seat 247 on latch 246, at which time the rate of movement of the grinding wheel into the work will be materially reduced. This changing of the rate of movement of the wheel is automatically effected by shifting the trigger from beneath the latch to permit a shifting of the valve 211 to the left to connect the discharge conduit 226 from the cylinder 189 with the conduit 265 through which the medium is controlled on its way to the tank or sump 83.

The mechanism for automatically shifting the valve 211 comprises a bracket 273 in which is rotatably mounted the gear 274 slidably splined for rotative movement therewith but for axial movement relative to the shaft 275, which, for convenience has been termed a trigger or trip shaft. The outer end of the trip shaft 275 has an abutment 276 seated against the end of worm screw 237 having a splined portion 277 adjacent thereto receiving the driven gear of the hand adjustment transmission above indicated. Projecting from the other end of trip or trigger shaft 275 is a screw 278 threaded into a nut 279 fixed in a bracket 280 carried by the intermediate plate 180. One end of the nut 279 is counter bored and provided with internal threads receiving the external threads of a sleeve nut 281. The nut 281 has a flange 282 formed on its outer end adapted to abut a shifter fork 283 depending from the cylinder bracket 188. A lock nut 284 is threadedly carried by the sleeve nut 281 to lock the nut 279 and sleeve 281 in position relative one to the other so that the abutment flange 282 is fixed relative to the screw portion 278.

From this it will be seen that as the tool carriage 183 is actuated toward the work table and work the shifter fork 283 carried thereby will engage with abutment flange 282 and shift the trip or trigger shaft 275 forwardly to actuate the worm screw 237 and stud 236 as above described, thereby shifting valve 211 to the position to have the discharge from the opposite end of the cylinder 189 controlled. The movement of the wheel into the work to reduce the size thereof continues until the desired size is reached whereupon electromagnetic means are energized for shifting the valve to a neutral position and stopping further movement of the wheel, this electromagnetic means and electrical interlock will be described in detail later.

The grinding wheel and carriage are now held stationary as far as any movement of them relative to the bed is concerned to permit a sparking out of the wheel and work and to permit the desired finish to be had on the work. The handle 214 is then manually actuated in a clockwise direction or toward the table 28 for shifting the valve 211 to connect the pressure line 210 through the valve 211 with the conduit 285 for directing the hydraulic medium under pressure into the conduit 226 to the right hand side of the piston 190 to retract the grinding wheel and carriage from the work and table. At this time the port 264 of conduit 265 is closed off to prevent any flow of the medium therethrough. The movement of the carriage and wheel toward the rear of the bed or away from the work and table continues until the other side 286 of the shifter fork 283 carried by the cylinder bracket 188 engages with lock nuts 287 carried by sleeve nut 288 for shifting same. This sleeve nut 288 is threadedly carried by threaded portion 289 of a stop shaft 290 which moves with the nut 288. The shaft 290 is pro-

vided adjacent the threads 289 with a splined portion 291 for rotating therewith a gear 292. The gear 292 has a hub 293 forming the bearing for rotation thereof which is journaled in the bracket 273, similarly to the mounting of the trigger or trip shaft 275 and its gear 274. On the other side of the bracket 273 the shaft 290 has secured thereto for movement therewith a fork 294 yieldably mounted on the shaft by a spring 295 so that the fork may give in the event of an obstruction or undue pressure being applied thereto. The lower end of the fork 294 is connected with a valve rod 297 extending from the rear of valve 211 for shifting the valve to a neutral position and stopping the rearward movement of the carriage 183.

From this it will be understood that actuation of the handle 214 will initiate a movement of the grinding wheel carriage toward the rear and through the interengagement of a shifter fork depending from the carriage with the stop shaft the said stop shaft will be shifted for correspondingly actuating the reverse valve and stopping the carriage.

As was noted above the foregoing description deals with the shifting of the grinding wheel and carriage continuously toward the work supporting table and work at first at a rapid speed which is automatically reduced to a slow or feeding rate to feed the wheel into the work supported by the table. To actuate the grinding wheel toward the table to feed same into the work piece at each end of the stroke of the reciprocable table the knob 228 is adjusted to open the port 268 and close the port 267 of the valve casing 266. The grinding wheel and carriage are then actuated toward the table at a rapid rate in the same manner as described above by manually shifting the handle or lever 214 about its pivot toward the operator to shift the valve 211 to the position shown in Figure 21. This movement continues until, as above noted, the trigger shaft engages the worm screw to dislodge the latch from beneath the trigger when spring 257 will shift the valve 211 to connect conduit 226 and port 262 with port 264 conduit 265 thereby directing the hydraulic medium discharged from the cylinder on the other side of the piston 190 into and through the conduit 265. At this time however, the hydraulic medium passes through valve casing 266 through port 268 to and through conduit 298 to a valve casing 299. The valve casing 299 encloses a shiftable valve 300 having cannelures 301 and 302. As shown in Figure 21, the hydraulic medium passes from the conduit 298 through port 303 into the sleeve 299 which port 303 is connected by cannelure 302 with a port 304 from which conduit 305 extends. This conduit 305 terminates at one end of shuttle valve casing 306 which encloses a shuttle valve 307. The casing 306 on the other side of valve 307 communicates through port 308 with a conduit 309 terminating at its other end with port 310 in valve casing 299. This port 310 is connected through the cannelure 301 with a port 311 from which a conduit 312 extends for conveying the hydraulic medium back to the tank or sump 83. The grinding wheel carriage and grinding wheel are fed into the work an amount equal to the displacement of the hydraulic medium between the end of the valve 307 and the end of the casing 306. This distance is adjusted through the knob or control element 231. In other words, the amount or volume of hydraulic medium displaced from the casing 306 by the valve 307 removes that amount of medium from the right hand side of piston 190 and permits the wheel to be fed into the work a distance corresponding to the said volume of oil displaced.

To reverse the valve 300 and consequently change the direction of flow of the medium through casing 299 and effect a shifting of the shuttle valve 307, the said valve 300 is coupled in with the hydraulic motor 40 so that upon each reversal of rotation of the motor 40 the valve 300 is reversely shifted through its casing. To this end a conduit 313 connects the right hand side of the casing 299 with the lower side of the motor 40, as seen in Figure 21, while a similar conduit 314 connects the opposite or left hand side of the casing 299 with the upper side 40 of the motor. Assuming now that if the pressure has been flowing from the directional control or reverse valve 94 through the conduit 95 to actuate the motor 40 and a reversal of the valve takes place thereby introducing the medium under pressure through conduit 96 to the upper side of the motor the medium will at the same time flow through the conduit 314 to the left hand side of the valve 300 and shift same to the right thereby connecting port 310 with 303 through the cannelure 301 and connecting port 304 with port 315 through the cannelure 302. At this time the hydraulic medium being discharged through conduit 298 will pass through the ports 303 and 310 through to conduit 309 and port 308 to the left hand side of shuttle valve 307 to shift same to the right thereby discharging the medium ahead of the valve out through the conduit 305, ports 304 and 315 through conduit 316 to discharge conduit 312 and at the same time permitting an infeed movement of the grinding wheel carriage 183 and grinding wheel 39. Again this intermittent feeding of the grinding wheel into the work will continue to take place at each end of the reciprocable stroke of the table until the work has been reduced to the desired size at which time the electromagnetic means come into play for again shifting the valve 211 to the neutral position and stopping further movement of the wheel and carriage relative to the bed.

Associated with the tarry valve 134 and supported by the head 164 of spool valve 152 is a switch arm 317 for closing a switch 318 normally held open during the longitudinal movement of the table but closed when the said table is stopped. From this it will be seen that each time the table stops at the end of its reciprocable movement before a reversal thereof is initiated the switch 318 is closed. This switch is wired in series with a switch that controls the sizing of the work and which will now be described.

Mounted on the angularly extending guide ways 319 of the table is a base plate 320 secured thereto by any desirable means, such as a clamp 321. The plate 320 has projecting upwardly therefrom a lug 322 through which an adjusting screw 323 extends. The threaded portion 324 of the screw is received in an internally threaded bore formed in pivot slide block 325. The slide block 325 has extending therefrom an ear 326 through which a pivot 327 extends for pivotally securing a casing or housing 328 thereto. Slidable through a bore 329 formed in the housing 328 is a rack bar 330 being yieldably urged in one direction by a spring 331 abutting it on one end. The other end of the spring 331 engages an adjustable abutment 332 for providing the proper tension on the spring 331. Meshing with the rack teeth of the bar 330 are the teeth of a gear 333 rotatable with

a shaft 334 journaled in the side walls of the casing 328. A pinion 335 also meshes with the gear 333 and is secured to a shaft 336 likewise journaled in the sides of the housing or casing 328 but extending beyond one side thereof. A finger or sizing arm 337 is secured to the said shaft 336 on its protruding end and has a contact point 338 riding on the surface of the work piece 33.

Referring to Figure 20, the spring 331 tends to actuate the rack bar 330 toward the left thereby tending to rotate the gear 333 in a counter clockwise direction and through this gear to rotate the pinion 335, shaft 336 and gauging finger 337 in a clockwise direction. This holds the contact point 338 of the finger in engagement with the surface of the work piece which prevents further rotation of the parts just described and holds the spring 331 under tension. As the surface of the work piece is reduced the arm 337 gradually completes its revolution until the work piece has been reduced to the desired size at which time the point 338 of the arm 337 is clear of the surface and the spring expands to actuate the rack bar the limit of its movement.

At this time the contact point 339 carried by an upstanding lug 340 on the bar 330 engages the fixed contact 341 carried by the housing 328 to complete an electrical circuit. This switch is wired in series with the switch 318 so that if the switch 318 is closed at the time of completion of the work piece to size an electrical circuit is complete for energizing a solenoid 342 mounted, see Figure 15, on the bracket 217 and connected with the upper end of arm 220 for shifting the valve 211 to a neutral position and stopping further in-feed movement of the grinding wheel and its supporting carriage.

After the work piece has been reduced to size and it is desired to replace the work piece on the table 28 the sizing device housing or casing 328 is actuated through the medium of handle 342*a* in a counter clockwise direction about its pivot 327 to the position shown in Figure 19. This movement of the housing 328 about the pivot 327 causes a pin 343 extending upwardly from the pivot 327 to engage a laterally extending lug 344 on the rack bar 330 to retract the said rack bar and rotate the size arm 337 to the downward position shown in Figure 19. As soon as the work piece has been positioned the housing 328 is returned to the position shown in Figures 18 and 20 bringing the contact point of the arm 337 again into engagement with the surface of the grinding wheel.

As was noted above, the switch 318 is closed whenever the work supporting table 28 is held in a stationary position or any movement thereof is interrupted so that the said switch is closed during the performance of a plunge cut grinding operation since the reciprocating table is locked against movement at this time and the switch is likewise closed at the time the reciprocating movement of the table is interrupted at each end of its stroke. Therefore, as soon as the work piece has been reduced to size during the performance of a plunge cut grinding operation the in-feed movement of the grinding wheel carriage and grinding wheel is immediately stopped. During the performance of a cylindrical grinding operation utilizing the reciprocation of the work supporting table the switch 318 is normally open being only closed at the ends of the movement of the table. Now, should the work piece be reduced to size after the reversal of the table the switch 318 would be open while the switch within the casing 328 would be closed and remain closed so that upon reaching the end of the stroke of the table in the other direction the closing of the switch 318 would then complete the electrical circuit and actuate the solenoid 342 to stop the in-feed movement of the carriage and wheel.

In the operation of the machine various sizes of work pieces are adapted to be ground necessitating the adjustment of the grinding wheel and its carriage relative to the bed. This adjustment, as noted above, is obtained through the cross feed hand wheel 203 for actuating the cross feed screw 194. At the same time it is necessary that the trigger shaft 275 and stop shaft 290 be adjusted as a unit with the adjustment of the said grinding wheel and carriage so that the trip mechanism will function at the desired point to change the rapid movement of the said carriage to the desired slow feeding movement. This is accomplished through the gears 274 and 292 which mesh with the gear 196 on the screw 194 for simultaneously adjusting the nuts 279 and 288 relative to the screw portions 278 and 289 respectively on the trigger and stop shafts. From this it will be seen that the zone of movement of the grinding wheel carriage under the influence of the hydraulic medium may be changed without disturbing the particular setting of the trip mechanism.

What is claimed is:

1. In a grinding machine the combination of a bed, a work supporting table carried thereby and translatable longitudinally thereof, a grinding wheel carriage carried by the bed and movable transversely thereof toward and from the work supporting table, hydraulic means for effecting the movement of the carriage including a reciprocating motor, an hydraulic medium for actuating the motor, means controlling the flow of the medium to actuate the carriage at a rapid rate, means controlling the flow of the medium for actuating the carriage at a slow rate, means operable by the position of the carriage for automatically operatively connecting one of the above mentioned means with the medium to automatically change the rate of movement of the carriage, and additional means independent of the position of the carriage for automatically shifting the valve to connect the medium with the other rate control means for automatically changing the rate of movement of the carriage.

2. In a grinding machine the combination of a bed, a grinding wheel carriage carried thereby and movable transversely thereof at a fast and a slow rate, an hydraulic reciprocating motor for effecting said movements, an hydraulic medium for actuating the motor, a valve controlling the flow of the medium, manual means for initiating a movement of the carriage in reverse directions, automatic means for shifting the valve to change the rate of movement of the carriage from fast to slow in one direction, automatic means for shifting the valve to a neutral position to stop the movement of the carriage in the said one direction, and automatic means for shifting the valve to a neutral position to stop the movement of the carriage in the reverse direction.

3. In a grinding machine the combination of a bed, a work supporting table carried thereby and translatable longitudinally thereof, a grinding wheel carriage supported by the bed and movable transversely thereof toward and from the table, a grinding wheel supported by the carriage for effecting a stock removal from the work piece

supported by the table, hydraulic means for effecting the said movement of the carriage including an hydraulic medium under pressure, a conduit for the medium, a valve in the conduit controlling the flow of the medium and having a neutral position to stop the said flow and an operative position to permit the said flow, manual means for shifting the valve to its operative position, electromagnetic means for shifting the valve to its neutral position, and means carried by the table controlling the size of the work piece and electrically connected with the electromagnetic means for shifting the valve to the neutral position when the work piece has been reduced to the desired size.

4. In a grinding machine the combination of a bed, a work supporting table carried thereby and translatable longitudinally thereof, a grinding wheel carriage supported by the bed and movable transversely thereof toward and from the table, a grinding wheel carried by the carriage for effecting a stock removal from the work piece supported by the table, an hydraulic reciprocating motor for effecting the said movement of the grinding wheel carriage, an hydraulic medium for actuating the motor, a valve controlling the flow of the medium having a neutral position for stopping the said flow of the medium, an operative position to permit an unrestricted flow of the medium to actuate the carriage at a rapid rate and an intermediate position for actuating the carriage at a slow feeding rate, manual means for shifting the valve to its operative position, restrained yieldable means released by movement of the carriage for shifting the valve to its intermediate position, and electro-magnetic means controlling the size of the work piece and operable to shift the valve to its neutral position upon reducing the work piece to its desired size.

5. In a grinding machine the combination of a bed, a work supporting table carried thereby and translatable longitudinally thereof, a grinding wheel carriage supported by the bed and movable transversely thereof toward and from the work supporting table, a grinding wheel supported by the carriage for effecting a stock removal from the work piece supported by the table, hydraulic means for effecting the movement of the grinding wheel carriage comprising a cylinder carried by and movable with the carriage, a fixed piston within the cylinder, an hydraulic medium for actuating the cylinder relative to the piston, a valve controlling the flow of the medium having a neutral position for stopping the flow of the medium, an open position permitting an unrestricted flow of the medium and a movement of the carriage at a rapid rate, an intermediate position for restraining the flow of the medium and a movement of the carriage at a slow work feeding rate and a reverse position permitting an unrestricted flow of the medium and a rapid retraction of the carriage, and means automatically shiftable for adjusting the valve to its various positions including a pivotally mounted trigger having an operative connection with the valve, yielding means for actuating the trigger about its pivot, a latch controlling the movement of the trigger, and a trigger shaft slidably carried by the bed adapted to be actuated by the carriage for disengaging the trigger and latch permitting a shifting of the valve from an open position to its intermediate position under the influence of the yielding means.

6. In a grinding machine the combination of a bed, a work supporting table carried thereby and translatable longitudinally thereof, a grinding wheel carriage supported by the bed and movable transversely thereof toward and from the work supporting table, a grinding wheel supported by the carriage for effecting a stock removal from the work piece supported by the table, hydraulic means for effecting the movement of the grinding wheel carriage comprising a cylinder carried by and movable with the carriage, a fixed piston within the cylinder, an hydraulic medium for actuating the cylinder relative to the piston, a valve controlling the flow of the medium having a neutral position for stopping the flow of the medium, an open position permitting an unrestricted flow of the medium and a movement of the carriage at a rapid rate, an intermediate position for restraining the flow of the medium and a movement of the carriage at a slow work feeding rate and a reverse position permitting an unrestricted flow of the medium and a rapid retraction of the carriage, means automatically shiftable for adjusting the valve to its various positions including a pivotally mounted trigger having an operative connection with the valve, yielding means for actuating the trigger about its pivot, a latch controlling the movement of the trigger, a trigger shaft slidably carried by the bed adapted to be actuated by the carriage for disengaging the trigger and latch permitting a shifting of the valve from an open position to its intermediate position under the influence of the yielding means, and a stop shaft slidably carried by the bed operatively connected with the valve and adapted to be slidably actuated by the carriage during its reversing movement for shifting the valve from a reverse position to its neutral position to stop the reverse movement of the carriage.

7. In a grinding machine the combination of a bed, a work supporting table carried thereby and translatable longitudinally thereof, a tool supporting carriage carried by the bed movable transversely thereof toward and from the work supporting table, hydraulic means for effecting the movement of said tool carriage including an hydraulic medium, a conduit for the medium, a valve in the conduit having a neutral position, an open position, an intermediate position and a reversing position, mechanical means operable by the carriage for shifting the valve from an open position to an intermediate position for changing the rate of movement of the tool carriage from a rapid rate to a slow one, electromagnetic means for shifting the valve to a neutral position when the work piece on the work supporting table has been reduced to the desired size, and mechanical means operable by the carriage for shifting the valve from a reverse position to a neutral one for stopping the reverse movement of the carriage.

8. In a grinding machine the combination of a bed, a work supporting table carried thereby and translatable longitudinally thereof, a tool supporting carriage carried by the bed movable transversely thereof toward and from the work supporting table, hydraulic means for effecting the movement of said tool carriage including an hydraulic medium, a conduit for the medium, a valve in the conduit having a neutral position, an open position, an intermediate position and a reversing position, mechanical means operable by the carriage for shifting the valve from an open position to an intermediate position for changing the rate of movement of the tool carriage from a rapid rate to a slow one, electromagnetic means

for shifting the valve to a neutral position when the work piece on the work supporting table has been reduced to the desired size, mechanical means operable by the carriage for shifting the valve from a reverse position to a neutral one for stopping the reverse movement of the carriage, and means for varying the point at which the rapid movement of the carriage is changed to a slow movement thereof.

9. In a grinding machine the combination of a bed, a work supporting table carried thereby and translatable longitudinally thereof, means for automatically reversing the translatory movement of the table, means for effecting a slight tarry of the table at each reversal thereof, a tool carriage carried by the bed and movable transversely thereof toward and from the table to effect a stock removal from the work piece supported by the table, means for feeding the tool into the work piece at each reversal of the table, an electric switch associated with the tarry means and adapted to be closed at each reversal of the table, a sizing device controlling the size of the work piece supported by the table, an electric switch associated with the sizing device and adapted to be closed when the work piece has been reduced to the desired size, said switch being wired in series with the switch associated with the tarry means, and means in series with the electrical switches for stopping further feed of the tool carriage toward the work when the said switches are both closed.

10. In a grinding machine the combination of a bed, a translatable work supporting table carried thereby and movable longitudinally thereof, a rotating tool carriage carried by the bed and movable transversely thereof toward the work supporting table to feed the tool carried thereby into the work, means for actuating the said tool carriage including an hydraulic medium and a valve controlling the medium, electromagnetic means for actuating the valve to check the flow of the medium and stop further movement of the tool carriage, a housing carried by the work supporting table, a work piece size controlling mechanism carried by the housing including a rotatable shaft, yielding means tending to rotate the shaft, a feeler arm on the shaft having a contact point in engagement with the surface of the work piece, the said contact between the arm and the work piece restraining the yielding means from rotating the shaft until the work piece has been reduced to the desired size, and means closable by the yielding means when the work piece has been reduced to the desired size for completing an electrical circuit and energizing the electromagnetic means for actuating the valve to its stop position.

11. In a grinding machine the combination of a bed, a translatable work supporting table carried thereby and movable longitudinally thereof, a rotating tool carriage carried by the bed and movable transversely thereof toward the work supporting table to feed the tool carried thereby into the work, means for actuating the said tool carriage including an hydraulic medium and a valve controlling the medium, electromagnetic means for actuating the valve to check the flow of the medium and stop further movement of the tool carriage, a housing carried by the work supporting table, a work piece size controlling mechanism carried by the housing including a rotatable shaft, yielding means tending to rotate the shaft, a feeler arm on the shaft having a contact point in engagement with the surface of the work piece, the said contact between the arm and the work piece restraining the yielding means from rotating the shaft until the work piece has been reduced to the desired size, means closable by the yielding means when the work piece has been reduced to the desired size for completing an electrical circuit and energizing the electromagnetic means for actuating the valve to its stop position, and means pivotally securing the housing to the work supporting table whereby actuation of the housing about the pivotal mounting will position the feeler arm for proper engagement with a new work piece.

12. In a grinding machine of the class described the combination with a bed, of a grinding wheel slide mounted thereon and movable transversely thereof, a work supporting table on the bed movable relative thereto, means for effecting the movement of said slide and table, means for reversing the movement of the table, means for determining the final size of the work being operated upon, and an interlock between the table reversing means and the size indicating means for stopping further movement of the grinding wheel carriage when the work is reduced to the desired size.

13. In a grinding machine of the class described the combination with a bed, of a grinding wheel slide mounted thereon and movable transversely thereof, a work supporting table on the bed movable relative thereto, means for effecting the movement of said slide and table, means for reversing the movement of the table, means for determining the final size of the work being operated upon, and an interlock between the table reversing means and the size indicating means for stopping further movement of the grinding wheel carriage when the work is reduced to the desired size, said means comprising an electrical control mechanism including a pair of switches one associated with the table reversing means and the other with the work sizing means.

14. In a grinding machine of the class described the combination with a bed, of a work supporting table mounted thereon for traversing movement relative thereto, a grinding wheel carriage mounted on the bed for movement toward the work supporting table to effect a stock removal from the work piece thereon, hydraulic means for effecting the movement of said table and grinding wheel carriage, each including a valve, means for shifting the table valve to reverse positions for effecting reverse translations of the table, means for shifting the carriage valve to a neutral position for stopping the said carriage, means operable by the table for effecting the movement of the table valve, a sizing device operable when the work reaches final size, and interlock means associated with the sizing device and table valve actuating means to energize the carriage valve shifting means and thereby shift said valve to its neutral position and stop further movement of the carriage.

15. In a grinding machine of the class described the combination with a bed, of a work supporting table mounted thereon for traversing movement relative thereto, a grinding wheel carriage mounted on the bed for movement toward the work supporting table to effect a stock removal from the work piece thereon, hydraulic means for effecting the movement of said table and grinding wheel carriage, each including a valve, means for shifting the table valve to reverse posi-

tions for effecting reverse translations of the table, means for shifting the carriage valve to a neutral position for stopping the said carriage, means operable by the table for effecting the movement of the table valve, a sizing device operable when the work reaches final size, and interlock means associated with the sizing device and table valve actuating means to energize the carriage valve shifting means and thereby shift said valve to its neutral position and stop further movement of the carriage, said means comprising a pair of switches operable when the said table valve is shifted after the sizing device has operated.

16. In a grinding machine of the class described the combination of a bed, a slide mounted thereon for movement relative thereto at fast and slow rates in a given direction, hydraulic means for effecting the movement of the slide including a valve for controlling the speed thereof, a trip member carried by and movable with the slide, latch means in the path of movement of the trip member for holding the valve in one position, additional yielding means for shifting the valve to a second position upon release thereof by the trip mechanism, and electro-magnetic means for further shifting the valve and stopping the movement of the slide in the said one direction and initiating a retracting movement thereof.

17. In a grinding machine of the class described the combination of a bed, a slide mounted thereon for movement relative thereto at fast and slow rates in a given direction, hydraulic means for effecting the movement of the slide including a valve for controlling the speed thereof, a trip member carried by and movable with the slide, latch means in the path of movement of the trip member for holding the valve in one position, additional yielding means for shifting the valve to a second position upon release thereof by the trip mechanism, electro-magnetic means for further shifting the valve and stopping the movement of the slide in the said one direction and initiating a retracting movement thereof, and means for stopping the retracting movement of the said slide.

18. In a grinding machine of the class described the combination of a bed, a grinding wheel carriage movable thereon at rapid and feeding rates through a given zone, hydraulic means including a valve for effecting the movement of the carriage, latch means for holding the valve in one position to effect the rapid movement of the carriage, yielding means for shifting the valve to a second position upon release of the latch means to effect the movement of the slide at a slow rate, trip means carried by the slide for releasing the latch, means for varying the effectiveness of the latch means and thereby varying the point at which the change from rapid to slow takes place, stop means for limiting the reverse movement of the carriage, means for changing the zone through which the movement of the slide takes place without changing the point in said zone at which the change in movement occurs, said means comprising a trip shaft and a stop shaft, means for adjusting the position of the slide as respects the bed, and a coupling between said slide adjusting means and the trip and stop shafts for simultaneously positioning them with respect to the slide as the slide is positioned with respect to the bed.

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