May 15, 1945. J. DECKER ET AL 2,376,236

GRINDING MACHINE

Filed Dec. 19, 1942 6 Sheets-Sheet 1

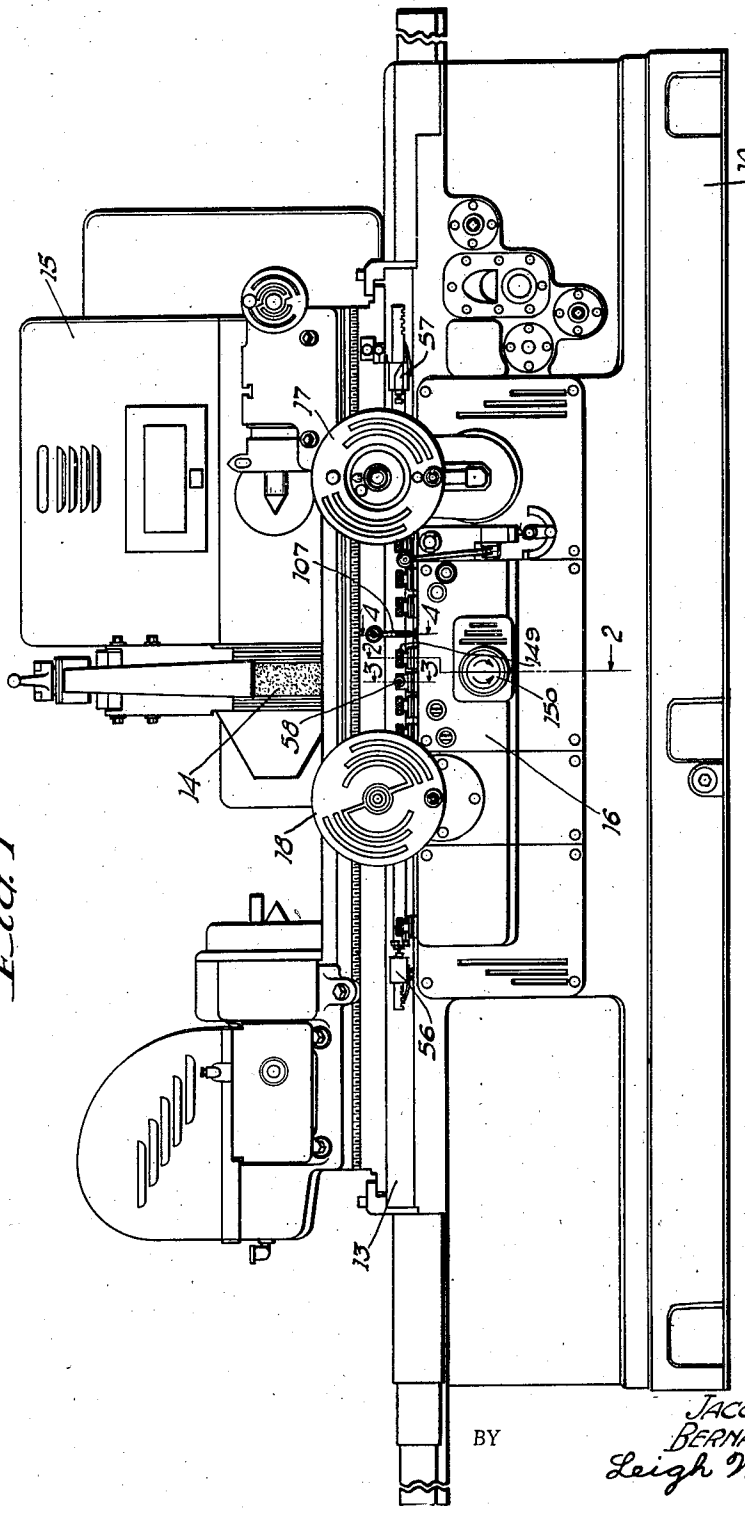


Fig. 1

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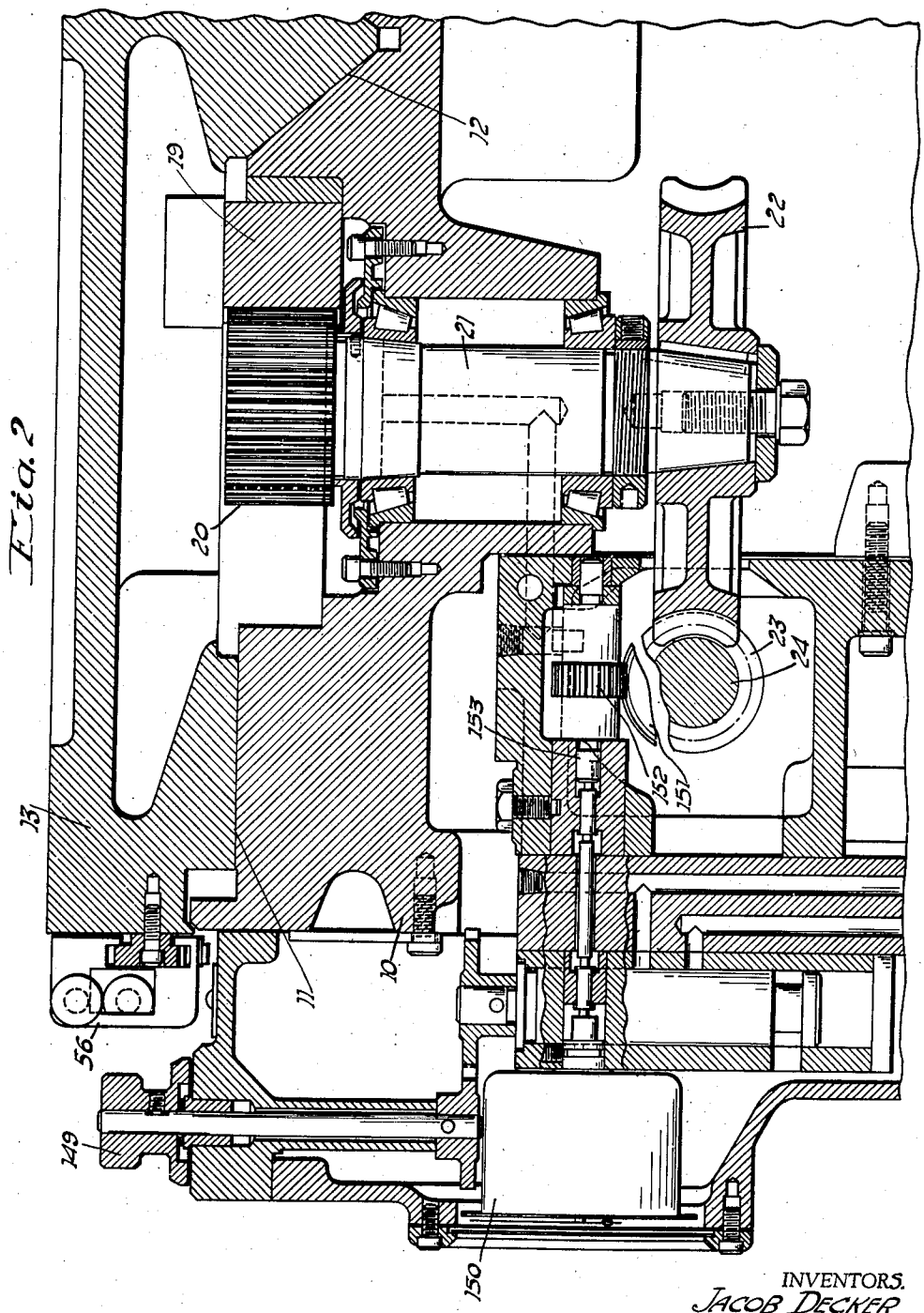


Fig. 2

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Fig. 3

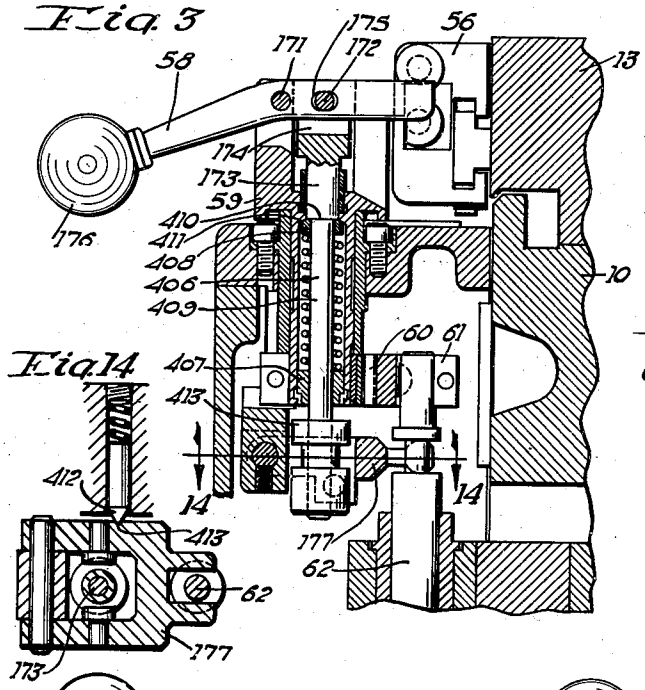


Fig. 14

Fig. 5

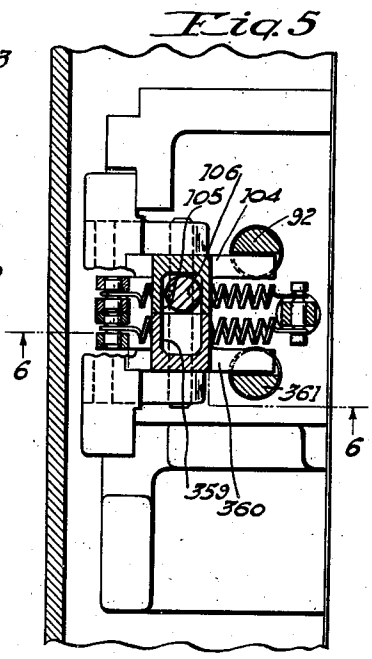


Fig. 4

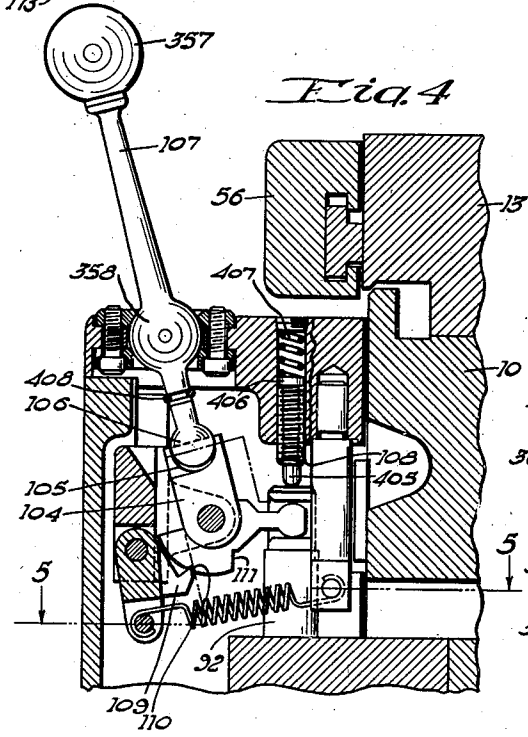
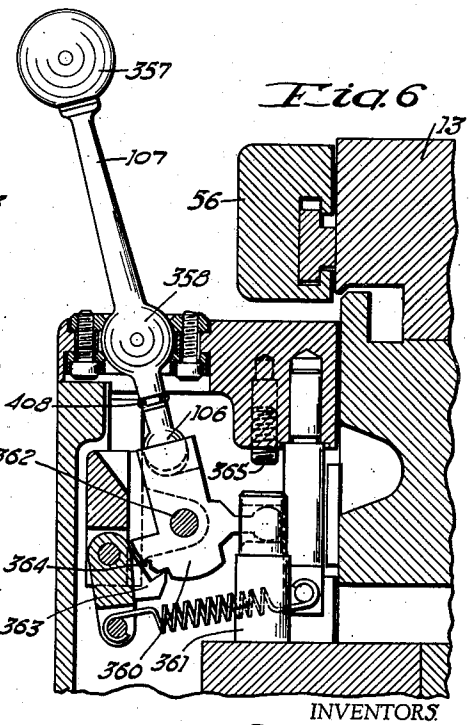


Fig. 6



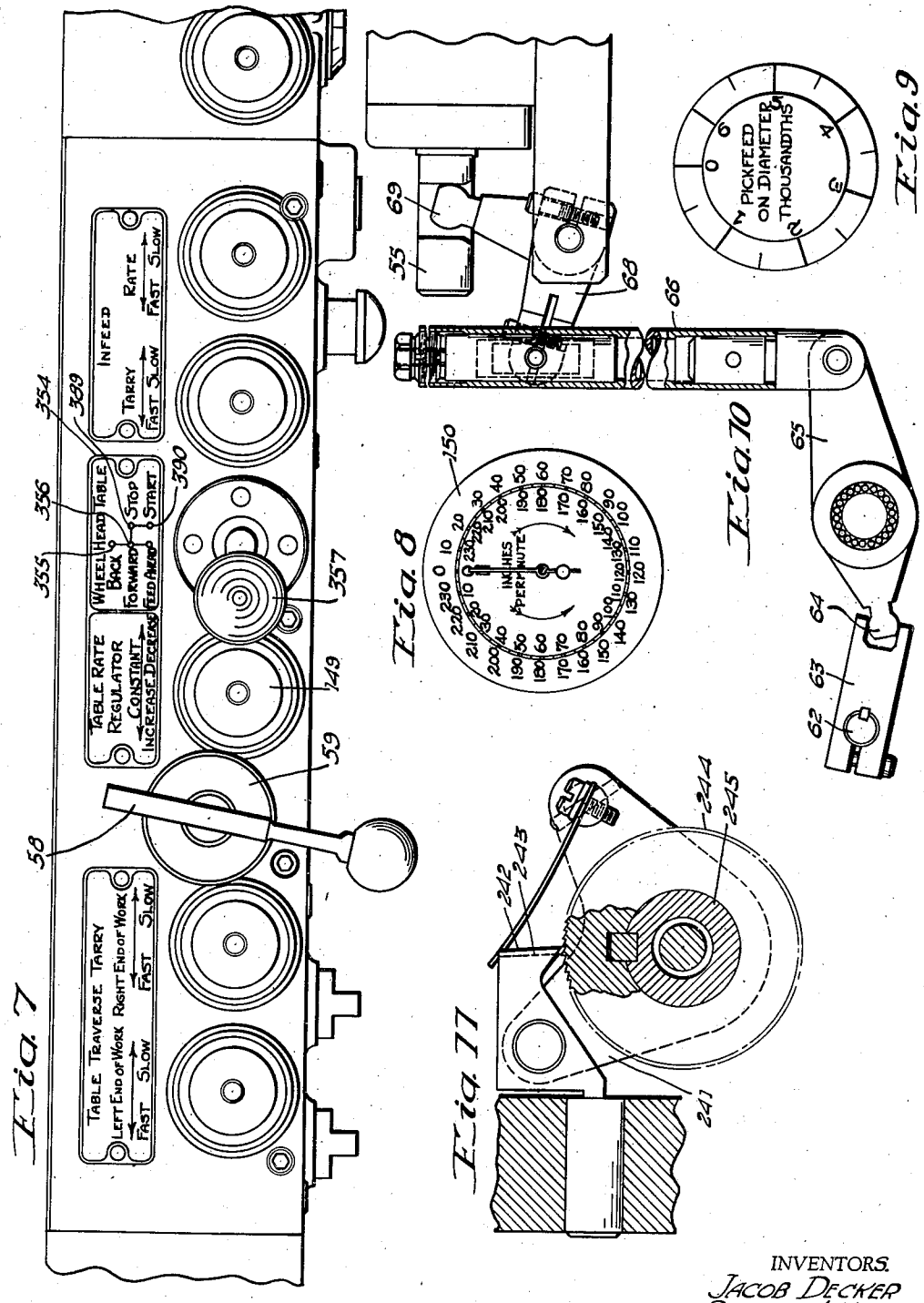
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GRINDING MACHINE

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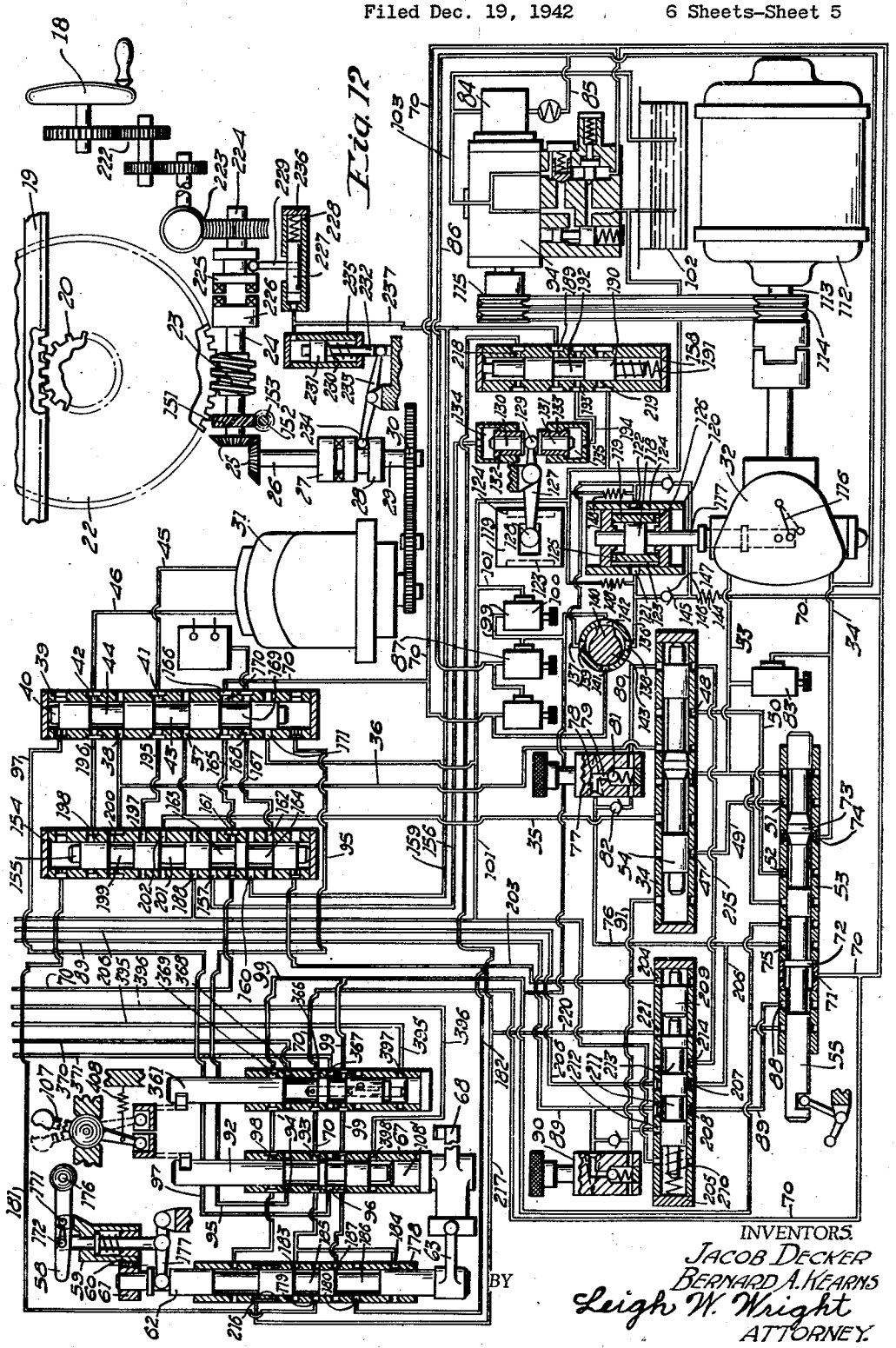
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Fig. 12



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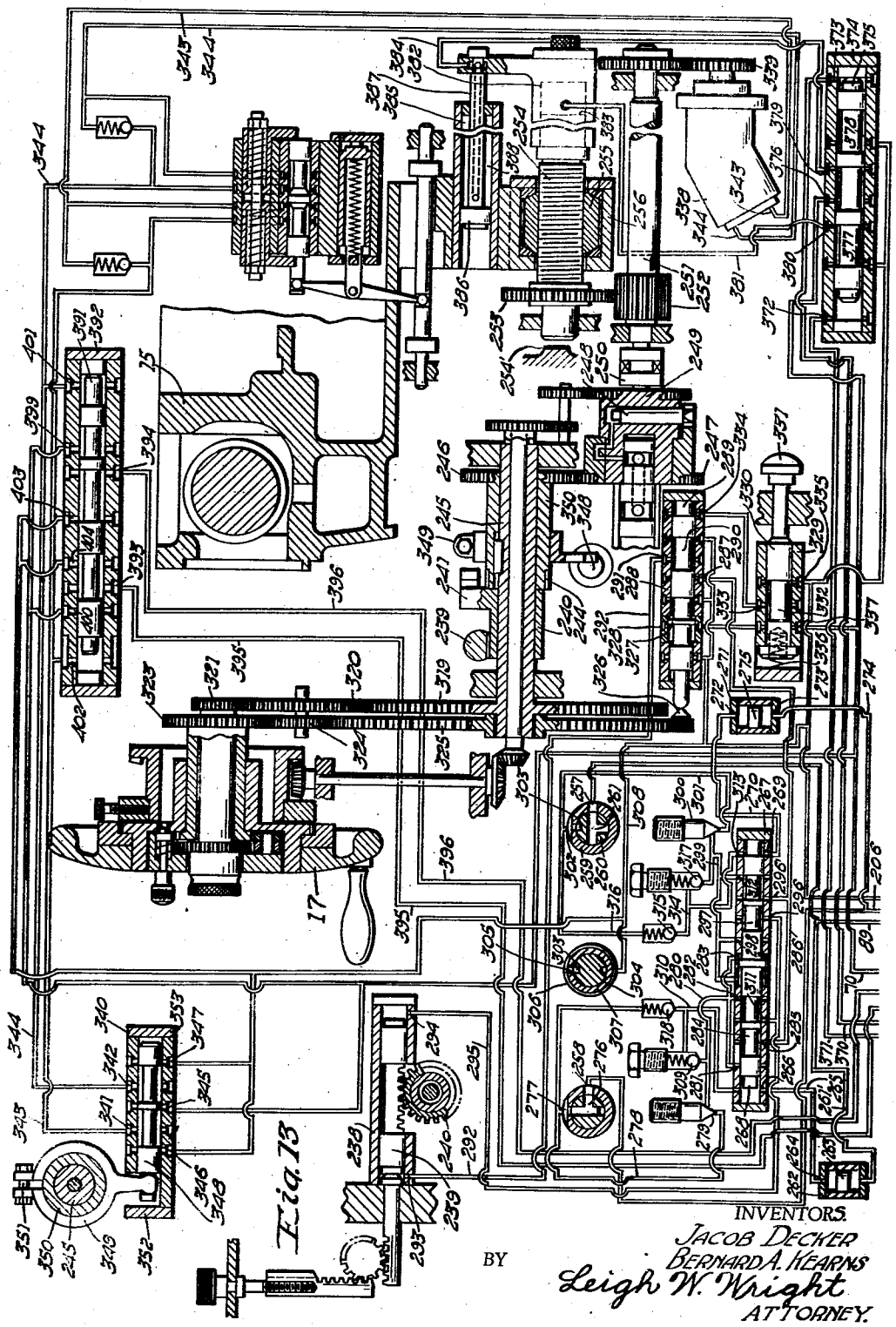


Fig. 13

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2,376,236

UNITED STATES PATENT OFFICE

2,376,236

GRINDING MACHINE

Jacob Decker and Bernard A. Kearns, Cincinnati, Ohio, assignors to The Cincinnati Milling Machine Co., Cincinnati, Ohio, a corporation of Ohio

Application December 19, 1942, Serial No. 469,758

25 Claims. (Cl. 51—95)

This invention relates to grinding machines and more particularly to improvements in the transmission and control mechanism therefor.

One of the objects of this invention is to provide an improved and simplified transmission for traversing purposes which may be infinitely varied as to rate.

Another object of this invention is to provide an improved hydro-mechanical transmission for grinding machines.

A further object of this invention is to improve the operation and control of a grinding machine by providing a single control for causing fast approach of the grinding wheel to the work and starting the reciprocation of the table for a traverse grinding operation and a second control for causing fast return of the grinding wheel and stoppage of the table after the grinding operation has been completed.

Another object of this invention is to provide an improved manual and power transmission for a grinding machine table having suitable interlocks for connecting and disconnecting them so as to prevent manual operation during power operation and thereby improve the safety of the machine.

Another object of this invention is to provide an improved power operable pick feed mechanism for automatic actuation from the table control transmission and selective with respect to sequential or alternate operation.

A further object of this invention is to provide means for automatically reducing the torque required for rotation of the infeed screw by either the manual control or the pick feed mechanism.

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.

Referring to the drawings in which like reference numerals indicate like or similar parts:

Figure 1 is a front elevation of a machine tool embodying the principles of this invention.

Figure 2 is a vertical section on the line 2—2 of Figure 1 showing the mechanical drive to the table.

Figure 3 is a section on the line 3—3 of Figure 1 showing the trip operable reversing mechanism.

Figure 4 is a section on the line 4—4 of Figure 1 showing the starting control lever.

Figure 5 is a section on the line 5—5 of Figure 4.

Figure 6 is a section on the line 6—6 of Figure 5.

Figure 7 is a plan view of the control panel on the machine.

Figure 8 is an elevational view of the speedometer for the table.

Figure 9 is an elevational view of the pick feed adjustment dial.

Figure 10 is a plan view of the interconnecting linkage between the trip plunger and the reversing pilot valve.

Figure 11 is a detail view of the pick feed ratchet mechanism.

Figure 12 is a diagrammatic view of the hydraulic table transmission.

Figure 13 is a continuation of the diagram shown in Figure 12 including the pick feed control mechanism.

Figure 14 is a detail section on the line 14—14 of Figure 3.

Referring to Figures 1 and 2 of the drawings the reference numeral 10 indicates in general the bed of the machine upon the top of which is formed a flat guideway 11 and a V-guideway 12 for receiving and guiding a work supporting table 13 for traversing movements relative to a grinding wheel 14 which is rotatably journaled upon a cross slide which is indicated generally by the reference numeral 15. The cross slide or wheel head has a self-contained transmission for rotating the grinding wheel.

In the middle front of the bed there is mounted a control panel 16 upon which is nested all of the controls necessary to govern the operation of the machine. It will be noted that these are conveniently arranged as more particularly shown in Figure 7 and that all are within easy reach of the operator from his normal position at the front of the machine. These various controls are arranged between a manual control wheel 17 for the wheel head and a manual control wheel 18 for the table.

For convenience of explanation the table transmission is shown diagrammatically in Figure 12. Referring to Figure 2, however, it will be seen that the table is provided on its underside with a rack 19 that is engaged by a pinion 20 attached to the upper end of an anti-frictionally supported shaft 21 mounted in the bed. The lower end of this shaft is provided with a worm wheel 22 that is driven by a worm 23. The worm 23 is attached to a shaft 24 which is interconnected by bevel gearing 25 to a cross shaft 26 as shown in Figure

12. This shaft terminates in a clutch member 27 which is adapted to be engaged by a shiftable clutch member 28 splined on shaft 29. The shaft 29 is power driven through a gear train 30 by a hydraulic motor 31. The hydraulic motor is a constant displacement motor but is supplied by a variable displacement pump 32 so that by variation of the pump displacement an infinite change in rate may be obtained.

The pump and motor are connected together by supply and return lines in what is known as a closed circuit in that the intake supply to the pump comes directly from the motor rather than from reservoir as is the case in an open circuit. Means are provided for maintaining a pressure differential between the supply and return lines by supercharging the return line to a predetermined pressure which compensates for leakage and thus establishes a substantially constant operating condition.

To this end, the pump 32 which is unidirectionally driven has a delivery line 33 and a return line 34. The delivery line 33 is alternatively connectible by annular grooves in reversing valve 34 to channels 35 and 36 which terminate in ports 37 and 38 of a start and stop valve 39. When the plunger 40 of the valve is in the start or running position which is that shown in Figure 12 the ports 37 and 38 are connected to ports 41 and 42 by annular grooves 43 and 44 respectively which are formed in the plunger 40. The ports 41 and 42 are connected by channels 45 and 46 to the motor 31.

The reversing valve 34 has a pair of return ports 47 and 48 so that the remaining one of the pair of channels 35, 36 may be connected to return when the other is connected to pressure. The ports 47 and 48 are connected by channels 49 and 50 to ports 51 and 52 of a pilot valve 53 which serves to control hydraulic shifting of the reversing valve plunger 54, and also to complete connection of port 51 or 52 to return channel 34. It will thus be seen that there are two parallel conduit systems extending from the pump to the reversing valve and that these two conduits are connected to the motor lines 45 and 46 by the reversing valve 54 either direct or in transposed relation depending upon the direction of table movement desired.

The pilot valve plunger 55 is adapted to be trip controlled from the table and to this end the table is provided with longitudinally adjustable reversing dogs 56 and 57 shown in Figure 1 which alternatively engage a trip lever 58 shown in Figure 3 for rotation of a sleeve 59 to which it is connected. The sleeve 59 is provided with gear teeth 60 which mesh with a pinion 61 secured to the upper end of a plunger 62 which is supported for rotation as well as axial movement. The rotation is utilized to effect trip operation of the pilot valve plunger 55 and to this end the lower end of plunger 62 has a crank 63 keyed thereto as shown in Figure 10 and this crank is connected by a ball and socket joint 64 to a centrally pivoted lever 65. The lever 65 is connected by an adjustable link 66 to a bell crank 68 which has a ball ended arm 69 operatively engaging the pilot valve plunger 55. It should now be apparent that dog actuation of the trip plunger 58 will effect shifting of the plunger 55.

To insure complete shifting of the plunger a hydraulic detent is provided by connecting a pressure line 70 to port 71 in the valve bushing 53 and providing the plunger 55 with an enlarged spool 72 in position to move relative to the port 71 whereby after the spool passes the port a pressure differential is created which completes the shifting of the plunger.

The pump return line 34 is connected through the pilot valve for table deceleration purposes and to that end the plunger 55 is provided with a double tapered spool 73 which is movable relative to the port 74 to which the line 34 is connected, whereby as the spool moves under trip action by the table the port 74 closes, thus gradually restricting the return line from motor 31 and causing it to slow down before the point of reversal is reached.

The spools 72 and 73 are so related that just before the spool 73 completely closes the port 74, the spool 72 has reached a point sufficiently past the pressure port 71 to permit the admittance of pressure on the other side of the spool and complete the shifting movement. This will result in port 71 being connected to port 75 and thereby through channel 76 to the tarry valve 77. This valve has a V-shaped groove 78 which may be rotatably adjusted to variably restrict the flow through the valve and thereby vary the length of tarry at table reversal.

An interdrilled passage 79 connects groove 78 to channel 80 which leads to the right hand end of the reversing valve 34. Within the passage 79 is a check valve 81 which blocks the return flow through the valve, but a second check valve 82 is provided in parallel therewith but oppositely positioned to open under return flow whereby exhausting fluid may bypass the tarry valve.

When the plunger 54 has passed through its center position it connects the pump line 33 to channel 36 and at the same time interconnects port 47 with channel 35 to reverse the direction of rotation of the table motor 31. Attention is invited to the fact that between the time that the pilot plunger 55 has completed its shifting movement and before the plunger 54 has passed through center, the line 49, being connected to the return channel 34 of the pump 32, would tend to become vacuumized by the pump because connected to the suction side thereof and, therefore, to prevent this condition a differential valve 83 is connected across the channels 33 and 34 and adjusted to maintain a prescribed pressure differential between the two lines.

Thus, when the pressure in line 34 drops, for instance, and the pressure in line 35 rises due to inaction of the motor 31, pressure fluid will be bypassed through the valve 83 from the line 33 to the line 34 and thereby prevent such a condition from arising. Furthermore, the line 34 is supercharged by a pump 84 which has a delivery line 85 that is connected to the line 34. The line 85 also has a branch 86 that is connected to a relief valve 87 for determining the pressure in line 85 which pressure should correspond to the normal operating pressure desired in the line 34 taking into consideration its pressure differential relationship to the line 33. This supercharging pump serves to replace losses due to leakage and insures against starvation of fluid in the line 34.

When the pilot valve plunger 55 is trip actuated in the opposite direction, fluid pressure from port 71 passes through port 88 and line 89 to tarry valve 90 and then through channel 91 to the left hand end of the reversing valve 34 shifting the plunger 54 to the right.

The starting and stopping of the table motor 31 is controlled by the valve plunger 40 of valve

39 and this plunger is shifted hydraulically from one position to the other under control of a pilot valve 92 which is manually operated by the operator. The valve 92 has a pressure port 93 which is supplied from channel 70, which numeral represents in general the pressure line network supplied by a pump 94. In the running position, the port 93 is connected to port 94' and thereby through channel 95 to the lower end of the start valve 39. When the valve 92 is moved upward the port 93 is connected to port 96 and thereby through channel 97 to the upper end of valve 39. At that time the port 94' becomes connected to an exhaust port 98 and return channel 99 which leads to a low pressure relief valve 100.

The exhaust line 101 from the relief valve goes to the reservoir 102 from which the pumps 84 and 94 draw fluid through channel 103. As shown in Figure 4, the valve 92 is equipped with an operating bell crank 104 which has a socket 105 in which is fitted a ball-shaped end 106 of a pivoted starting lever 107. A threaded stud 108 is adjustably positioned to limit the upward or stop movement of the valve 92, while the plug 108' in the lower end of the valve sleeve as shown in Figure 12 limits the downward or start movement of the valve 92. In addition, a spring-pressed detent 109 is provided for selectively engaging notches 110 and 111 in the bell crank for holding the lever in either one of its two positions. Thus, if the lever 107 is pulled toward the operator, the table starts, and by pushing it away from the operator or toward the table, the table stops.

The pump 32 is continuously driven by a prime mover such as an electric motor 112 and the armature shaft 113 of the motor has a pulley 114 which is belt-connected to a pulley 115 for also driving the pumps 94 and 84. Since the pump 32 is continuously driven it will be apparent that it is simply necessary to throw the valve 92 by the manual control lever 107 to start reciprocation of the work supporting table.

The variable delivery pump 32 is a unidirectional pump and its volumetric output is varied from zero to a predetermined maximum by a pintle 116 which is operatively connected to a control rod 117. This rod has a piston 118 formed integral therewith which is slidable in a cylinder 119, it being noted that the rod extends through both ends of the cylinder whereby equal pressure in both ends of the cylinder will hold the piston stationary.

The cylinder 119 is built as a unit and in turn is slidably mounted in a fixed sleeve 120. This sleeve has a pair of independent ports 121 and 122 formed on opposite sides thereof and these ports communicate with axially extending grooves 123 and 124 respectively formed in opposite sides of the cylinder 119. It will be noted that these grooves are closed at both ends as shown in the plan view just above the sectional view. The groove 123 has a port 125 at one end which communicates with one end chamber of the cylinder 119, and the groove 124 has a port 126 which communicates with the other end chamber of the cylinder. The cylinder 119 is normally held stationary by hydraulic means and this is accomplished by connecting one end of a pivoted lever 127 at 128 to the cylinder, and interposing the other end 129 between a pair of fluid operable pistons 130 and 131.

These pistons are slidably mounted in centralizing sleeves 132 and 133, it being noted that the sleeves have a collar integrally formed on one end which limits their movement toward one another but when they are both hydraulically urged toward one another their length is such as to clamp the end 129 rigidly between them. The sleeves are slidably mounted in cylinders 134 and 135. It should now be obvious that if pressure is maintained in both cylinders 134 and 135 that the cylinder 119 will be held stationary. This is the normal condition.

With the cylinder 119 held stationary it becomes possible by changing the pressural conditions in opposite ends thereof to cause movement of the piston 118 and thereby vary the displacement of pump 32. This is accomplished by connecting the ports 121 and 122 by channels 136 and 137 to ports 138 and 139 of a rate control valve 140. This valve has a pressure port 141 which is supplied from the pressure channel 70 and an exhaust port 142 which is connected to the low pressure return line 99.

The valve has a rotatable plunger 143 which in its normal position closes the ports 141 and 142. This would normally mean that fluid would be trapped in opposite ends of the cylinder but should a slight leakage take place the piston 118 might tend to creep in one direction or the other.

In order to maintain a constant pressure in spite of these ports being closed the pressure channel 70 has another connection through a resistance 144, and parallel branch lines 145 and 146 to the channels 136 and 137. Check valves 147 are interposed in the lines 145 and 146 to prevent return escape of fluid and insure a steadier condition. In addition, the lines 136 and 137 have branch connections through resistances 148 to the reservoir line 101. The effect of all this is that there is a source of pressure, a resistance to the flow to each end of the cylinder and independent resistances to the escape of fluid from the opposite ends of the cylinder whereby if the resistance "in" is equal to the resistance "out" the pressure in each end of the cylinder is equal to one-half of the pressure in line 70 in accordance with hydraulic principles. The check valves serve to prevent intercommunication from one end of the cylinder to the other and make it possible to use only one ingoing resistance such as the resistance 144. It will be noted that there is a continuous flow condition created which is necessary in order to maintain predetermined pressures.

The valve plunger 143 has recesses formed in opposite sides thereof and it should now be evident that if the valve is rotated to uncover the exhaust port 142 and thereby establish communication with port 139, for instance, the pressure port 141 will be connected to port 138, thereby permitting the introduction of additional fluid into line 136 which would differentiate the pressure with respect to channel 137 and cause movement of the piston 118 in a downward direction as viewed in Figure 12, forcing fluid out of the cylinder through channel 137. Upon closing of the valve the piston 118 will be held stationary in its new position.

The rate control valve 143 has an operating knob 149 located on the control panel as shown in Figure 7.

In order that the operator may know what the rate setting is, a speedometer, indicated generally by the reference numeral 150 in Figure 8, is mounted on the front of the machine, and the speedometer is driven from the table transmission as follows. The shaft 24 shown in Figure 12 has a spiral gear 151 which intermeshes with

a spiral gear 152 mounted on a shaft 153. The shaft 153 is connected to and drives the speedometer as shown in Figure 2 and it will be noted that the shaft is responsive to the direction of rotation of the table transmission, or in other words to the direction of movement of the table. Therefore, as shown in Figure 8, the dial is provided with two sets of figures for indicating the feed rate in inches per minute, one set being for one direction of movement of the table and the other set for the other direction of movement of the table. Thus with the table traveling, the operator observes the dial and then rotates the knob 149 to effect an increase or a decrease in the rate of table movement.

It is, of course, necessary to intermittently interrupt grinding operations to true or dress the grinding wheel, which requires fast movements of the table for set-up or positioning purposes and a very slow rate of table movement for the actual truing or dressing operation. In order that these changes may be made without disturbing the setting of the feed rate mechanism, a separate control means is provided which has two positions, one of which will yield a rapid traverse rate and the other a slow or truing rate.

To this end the cylinders 134 and 135 are connected to a rapid traverse truing control valve 154 having a plunger 155, positioning of which is determined by the axial movement of plunger 62 which as previously explained is capable of rotation or axial movement. This control means effects rapid traverse movement of the table by setting the pump at its maximum displacement, or a slow rate of table movement by setting the pump at a minimum displacement. In addition, means are provided for setting the pump to minimum displacement when the table is stopped by the start and stop valve.

The cylinder 134 is connected directly by channel 156 to port 157 of valve 154, while the cylinder 135 is connected through a valve 158 and channel 159 to port 160 of the control valve 154. The plunger 155 is shown in the truing position whereby the ports 157 and 160 are connected to ports 161 and 162 by annular grooves 163 and 164 respectively. The port 161 is connected by channel 165 to annular groove 166 in the valve sleeve 39, which annular groove is connected to the pressure line 70 whereby the port 161 is always under pressure. The port 162 is connected by channel 167 to port 168 in the valve sleeve 39 and when the plunger 40 is in the running position shown, the annular groove 169 connects the port 168 to the pressure port 70 which is formed in the annular groove whereby the port 162 becomes a pressure port. It will now be evident that channels 156 and 159 are connected to pressure during translation of the table, whereby the cylinder 119 is held fixed in the position shown by hydraulic pressure.

When the plunger 40 is shifted to a stop position it disconnects pressure from port 168 and connects it to an exhaust port 171. Thus, the cylinder 135 is connected to exhaust and since pressure is still maintained in cylinder 134, the cylinder 119 is shifted by piston 130 in a direction to reduce the displacement of the pump 32 and thereby decrease the amount of oil being pumped during non-movement of the table which prevents the oil from becoming overheated. It will be noted that this result is obtained automatically through operation of the start and stop valve.

The trip lever 58 is pivotally supported on a pin 171 carried by the rotatable sleeve 59, as shown in Figure 3, and is operatively connected by a pin 172 to a plunger 173. The lever 58 is mounted in a cross slot 174 formed in the end of the plunger and it has an elongated hole 175 through which the pin 172 passes whereby the lever 58 may be pivoted about the pin 171 to effect axial movement of the plunger 173 without binding. A ball handle 176 serves to operate the lever 58. The plunger 173 is so connected that raising the lever 58 will effect rapid traverse movement of the table, and lowering the lever will effect a slow movement of the table for truing purposes when the table is stopped.

The plunger 173 is operatively connected by a lever 177 to the valve plunger 62 for effecting axial movement thereof. The plunger 173 is normally held in a central position by a surrounding spring 406 which is interposed between a fixed plug 407 which also serves as a bearing for the lower end of the plunger and a washer 408 slidably fitted on the reduced portion 409 of the plunger. The washer engages a shoulder 410, formed by reducing the portion 409, to exert an upward thrust on the plunger. The washer, however, is made large enough in diameter to engage a fixed shoulder 411 which limits the movement of the washer and thereby the plunger.

In addition, the lever 177 is provided with a spring-pressed detent 412 as shown in Figure 14 which engages a depression 413 formed in the side of the lever which assists in centralizing the plunger. The detent also serves to engage the underside of the lever 177 when the plunger is moved upward to hold the parts in that position when the lever is released as in truing operations. It will be noted that during upward movement, the portion 409 merely slides through the spring 406 and washer 408, those parts remaining in the same position. A shoulder 413 engaging the plug 407 limits the extent of the upward movement whereby the detent serves to hold the weight of the parts.

The valve sleeve 178, in which the plunger 62 slides, has a pair of ports 179 and 180 which are connected by channels 181 and 182 to opposite ends of the control valve 154 to effect hydraulic shifting of the plunger 155. The pump line 70 supplies a pair of pressure ports 183 and 184 in the sleeve 178 and with the plunger 62 in its central position, the port 183 is connected by the annular groove 185 to the port 179, which hydraulically positions the plunger 155 as shown. At this time the port 180 is connected by the annular groove 186 to an exhaust port 187 which is connected to the low pressure return line 99.

When the trip lever 58 is manually pulled upward it moves the plunger 62 downward and thereby interconnects the port 179 with the exhaust port 187, draining the upper end of the valve 154, and connects the port 180 to the pressure port 184 causing admission of fluid pressure to the lower end of valve 154, thereby shifting the plunger 155 upward to a rapid traverse position which in effect serves to by-pass the start and stop valve. In other words, the pressure port 161 is connected to port 160 so that pressure is supplied to the line 159 regardless of the position of the start and stop valve, and the port 157 is connected to an exhaust port 188 whereby the fluid may drain through the line 101 to reservoir.

The pressure in line 159 flows to port 189 of the control valve 158 which has a plunger 190

normally held in the position shown by a spring 191 whereby the annular groove 192 interconnects port 189 to port 193 and channel 194 leading to the cylinder 135. This shifts the pump pintle 117 to maximum displacement which will cause rapid traverse movement of the table. If the start and stop valve plunger 40 is in its stop position, the ports 41 and 42 will obviously be closed, but these ports are in the form of annular grooves in the sleeve 39 which are connected by channels 195 and 196 to ports 197 and 198 of valve 154. When the valve plunger 155 is moved upward port 198 is interconnected by the annular groove 199 to port 200 and thereby to line 36, and port 197 is connected by annular groove 201 to port 202 and thereby to line 35 with the result that both of the motor channels 46 and 45 are connected to the supply lines 36 and 35 in the same manner as if connected by the start and stop valve.

In other words, the effect is that the valve plunger 155 has by-passed the start and stop valve by connecting the motor to its pump and simultaneously increased displacement of the pump to effect rapid operation of the motor 31.

When the table is moved at a rapid traverse rate it is not necessary to utilize the tarry valves at reversal and therefore a connection is provided whereby these tarry valves may be automatically rendered ineffective. This connection comprises a branch line 203 from channel 182 to port 204 of a tarry by-pass valve 205. The channel 76 that leads from the pilot valve 53 to the tarry valve 77 has a branch 206 which terminates in port 207 of valve 205, and the channel 89 that leads to the tarry valve 90 is connected to a port 208 in valve 205.

When the plunger 209 of this valve is shifted against the resistance of a spring 210 which normally holds the valve in the position shown, the annular groove 211 connects port 208 to port 212 and thereby directly to line 91 leading to the left end of the reversing valve. Similarly, the port 207 is connected by annular groove 213 to port 214 and thereby to channel 215 which leads directly to the right hand end of the reversing valve. It will now be apparent that upon trip operation of the pilot valve 53 fluid pressure will flow directly to the reversing valve and shift the plunger thereof without delay.

When the trip lever 58 is moved downward to its truing position the pressure port 183 is connected to port 216 by groove 185 and thereby to channel 217 which terminates in port 218 of valve 158. Admission of pressure to this port shifts the plunger 190 against the spring 191, thereby closing port 189 and interconnecting port 193 through the annular groove 158 to the exhaust port 219. This relieves the pressure in cylinder 135 whereby the pressure still present in cylinder 134 shifts the cylinder 119 in a direction to reduce the pump displacement to a minimum.

For truing operations it is also not necessary to utilize the tarry devices and therefore connections are simultaneously made to render these ineffective. In this case, the line 217 has a branch connection 220 to port 221 of the by-pass valve 205 which will cause a shifting of the plunger 209 effecting the same connections as in the case of rapid traverse operation whereby upon actuation of the reversing pilot valve, the reversing valve will be immediately fired. It will now be apparent that the trip lever 58 may also be utilized to effect fast or slow movement of the table without interfering with the feed rate setting.

The table may be traversed manually by the hand wheel 18 which is connected through a gear train, indicated generally by the reference numeral 222 in Figure 12 to a worm and worm gear 223, the worm being attached to a shaft 224. This shaft carries a shiftable clutch member 225 which is adapted to be moved into engagement with a fixed clutch member 226 carried by the shaft 24. The clutch members are normally held engaged by a shifter 227 urged by a spring 228 in the proper direction, the shifter 227 carrying a shifter fork 229 which engages the clutch.

Similarly, the clutch 28 located in the power drive to the table is normally held disengaged by a spring 230 operating on a piston 231, the piston being connected by a piston rod 232 to a centrally pivoted lever 233. This lever has a fork 234 connected to the clutch 28. A cylinder 235 contains the piston 231, and a cylinder 236 contains the plunger 227 and the ends of these cylinders are connected to a common channel 237 which is a branch of line 159.

Whenever line 159 is connected to pressure by either the start and stop valve or the rapid traverse valve, the pistons 231 and 227 are actuated in such a manner as to disengage the clutch 225 and engage the clutch 28, or, in other words, to disengage the manual drive and engage the power drive to the table. This eliminates the possibility of the operator attempting manual operation while the power is connected, and also eliminates rotation of the hand wheel 18 during power actuation of the table for reasons of safety.

During traverse grinding, means have been provided for automatically pick feeding the wheelhead, comprising a pick feed motor and a hydraulic control circuit which is operable by the table reversing mechanism. The pick feed motor comprises a cylinder 238 containing a reciprocable rack piston 239 which operatively engages a pinion 240. The pinion 240 has a lever 241 integrally connected thereto, the lever carrying a pair of pick feed pawls 242 and 243 as more particularly shown in Figure 11. These pawls are adapted to engage a pick feed wheel 244 which is keyed to a sleeve 245. A gear 246 also connected to the sleeve and wheel meshes with the gear 247 which is operatively connected by a clutch 248 to a shaft 249. The shaft is connected by a coupling 250 to a shaft 251 which extends parallel to the direction of movement of the wheel slide. This shaft carries an elongated pinion 252 which is engaged by a gear 253 formed integral with the cross slide feed screw 254. A nut 255 supported by a depending bracket 256 on the under side of the wheelhead engages the screw 254 for imparting motion to the wheelhead.

It should now be apparent that upon reciprocation of the piston 239 that a small movement may be imparted to the wheelhead. Reciprocation of the piston 239 is controlled from the table reversing pilot valve 53. As previously explained, this valve has two ports 75 and 88 which are alternately connected to pressure by plunger 55. Channels 89 and 206, which are connected to these ports, are extended to Figure 13 and connected to ports 257 and 258 of a pick feed selector control valve 259 which is shown in three sections in the diagram.

This valve has a rotatable plunger 260 which

may be set to produce a pick feed only at either end of the table stroke, or it may be set to produce a pick feed at both ends of the table stroke. In the position shown it will effect a pick feed at only one end of the table stroke.

In accordance with the position of the table reversing pilot valve, the line **89** is under pressure but it will be noted that the port **257** is in communication with a T-shaped passage **261** which has no outlet and therefore no pick feed action will occur. The line **89** has a branch connection **261'** which leads to an accumulator cylinder **262** having a contained piston **263**. One end of this cylinder has a port **264** which is connected by a branch channel **265** to a port **266** located in the end of the pick feed reversing valve **267**. This valve controls reciprocation of the piston **239**.

When pressure is admitted to the channel **261'** the piston **263** is moved in a direction to force the fluid ahead of it into the end of valve **267** shifting the valve plunger **268** into its right hand position. The fluid in the other end of the valve will escape through port **269** and channel **270** into a second accumulator **271** through port **272**. The other end of this accumulator has a port **273** which is connected by channel **274** to line **206**. Since this line is now connected to a low pressure return through the valve **55** it is possible for the piston **275** to be moved by the exhausting fluid.

Upon reversal of the pilot valve the line **206** will be under pressure, thereby shifting the piston **275** in the opposite direction and forcing the valve plunger **268** to the left and returning the accumulator piston **263**. The pressure in line **206** will flow through the port **258** and the T-shaped passage **276** to port **277** and thus cause a pick feed action as follows. The port **277** has a channel **278** connected thereto which leads to a throttle valve **279** which may be adjusted to determine the rate of movement of the pick feed piston. This valve will effect a drop in pressure in the fluid flowing therethrough to line **280**. This line is parallelly connected to ports **281**, **282** and **283** of the pick feed control valve.

Since the plunger **268** is now in its left hand position, the port **281** is connected by the annular groove **284** to port **285** and thereby to channel **286** which leads to port **287** of a pick feed stop valve **288**. The plunger **289** of this valve is normally to the left of the stop position shown whereby the port **287** is connected by annular groove **290** to port **291** so that the fluid may continue through channel **292** to port **293** of the pick feed cylinder.

This will shift the plunger **238** to the right, the fluid in the other end escaping through port **294** and channel **295** to port **296** of the pick feed control valve. Since the plunger **268** is to the left the port **296** is connected by annular groove **297** to a port **298**. This port is connected by channel **299** to a second throttle valve **300**. A channel **301** connects this valve to port **302** of the pick feed selector valve. It will be noted that this port is in communication with a longitudinally extending groove **303** which terminates in section **304** of the valve. In the position shown the groove **303** is in registry with a port **305** that is formed in the annular groove **306** in the valve bushing **307**, and a return channel **308** is connected to this groove whereby the fluid exhausts to reservoir.

After the plunger **239** has completed its movement the pressure will rise in channel **280** and open a check valve **309** which is branch-connected thereto whereby the fluid will escape through line **310** to the left end of the pick feed control valve and shift the plunger **268** back to its right hand position. This will effect interconnection of port **282** with port **311** whereby the fluid in channel **280** may now flow through channel **295** to effect return movement of the pick feed piston. The fluid ahead of the piston will return through channel **292**, interconnected ports **291** and **287** of the pick feed stop valve, and channel **286** to port **296'**. This port is now connected to port **312** which is branch-connected to channel **299** whereby the fluid will escape to reservoir through the throttle valve **300**.

It will be noted that the fluid pressure entering the left end of the valve **267** for shifting the plunger **268** to the right may continue through the port **266** and channel **265** and shift the accumulator piston **263** to the lower end of its cylinder because the line **261** which is connected to the lower end of the cylinder is part of channel **89** which is connected to exhaust by the pilot valve **55**.

Attention is also invited to the fact that since the other accumulator piston **275** is at the top of its stroke and held in that position by fluid pressure from channel **206** that the fluid pressure cannot be forced into the accumulator because it has the same operating pressure and therefore the fluid will escape through port **313** and channel **314** to a low pressure check valve **315** which will open so that the fluid may continue through line **316** to port **302** that is connected to exhaust. Upon the next reversal of pressure in channels **89** and **206** no pickfeed will occur. This is the manner of effecting a pick feed action at one end of the table stroke only. Should the valve plunger be rotated 180 degrees the same action will be produced for the right end of the table stroke with no action taking place at the left end of the table stroke.

Should the valve be rotated 90 degrees from the position shown, that is, in a counterclockwise direction, the connections are such that a pick feed action will take place at both ends of the table stroke.

In other words, the port **257** is connected to the port **302** and port **258** is connected to port **277**. Should the line **89** be connected to pressure and the line **206** connected to exhaust by the table control valve, fluid pressure will enter channel **261'** and shift piston **263** in a direction to shift the pick feed control valve plunger **268** to the right. At the same time fluid pressure will flow through the interconnected ports **257** and **302** of the pick feed selector valve to the throttle valve **300** and thereby to port **312**.

Since this port is connected to port **296'** the fluid pressure will continue to port **293** of the pick feed cylinder and shift the plunger **239** to the right. After this has been completed the fluid pressure will rise in channel **299** and open check valve **317** and thereby continue through channel **314** to the right hand end of the pick feed control valve, shifting the plunger **268** to the left. This will interconnect ports **296** and **298**, whereby the fluid pressure will flow through channel **295** and return the pick feed piston **239** to its starting position. The fluid in the left end of the pick feed cylinder will return the piston **263** to its lower position and then any excess fluid will open a low pressure check valve **318** whereby the fluid can escape to reservoir through line **206** which is an exhaust line.

Upon the next reversal of the table, line **206** will be under pressure, and line **89** connected to exhaust. This will cause actuation of the piston

275 in cylinder 271 but this will produce no result at the time because the piston 268 is already in a left hand position. Fluid pressure will flow, however, through the interconnected ports 258 and 277 of the pick feed selector valve to the throttle valve 279 and then continue through channel 280 to port 281. This port will be connected to port 285 whereby the fluid will again flow through channel 286 to effect movement of the pick feed piston 239 to the right. As the pressure rises in channel 280 the check valve 309 will open and fluid pressure will flow through channel 310 to the left end of the pick feed control valve, shifting the plunger 268 to the right.

This will result in the port 282 becoming connected to port 311 whereby fluid will flow through channel 295 to effect return of the piston 239.

As the pick feed mechanism is operated it rotates the gear 246 which is connected as shown for rotation of the pinion 252. It will also effect a feed back through the sleeve 245 which is keyed to the sleeve 350 and thereby to the gear 319 which is connected by an intermediate idler 320 to a pinion 321 operatively connected with the hand wheel 17. The hand wheel 17 is also operatively connected to a gear 323 which drives through the gear 324, a gear 325 which carries a stop button 326. The pick feed stop valve 288 is mounted in the machine in the path of rotation of the stop button whereby the stop button may shift the stop plunger 289.

Hydraulic detent means are provided whereby after the plunger 289 has moved a certain distance an enlarged spool 327 will move past the pressure port 328 whereby after the port is reopened it will complete a shifting movement and hold the plunger in the position shown. After the stop button has been moved out of the path of the plunger 289 the stop valve may be repositioned by hydraulic means including a control valve 329 which has a plunger 330 that is operable by a knob 331. The plunger has an annular groove 332 which is normally in a position to interconnect a port 333 leading from a port 334 located in the right hand end of the control valve 288 to an exhaust port 335. When the plunger is moved against the resistance of a spring 336 a pressure port 337 is interconnected by the annular groove 332 to the port 333 whereby fluid pressure enters the right end of the stop valve to return the plunger 289 to a start or running position.

It will be noted that the cross slide feed pinion 252 is rotatable either by the hand wheel 322 or by the pick feed piston for imparting rotation to the cross feed screw 254. An appreciable force must be applied to effect this rotation due to the weight of the parts to be moved and the friction to be overcome.

Means have been provided for reducing this force by providing a booster motor 338 which is connected by gearing 339 to the shaft 251. Fluid pressure is connected to this motor at such a pressure that the motor will exert a torque on the shaft 251 and in the proper direction to assist the rotation but which is not great enough in itself to effect actual rotation. It is, therefore, a sort of counterbalancing force which is not sufficient in itself to completely overcome the resistances involved but greatly reduces the force to be applied by the operating agencies.

Actuation of this motor is controlled by a reversing valve 340 which has ports 341 and 342 that are connected to the motor by channels 343 and 344 respectively. This valve also has a pressure port 345 supplied by line 70 and a pair of exhaust ports 346 and 347. The plunger 348 of this valve is operated by a lever 349 which is frictionally connected to the sleeve 245 that interconnects to the ratchet wheel 244 to the gear 246. A clamping bolt 351 determines the amount of friction and must be so adjusted that the lever 349 will turn with the sleeve until the plunger 348 is shifted to one of its extreme positions into engagement with either the abutment 352 or the end 353 of the valve, after which slippage takes place. Thus, the valve is always in either a forward or a reverse position, and the directional effect on the motor is in the proper direction in accordance with the direction of rotation of the shaft 251.

In the operation of the machine, the table start and stop control lever 107 shown in Figure 4 is so connected that it serves as a single control lever to perform two functions, one of bringing the grinding wheel into the work and secondly of starting the table on its traversing movement. The rest of the traversing grinding cycle is automatically performed in the manner described, the table being automatically reversed at the end of each stroke and the pick feed mechanism being automatically operated until the necessary amount of infeed has been completed at which time the pick feed mechanism is automatically stopped.

The table may be allowed to reciprocate a few more times to insure that the work is rounded up and brought to the proper size. When the operator decides that the grinding operation has been completed he merely has to rotate the hand wheel 17 the necessary amount to effect retraction of the grinding wheel approximately the amount that it was fed in by the pick feed mechanism and in so doing he stops the table traverse and effects retraction of the grinding wheel the additional amount necessary for clearance to remove the work.

The manner of starting the grinding cycle will be explained first. The control lever 107 is movable through a path which is indicated on a diagram plate 354 attached to the front of the machine as shown in Figure 7 and located right behind the lever itself.

The lever has a back position indicated by the little circle 355 which indicates that the wheel head is back or away from the work the desirable amount necessary for work clearance during loading.

The lever is pulled forward to the position indicated by the circle 356 to start the wheelhead in. This corresponds to the position of the ball handle 357 on the lever. It will be noted that the lever 107 is supported at 358 for universal movement, Figure 4. This means that the lower ball-shaped end 106 of the lever moves in an opposite direction to the handle 357. The lever may also move crosswise from the socket 105 formed in the crank 104 as shown in Figure 5 to a socket 359 formed in a crank 360 with is operatively connected as shown in Figure 6 to an infeed control valve plunger 361. When the control lever 107 is in the back position indicated by the numeral 355, the end 106 is in engagement with the socket 359 and the bell crank 360 is rotated counterclockwise from the position shown about its supporting pivot 362 to such a position that the spring pressed detent 363 engages the notch 364 and the plunger 361 is in its uppermost position in engagement with a stop screw 365.

This means that the valve plunger 361 is moved upward from the position in which it is shown in the hydraulic diagram, Figure 12, a sufficient

amount that a pressure port 366 is connected to port 367, and a second port 368 is connected to an exhaust port 369.

The ports 367 and 368 are connected by channels 370 and 371 to ports 372 and 373 located in opposite ends of a wheelhead reversing valve 374 for shifting a contained plunger 375. This valve has a pressure port 376, a pair of exhaust ports 377 and 378 and a pair of control ports 379 and 380. The port 380 is connected by a channel 381 to a cylinder 382 located in a fixed part of the bed containing a piston 383 which is integrally formed on the end of the cross slide lead screw 254. This piston has a limited advance movement controlled by a fixed positive stop 254' and effects direct axial movement of the screw 254 as well as the connected gear 253 which slides axially relatively to the elongated pinion 252. The port 379 is connected by a channel 384 to a cylinder 385 which contains a piston 386. A piston rod 387 connects the piston to a fixed part of the bed of the machine and also serves to conduct fluid pressure to the chamber 388 located on one side of the piston.

In this case the cylinder 385 is part of the moving wheelhead whereby it will become apparent that when the valve plunger 375 is to the left corresponding to the upper position of plunger 361 the pressure port 376 is connected to the cylinder 385 and the wheelhead is retracted. It will now be evident that when the operator moves the lever from the position 355 to the position 356 he effects rotation of the bell crank 360 in a clockwise direction moving the valve plunger 361 downward to the position shown in the diagram, thereby connecting pressure to port 372 which results in the plunger 375 being shifted to the right. This immediately connects pressure to channel 381 and thereby to cylinder 382 causing rapid advance of the wheelhead. This, of course, can be so adjusted that the grinding wheel is about to engage the work.

The control lever is then moved in a direction at right angles to its first direction of movement, or in other words, to the position indicated by the circle 389 on the diagram plate. This results in the end 106 of the control lever 107 moving out of the socket 359 and into the socket 105 of the bell crank 104. The bell crank 360 will be held in the position shown by the spring pressed detent 363 while the lever 107 is out of engagement therewith. The lever 107 is moved forward again to the position indicated by the numeral 390. In so doing the bell crank 104 shown in Figure 4 is rotated in a clockwise direction, thereby moving the valve plunger 92 downward to the position in which it is shown in the hydraulic diagram. This results in a shifting of the start and stop valve plunger 40 to a running position in which it is shown, whereby the table will begin its movement. It will now be apparent that the lever 107 may be utilized to bring the wheelhead into the work at a rapid rate and for starting the table.

The lever remains in this position during the grinding cycle and after the grinding cycle has been completed the operator rotates the hand wheel 17 in a return direction, retracting the grinding wheel approximately the amount that it was moved in by the pick feed mechanism and in so doing operates the control valve 340 which serves not only the purpose of causing operation of the booster pump but also has a pilot valve for controlling the position of a plunger 391 of an interlock valve 392.

This valve has a pair of control ports 393 and 394 which are connected by channels 395 and 396 to ports 397 and 398 located in the bottom of the infeed control valve and table traverse valve respectively for hydraulically shifting the plungers 361 and 92 respectively. In addition, the valve 392 has a pair of pressure ports 399 and 400 which are connectable by annular grooves in the plunger 391 to the ports 394 and 393 respectively when the plunger 391 is shifted to the left through introduction of pressure to port 401 which is branch connected to the booster motor control line 344.

The other line 343 is branch connected to port 402 located in the opposite end of valve 392 for shifting the plunger 391 to the right which is its normal position during operation of the machine.

There are also a pair of exhaust ports 403 and 404 to which the ports 393 and 394 are connected during the operating cycle whereby the plungers 92 and 361 may be freely operated.

When fluid pressure is admitted to ports 397 and 398 both valve plungers 92 and 361 move upward. The movement of plunger 361 is limited by the stop screw 365.

The upward moving plunger 92 first engages a spring pressed plunger 405 slidably mounted in screw 108 and having a head 406 which engages the inner end of the screw to limit its outward movement. The spring 407 is compressed until the plunger 92 hits the end of the screw 108. This aligns the sockets 105 and 359 whereby the lever 106 is returned to the socket 105 by spring 408. Upon a slight reverse rotation of handwheel 17 the valve 391 is shifted to the right which releases the actuating pressure from the ends of plungers 92 and 361 whereby the spring pressed plunger 405 will return the plunger 92 until the detent 109 engages.

The return positioning of these plungers stops the table by the shifting of the valve 40 and causes return movement of the cross slide because the plunger 361 in its return position connects pressure port 70 to port 367 and line 371, shifting plunger 375 of the reverse valve 374 to connect pressure port 376 to port 379.

There has thus been provided an improved transmission and control mechanism for a grinding machine having infinite rate variation for the table, selective automatic pickfeed, unitary control for starting and stopping a traverse grinding cycle, and means contributing to the ease of operation of the wheelhead slide.

What is claimed is:

1. In a grinding machine having a support, a work table and a grinding wheel slide mounted on said support for relative movement, the combination of power operable means for advancing the slide toward the table, a control element for said power operable means, a second power operable means for reciprocating the table, a control element for initiating operation of said last-named power operable means, and a single control lever for sequentially operating said control elements.

2. In a grinding machine having a support, a work supporting table and a grinding wheel slide mounted on said support, the combination of means for controlling actuation of said parts including a first control element for initiating movement of the slide, a second control element for initiating movement of the table and a single control lever for actuating said control elements in sequence whereby the slide will move toward the table and then the table will be reciprocated.

3. In a grinding machine having a bed, a work support and a grinding wheel support reciprocably mounted on the bed, the combination of fluid operable means for shifting the grinding wheel support including a reversing valve, fluid operable means for reciprocating the table including a start and stop control valve, and a single control lever operatively connected for controlling the position of both of said valves.

4. In a grinding machine having a bed, a work table, a cross slide having a grinding wheel rotatably mounted thereon, the combination of a fluid operable piston having a prescribed stroke for advancing the cross slide relative to the table, a fluid operable motor for reciprocating the work table, a source of pressure, and a single control lever operated valve means for connecting said pressure to one side of said piston to advance the slide and to effect connections to said motor to effect reciprocation of the table in a sequential manner.

5. In a grinding machine having a bed, a work supporting able and a grinding wheel support slidably mounted on the bed, said grinding wheel support carrying a rotatable grinding wheel, the combination of means for effecting sequential relative movement between the table and the grinding wheel including a fluid operable piston for moving the grinding wheel support, a source of pressure, a control valve shiftable for connecting said source of pressure to one side of said piston to effect advance of the grinding wheel support, a rotatable fluid operable motor for shifting the work table, a start and stop control valve for connecting said motor to a source of pressure, fluid operable means for shifting each of said valves in a sequential manner, and a manually operable control lever for controlling said fluid operable means.

6. In a grinding machine having a rotatable grinding wheel, and a work support movable relative thereto, the combination of a driving member for effecting said movement, a power operable train including a prime mover terminating in said member, a manually operable train terminating in said member, a control clutch in each of said trains, and power operable control means for initiating actuation of said prime mover, engagement of one of said clutches, and disengagement of the other clutch.

7. In a grinding machine having a grinding wheel and a work support, the combination with means for effecting relative movement between said parts including a fluid operable motor and a variable displacement pump for supplying said motor, of control means for effecting a major change in the displacement of said pump from a predetermined minimum to a predetermined maximum, control means for connecting said pump to said motor in a closed circuit, and a common control for said means operatively connected to set the displacement of said pump at a predetermined maximum during connection of the pump to the motor and at a predetermined minimum when the pump is disconnected from said motor.

8. In a grinding machine having a grinding wheel and a work support, the combination of means for effecting relative movement between the supports including a fluid operable motor connected to the table, a variable displacement pump for supplying fluid to said motor, a displacement control for said pump including a pair of opposed plungers, means to supply pressure to said plungers to position said control in a predetermined minimum displacement position, a start and stop control valve for connecting said pump to said motor, fluid operable means for shifting said control valve to a start position, and means for connecting pressure to said fluid operable means and to both of said fluid operable plungers to set the pump at maximum displacement during operation of the motor.

9. In a grinding machine having a grinding wheel support and a work supporting table, the combination of means for effecting relative movement between the support and table including a manually operable hand wheel, a motion transmitting train connecting said hand wheel to the table, a clutch in said train, a fluid operable motor for power driving said table, means for maintaining said clutch engaged, a variable displacement pump, a fluid shiftable valve for connecting said pump to the motor, a displacement control for the pump, a fluid operable piston normally connected to pressure for shifting said control to a minimum displacement position, a second plunger for shifting said control to a maximum displacement position, and control means for simultaneously connecting pressure to effect shifting of said valve, actuation of the second plunger and disengagement of said clutch.

10. In a grinding machine having a grinding wheel and a work support, the combination of means for effecting relative movement between said supports including a fluid operable motor, a variable displacement pump, valve means for connecting and disconnecting said motor to the pump, means simultaneously controlled by said valve means for setting said pump displacement at a maximum during connection of the motor and at a minimum during disconnection of the motor, an auxiliary valve means for connecting said motor to the pump during disconnection thereof by said first-named valve means, and means operable by the second-named valve means to set the displacement of the pump to a higher rate than that set by the first-named valve means.

11. In a grinding machine having a grinding wheel and a work support, the combination of means for effecting relative movement between the wheel and the support including a fluid operable motor, a variable displacement pump for supplying said motor, and control means for varying the displacement of said pump and thereby the rate of operation of said motor including a fluid operable piston, a cylinder containing said piston, means for maintaining balancing fluid pressures in opposite ends of said cylinder to hold the piston against movement, and a rate control valve operatively connected for changing the amounts of fluid in opposite ends of the cylinder to change the position of said piston and thereby a change in the displacement of said pump.

12. In a grinding machine having a grinding wheel and a work support, the combination of means for effecting relative movement between the wheel and the support including a fluid operable motor, a variable displacement pump for supplying said motor, and control means for varying the displacement of said pump and thereby the rate of operation of said motor including a fluid operable piston, a cylinder containing said piston, means for maintaining balancing fluid pressures in opposite ends of said cylinder to hold the piston against movement, a rate control valve operatively connected for changing the amounts of fluid in opposite ends of the cyl-

inder to change the position of said piston and thereby a change in the displacement of said pump, and means responsive to rate changes of the motor to indicate the new rate effected.

13. In a grinding machine having a grinding wheel and a work support, the combination of means for effecting relative movement between the wheel and the support including a fluid operable motor, a variable displacement pump for supplying said motor and control means for varying the displacement of said pump and thereby the rate of operation of said motor including a fluid operable piston, a cylinder containing said piston, means for maintaining balancing fluid pressures in opposite ends of said cylinder to hold the piston against movement, a rate control valve operatively connected for inversely changing the amounts of fluid in opposite ends of the cylinder to change the position of said piston and thereby change the displacement of said pump, means responsive to operation of the motor to indicate the new rate effected, and means to move the piston and cylinder as a unit to effect major changes in the rate of operation of the work support.

14. In a grinding machine having a bed, a work support and a grinding wheel support reciprocably mounted on the bed, the combination of fluid operable means for effecting relative movement between the supports including a source of pressure, a reversing valve, means connecting said pressure for shifting said valve including tarry valve means, an auxiliary control for connecting pressure to said fluid operable means to effect rapid movement of the support, and means responsive to operation of said control for bypassing said tarry valve at reversals.

15. In a grinding machine having a bed, a work support and a grinding wheel support reciprocably mounted on the bed for relative movement, the combination of a fluid operable transmission and control means for effecting said relative movement including means for effecting said movement at a variable feed rate, at a relatively fast rate, or at a relatively slow rate, automatic reversing means including tarry valves, a control for effecting said movement at said fast rate or said slow rate, and means operable by said control for rendering said tarry valves ineffective at either the fast or slow rate.

16. In a grinding machine having a bed, a work support and a grinding wheel support mounted thereon, the combination of power operable means for traversing one of said supports, rate adjusting means for determining a variable feed rate, a relatively fast rate or a relatively slow rate, reversing means, a control member therefor, trip means carried by the traversing support for rotating said member to effect actuation of said reversing means, a manually operable lever operatively connected for axially shifting said control member at will, and means responsive to movement of said member in one direction to effect said fast rate and in the other direction to effect said slow rate.

17. In a grinding machine having a bed, a work support and a grinding wheel support mounted thereon, the combination of power operable means for traversing one of said supports, rate adjusting means therefor for determining a variable feed rate, a relatively fast rate, or a relatively slow rate, reversing means, a control member, trip means carried by the traversing support for rotating said member to effect actuation of said reversing means, a manually operable lever operatively connected for axial shifting of said control member at will, means responsive to axial movement of said control member in one direction to effect said fast rate, and in the other direction to effect said slow rate, and means to latch said lever in position for effecting said slow rate.

18. In a grinding machine having a bed, a work support and a grinding wheel support reciprocably mounted on the bed, the combination of a hand wheel operatively connected for advancing and retracting the grinding wheel support, power operable means for reciprocating the work support, control means therefor including a start and stop control lever for effecting reciprocation of the work support with the grinding wheel advanced, means responsive to rotation of the hand wheel in a direction to effect retraction of the grinding wheel support to effect shifting of said control lever to a stop position, said means including a pilot valve, frictionally operated means responsive to the direction of rotation of the hand wheel for shifting said pilot valve, a source of pressure connected to said valve, and fluid operable means connectable to said source of pressure by said pilot valve for shifting said control lever.

19. In a grinding machine having a bed, a work support and a grinding wheel support reciprocably mounted thereon for relative movement, the combination of fluid operable means for shifting the grinding wheel support, fluid operable means for traversing the work support, a control lever, a first valve operable by the lever for connecting pressure to the first-named fluid operable means, a second control valve operable by said lever for connecting pressure to said table traversing means, a manually operable control connected for actuation of the grinding wheel support independent of said fluid operable means, and means responsive to rotation of said hand wheel in a retractive direction to effect shifting of said control valves to a reverse position and simultaneously cause repositioning of said control lever.

20. In a grinding machine having a work support and a grinding wheel support and power operable means for effecting a relative traversing movement between said supports including a pair of control channels, the combination with means for reversing the pressural conditions in said channels and thereby changing the direction of said traversing movement, of a pick feed mechanism including a selector valve, separate connections from said selector valve to each of said channels, a pick feed piston operatively connected for moving said wheel support, a reversing valve for the piston, a pair of throttle valves, independent connections from the selector valve to the respective throttle valves, a pair of lines extending from the reversing valve to opposite sides of said piston, means in the reversing valve for connecting said throttle valves to said pair of lines, and check valve means responsive to a rise in pressure in one of said lines after said piston has completed its stroke for connecting fluid pressure to shift said reversing valve and thereby cause retraction of said piston.

21. In a grinding machine having a work support and a grinding wheel support and power operable means for effecting a relative traversing movement between said supports including a pair of control channels, the combination with means for reversing the pressural conditions in said channels and thereby changing the direction of

said traversing movement, of a pick feed mechanism including a selector valve, separate connections from said selector valve to each of said channels, a pick feed piston operatively connected for moving said wheel support, a reversing valve for the piston, a pair of throttle valves, independent connections from the selector valve to the respective throttle valves, a pair of lines extending from the reversing valve to opposite sides of said piston, means in the reversing valve for connecting said throttle valves to said pair of lines, check valve means responsive to a rise in pressure in one of said lines after said piston has completed its stroke for connecting fluid pressure to shift said reversing valve and thereby cause retraction of said piston, and means connecting said channels to opposite ends of said reversing valve to effect initial shifting thereof upon reversal of pressural conditions in said channels.

22. In a grinding machine having a work support and a grinding wheel support and power operable means for effecting a relative traversing movement between said supports including a pair of control channels, the combination with means for reversing the pressural conditions in said channels and thereby changing the direction of said traversing movement, of a pick feed mechanism including a selector valve, separate connections from said selector valve to each of said channels, a pick feed piston operatively connected for moving said wheel support, a reversing valve for the piston, a pair of throttle valves, independent connections from the selector valve to the respective throttle valves, a pair of lines extending from the reversing valve to opposite sides of said piston, means in the reversing valve for connecting said throttle valves to said pair of lines, check valve means responsive to a rise in pressure in one of said lines after said piston has completed its stroke for connecting fluid pressure to shift said reversing valve and thereby cause retraction of said piston, means connecting said channels to opposite ends of said reversing valve to effect initial shifting thereof upon reversal of pressural conditions in said channels, and means in said selector valve for selectively disconnecting one or the other of said channels from its respective throttle valve whereby said pick feed piston will be operated on alternate changes in pressure in said channel.

23. In a grinding machine having a work support and a grinding wheel support and power operable means for effecting a relative traversing movement between said supports including a pair of control channels, the combination with means for reversing the pressural conditions in said channels and thereby changing the direction of said traversing movement, of a pick feed mechanism including a selector valve, separate connections from said selector valve to each of said channels, a pick feed piston operatively connected for moving said wheel support, a reversing valve for the piston, a pair of throttle valves, independent connections from the selector valve to the respective throttle valves, a pair of lines extending from the reversing valve to opposite sides of said piston, means in the reversing valve for connecting said throttle valves to said pair of lines, check valve means responsive to a rise in pressure in one of said lines after said piston has completed its stroke for connecting fluid pressure to shift said reversing valve and thereby cause retraction of said piston, means connecting said channels to opposite ends of said reversing valve to effect initial shifting thereof upon reversal of pressural conditions in said channels, and means in said selector valve for selectively disconnecting one or the other of said channels from its respective throttle valve whereby said pick feed piston will be operated on alternate changes in pressure in said channel, said selector valve also having another position for disconnecting both of said channels from said throttle valves to prevent operation of said pick feed mechanism.

24. In a grinding machine having a bed, a work support and a grinding wheel support mounted on said bed for relative movement, the combination of a first power operable means for advancing the grinding wheel support, a second power operable means for reciprocating the work support, a source of power and a single control lever for causing sequential connection of said source of power to each of said power operable means in the order named.

25. In a grinding machine having a bed, a work support and a grinding wheel support reciprocatably mounted on the bed, the combination of a hand wheel operatively connected for advancing and retracting the grinding wheel support, power operable means for reciprocating the work support, control means therefor including a start and stop control lever for effecting reciprocation of the work support with the grinding wheel advanced, and means responsive to rotation of the hand wheel in a direction to effect retraction of the grinding wheel support to effect shifting of said control lever to a stop position.

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