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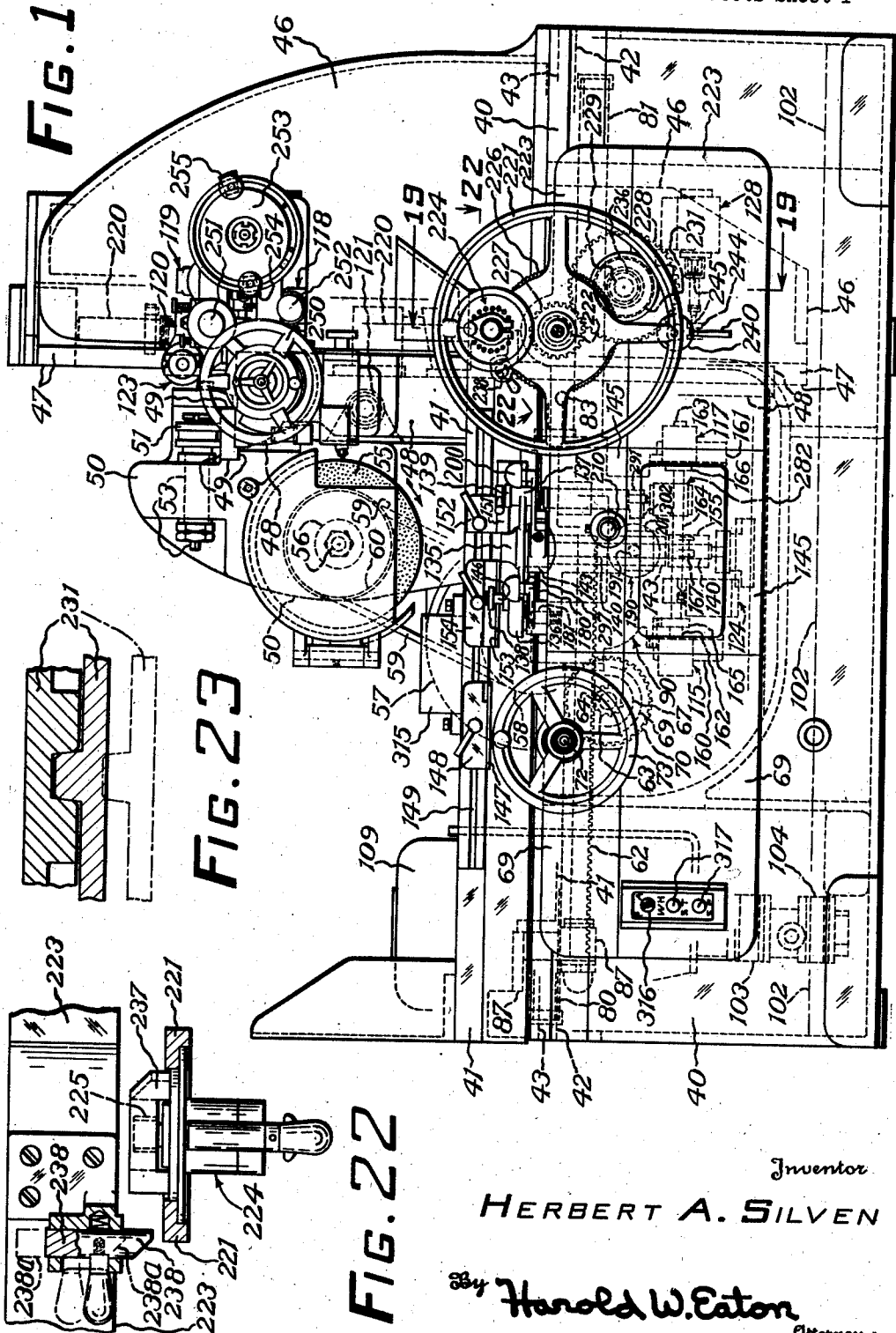
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2,296,064

SURFACE GRINDING MACHINE

Filed Oct. 14, 1941

6 Sheets-Sheet 1



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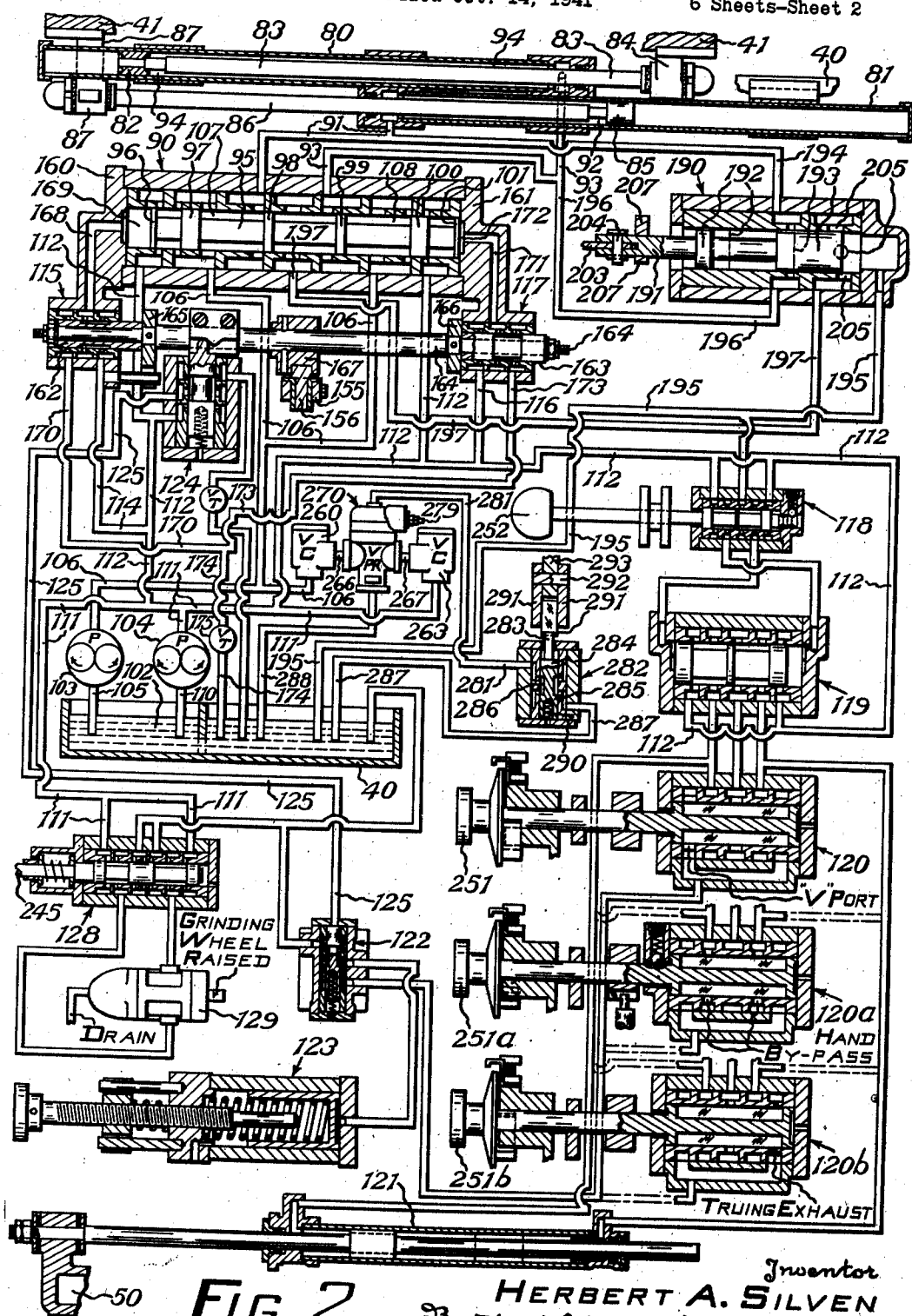
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SURFACE GRINDING MACHINE

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6 Sheets-Sheet 2



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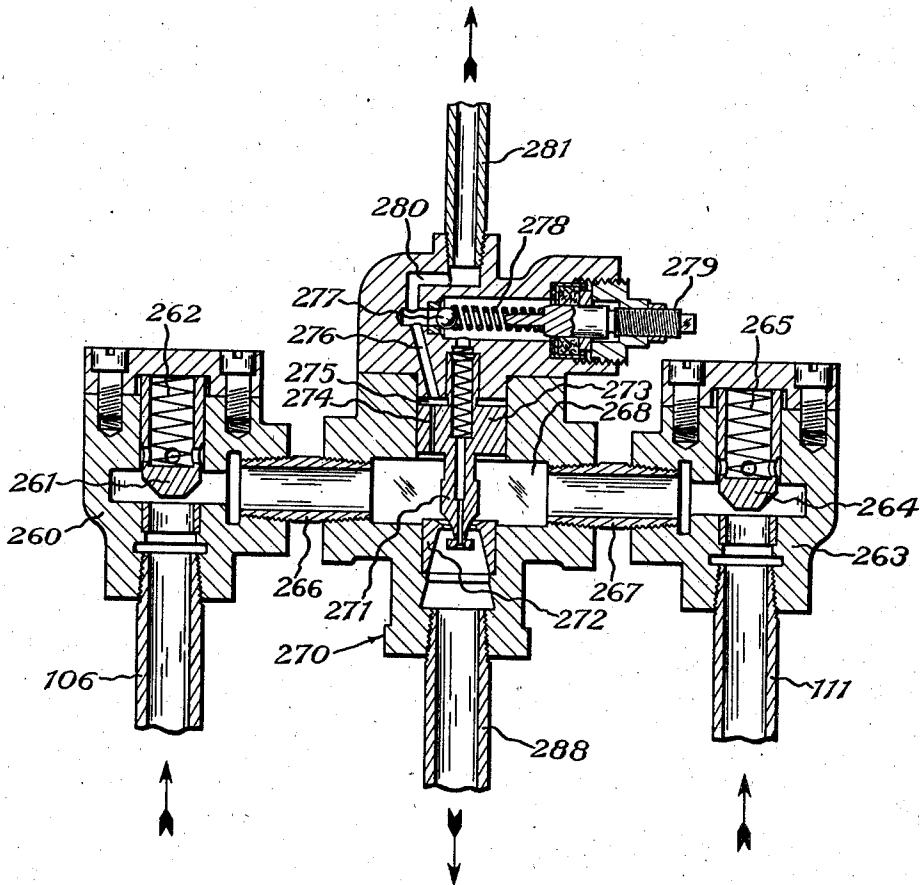
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SURFACE GRINDING MACHINE

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FIG. 3



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FIG. 4

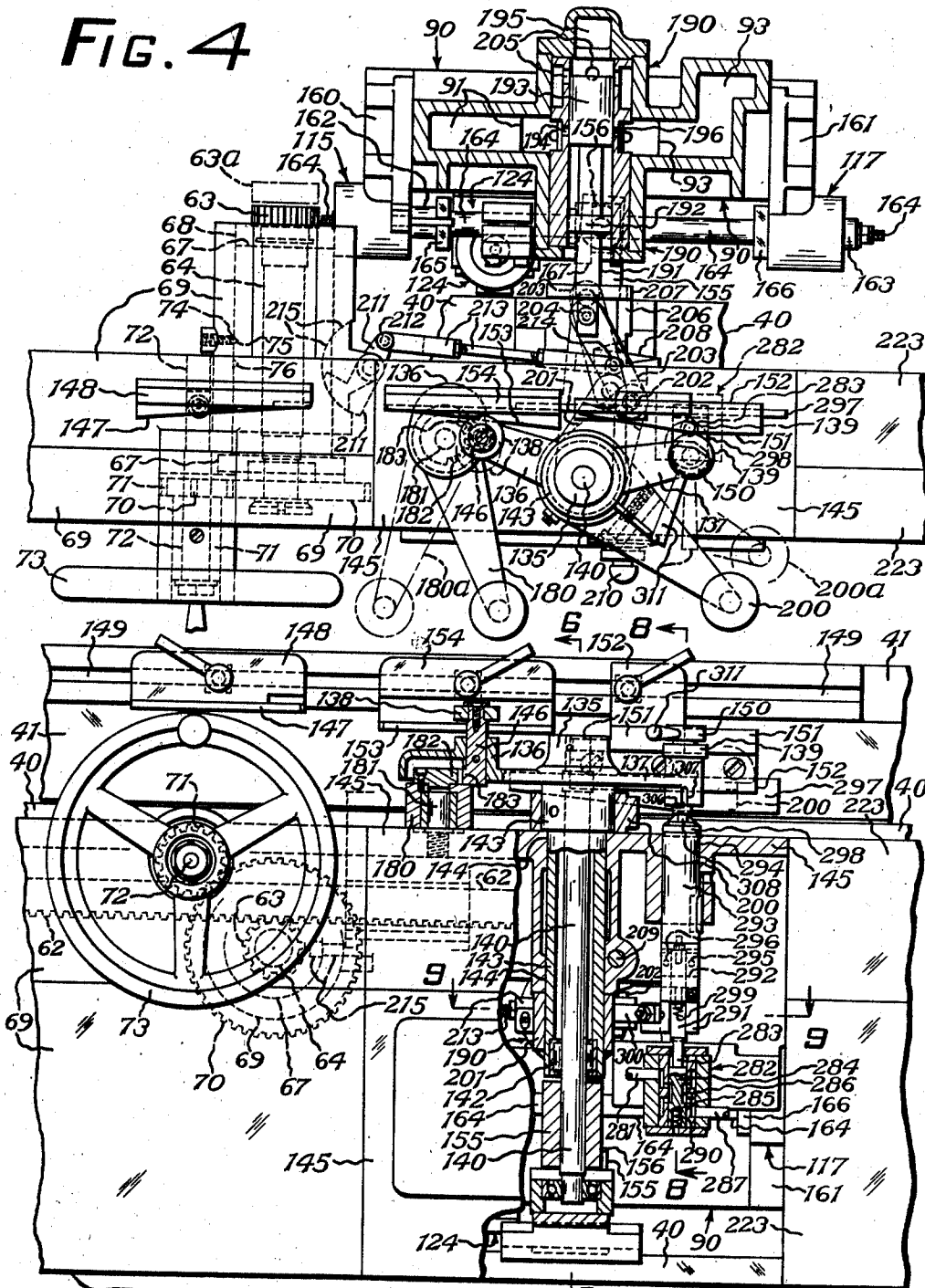


FIG. 5

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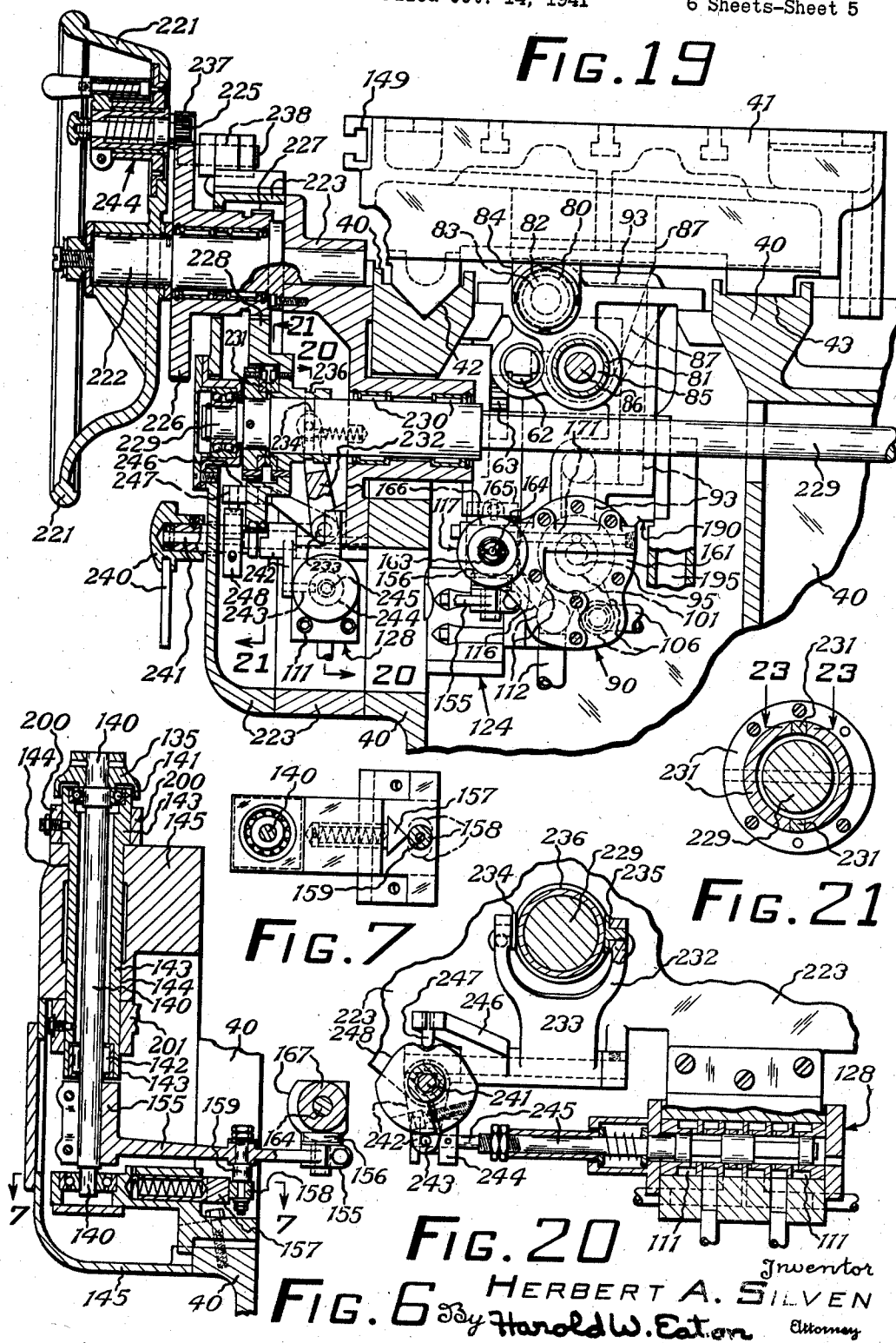
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SURFACE GRINDING MACHINE

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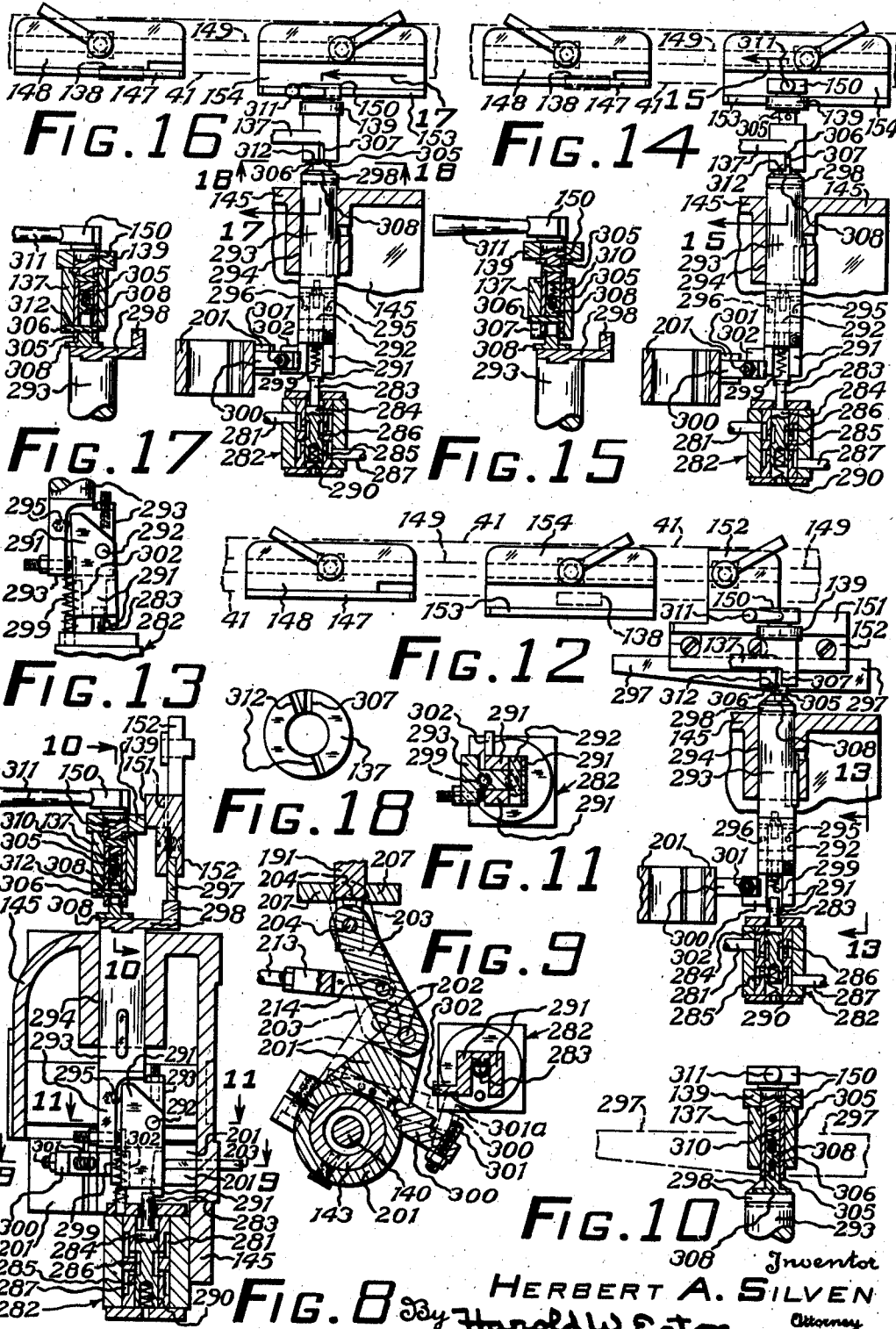
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SURFACE GRINDING MACHINE

Filed Oct. 14, 1941

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UNITED STATES PATENT OFFICE

2,296,064

SURFACE GRINDING MACHINE

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Application October 14, 1941, Serial No. 414,946

8 Claims. (Cl. 51-45)

The invention relates to grinding machines, and more particularly to a hydraulically operated surface grinding machine.

One object of the invention is to provide a thoroughly practical hydraulically controlled surface grinding machine. A further object of the invention is to provide a hydraulic surface grinding machine with a duplex fluid pump system which is arranged and controlled so that during table reciprocation both pumps supply fluid to the table cylinder. A further object of the invention is to provide a hydraulic control for a surface grinding machine having a duplex pump system, in which both pumps are automatically connected to reciprocate the table but during reversal one of the pumps is automatically connected to provide a transverse indexing movement of the grinding wheel.

Another object of the invention is to provide a fluid pressure controlled system for a surface grinding machine, in which the pressure within the system is automatically reduced substantially to zero when the machine is stopped in a loading position. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, as will be exemplified in the structure to be hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings in which is illustrated one of many possible embodiments of the mechanical features of this invention:

Fig. 1 is a front elevation of a surface grinding machine embodying the invention, showing some of the interior mechanism in dotted lines;

Fig. 2 is a fluid pressure diagram for the machine;

Fig. 3 is a vertical sectional view, on an enlarged scale, of the venting relief valve;

Fig. 4 is a fragmentary plan view, on an enlarged scale, of the table reversing mechanism, showing the stop and start valve in section and also showing the manually operable traverse mechanism;

Fig. 5 is a fragmentary front elevation, on an enlarged scale, partly in section, of the reciprocatory traverse control mechanism and also the manually operable traverse mechanism;

Fig. 6 is a fragmentary vertical cross sectional view, taken approximately on the line 6-6 of Fig. 5;

Fig. 7 is a fragmentary horizontal sectional

view taken approximately on the line 7-7 of Fig. 6;

Fig. 8 is a fragmentary vertical cross sectional view taken approximately on the line 8-8 of Fig. 5;

Fig. 9 is a fragmentary horizontal cross sectional view, on an enlarged scale, taken approximately on the line 9-9 of Figs. 5 and 8;

Fig. 10 is a fragmentary vertical cross sectional view taken approximately on the line 10-10 of Fig. 8;

Fig. 11 is a fragmentary horizontal cross sectional view taken approximately on the line 11-11 of Fig. 8;

Fig. 12 is a fragmentary front elevation similar to Fig. 5, showing the table dogs and the venting control valve in a tripped position at the loading station;

Fig. 13 is a fragmentary view, on an enlarged scale, taken approximately on the line 13-13 of Fig. 12, showing the latch for the venting control valve;

Fig. 14 is a fragmentary front elevation, on an enlarged scale, showing the table dogs and parts as positioned when the table is in the center of its reciprocatory grinding stroke;

Fig. 15 is a fragmentary sectional view, on an enlarged scale, taken approximately on the line 15-15 of Fig. 14;

Fig. 16 is a fragmentary front elevation, on an enlarged scale, of the table dogs and associated parts, showing the right-hand reversing roller depressed to allow the table to move to a loading position;

Fig. 17 is a fragmentary sectional view, on an enlarged scale, taken approximately on the line 17-17 of Fig. 16;

Fig. 18 is a fragmentary sectional view, on an enlarged scale, taken approximately on the line 18-18 of Fig. 16;

Fig. 19 is a fragmentary sectional view, on an enlarged scale, taken approximately on the line 19-19 of Fig. 1, illustrating the feeding mechanism for feeding the grinding wheel in a vertical direction;

Fig. 20 is a fragmentary sectional view, on an enlarged scale, taken approximately on the line 20-20 of Fig. 19;

Fig. 21 is a fragmentary sectional view, on an enlarged scale, taken approximately on the line 21-21 of Fig. 19, through the feed clutch;

Fig. 22 is a fragmentary sectional view, on an enlarged scale, taken approximately on the line 22-22 of Fig. 1, through a portion of the wheel feeding mechanism; and

Fig. 23 is a fragmentary sectional view, on an enlarged scale, taken approximately on the line 23—23 of Fig. 21, through a portion of the feed clutch.

A surface grinding machine has been illustrated in the drawings comprising a base 40 which supports a longitudinally reciprocable work supporting table 41 on the usual V-way 42 and flat way 43 formed on the upper surface of the base 40. The base 40 supports an upwardly projecting massive column 46 (Fig. 1) which is provided with a vertically extending slideway 47. A vertically movable slide 48 is provided with ways which mate with the slideway 47 so that the slide 48 may be moved and adjusted in a vertical direction. The vertically movable slide 48 is provided with a horizontally extending slideway 49 which serves as a support for a transversely movable wheel slide 50. In the preferred form an anti-friction support is provided for the wheel slide 50 which may comprise a plurality of anti-friction rollers 51 (only one of which is shown in Fig. 1) which are arranged at opposite ends of the wheel slide 50 and are each supported thereon by means of a shaft 53. The rollers 51 ride upon the slideway 49 and serve as an anti-friction support for the wheel slide 50.

The cross slide or wheel slide 50 serves as a support for a rotatable grinding wheel 55 which is supported at one end of a rotatable grinding wheel spindle 56. The wheel spindle 56 is journaled in suitable bearings (not shown) which are mounted in fixed relation with the wheel slide 50. The wheel spindle 56 may be driven by means of an electric motor 57 which is adjustably supported on a bracket depending from the wheel slide 50 (Fig. 1). The motor 57 is provided with a multiple V-groove pulley 58 which is connected by means of a multiple V-belt 59 with a multiple V-groove pulley 60 which is mounted on the end of the wheel spindle 56.

Hand table traverse

If desired, the work supporting table 41 may be traversed longitudinally by means of a manually operable traversing mechanism (Figs. 1, 4 and 5) comprising a rack bar 62 which extends longitudinally of and is fixedly mounted on the under side of the table 41. A gear 63 is mounted on the inner end of a rotatable shaft 64 which is journaled in suitable anti-friction bearings (not shown) which are supported within a slidably mounted sleeve 67 keyed within an aperture 68 formed integral with an apron 69 fixedly mounted on the front of the machine base 40. A gear 70 is keyed on the end of the shaft 64 (Figs. 4 and 5). The gear 70 meshes with a gear 71 which is rotatably supported on a shaft 72. The stud 72 is fixedly mounted relative to the apron 69. A manually operable traverse wheel 73 is supported to rotate with the gear 71.

The sleeve 67 is arranged for an axial sliding movement so that the gear 63 may be readily moved into or out of mesh with the rack bar 62. As illustrated in Figs. 4 and 19, the gear 63 is shown out of mesh with the rack bar 62 and is held in this position by means of a spring-pressed detent 74 (Fig. 4) carried by the apron 69 which engages a V-shaped notch 75 cut in the periphery of the sleeve 67. When it is desired to traverse the table 41 manually, the sleeve 67 is moved upwardly (Fig. 4) to shift the gear 63 from the full line position into the dotted line position 63a in mesh with the rack bar 62, in which posi-

tion a second V-notch 76 formed on the sleeve 67 is moved into engagement with the detent 74 to hold the sleeve 67 in an operative position.

During the normal grinding operation the table 41 is preferably traversed or reciprocated longitudinally by a hydraulically operated mechanism to be hereinafter described, and a hand traverse mechanism is maintained in an inoperative condition, as shown in Fig. 4, with the gear 63 out of mesh with the rack bar 62. The manual traverse mechanism, as above described, is preferably interlocked with the hydraulic table traverse mechanism so that the manual traverse mechanism is locked in an inoperative position during the power traverse of the table 41.

Hydraulic table traverse mechanism

The work table 41 is traversed or reciprocated longitudinally by means of a hydraulically operated table traverse mechanism comprising a pair of spaced parallel cylinders 80 and 81 (Fig. 2). The cylinders 80 and 81 are fixedly mounted relative to the base 40. The cylinder 80 contains a slidably mounted piston 82 which is connected by means of a piston rod 83 with a bracket 84 depending from the under side of the table 41 at its right-hand end (Fig. 2). Similarly, the cylinder 81 contains a slidably mounted piston 85 which is connected by means of a piston rod 86 with a bracket 87 depending from the under side of the table 41 at its left-hand end.

A table reversing valve 90 is provided to control the passage of fluid under pressure through a pipe 91 into a cylinder chamber 92 within the cylinder 81, or through a pipe 93 into a cylinder chamber 94 formed within the table cylinder 80. The reversing valve 90 is a piston type reversing valve comprising a valve stem 95 having formed integrally therewith the valve pistons 96, 97, 98, 99, 100 and 101.

A fluid pressure system is provided for conveying fluid under pressure to the various mechanisms of the machine, comprising a reservoir 102 (Figs. 1 and 2) which is preferably formed within the box-like base 40 of the grinding machine. A motor 109 drives a duplex fluid pressure pump comprising two independent fluid pressure pumps 103 and 104. The pump 103 is of a relatively large capacity and the pump 104 is of a relatively small capacity. The pump 103 draws fluid through a pipe 105 from the reservoir 102 and forces fluid under pressure through a pipe 106 (Fig. 19) which is connected to admit fluid under pressure to a valve chamber 107 located between the valve pistons 97 and 98 and also to a valve chamber 108 located between the valve pistons 99 and 100. Fluid under pressure entering the valve chambers 107 and 108, respectively, depending upon the position of the valve stem 95, is admitted either through the pipe 91 into the cylinder chamber 92 to cause the table 41 to move toward the right or is passed from the chamber 108, through the pipe 93, into the cylinder chamber 94 to cause the table 41 to move toward the left. The capacity of the pump 103 is utilized only to cause a reciprocatory or traversing movement of the work supporting table 41.

The smaller capacity pump 104 draws fluid from the reservoir 102, through a pipe 110, and forces fluid under pressure through a pipe 111 and a pipe 112 (Fig. 19) to the ends of the table reversing valve 90. Fluid under pressure passing through the pipe 112 is also conveyed through a

pipe 114 to a pilot valve 115 and through a pipe 116 to a pilot valve 117. Fluid under pressure passing through the pipe 112 is connected to supplement the capacity of the large pump 103 and passes into the table cylinders 81 or 80, respectively, to supplement the power supplied by the larger capacity pump 103 during the table traversing movement. Fluid under pressure passing through the pipes or passages 114 and 116 in the end caps of the reversing valve 90 (Fig. 19) into the pilot valves 115 and 117, respectively, serves during table reversal to shift the reversing valve 90 into its reverse position.

Fluid under pressure passing through the pipes 111 and 112 also passes through a manually operable reverse valve 118, a shuttle type pilot valve 119, and a control valve 120 to one end or the other of a wheel slide indexing cylinder 121. The exhaust of fluid from the grinding wheel indexing cylinder 121 is controlled by a stop and start valve 122 which controls the exhaust of fluid into a metering valve 123. The metering valve 123 serves to allow a predetermined quantity of fluid to be metered or exhausted from the cylinder 121 so as to facilitate a predetermined transverse indexing movement of the grinding wheel 55 and its supporting wheel slide 50. Fluid under pressure from the small capacity pump 104 passing through the pipes 111 and 112 enters a control valve 124 which is instantaneously opened during table reversal to pass fluid under pressure through a pipe 125 to actuate the stop and start valve 122 so as to allow the exhaust of fluid from the table indexing cylinder 121 in timed relationship with the reversal of the work table 41.

It will thus be seen that the smaller capacity pump 104 has four distinct functions, namely, to supplement the large capacity pump 103 during the longitudinal reciprocatory movement of the table 41, to shift the table reversing valve 90 into its reverse position at table reversal to supply fluid under pressure at all times either to one side or the other of the wheel slide indexing cylinder 121, and also to control the exhaust of fluid from the wheel indexing cylinder 121 so as to index the grinding wheel 55 transversely during reversal of the work supporting table 41.

The pipe 111 conveying fluid under pressure from the small capacity pump 104 passes fluid to a manually operable control valve 128 which controls the admission of fluid to a fluid motor 129 which is connected to raise or lower the wheel slide 50 so as to vary the position of the grinding wheel 55 relative to the work supporting table 41.

Reverse valve—Actuating mechanism

A reversing lever 135 (Figs. 1, 4 and 5) is mounted on the front of the machine base. The lever 135 is formed as a bell crank lever having oppositely projecting arms 133 and 137 which serve as supports for rotatably mounted rollers 138 and 139. The reversing lever 135 is fixedly mounted on the upper end of a rock shaft 140. The rock shaft 140 is arranged in a substantially vertical position and is supported in bearings 141 and 142. The bearings 141 and 142 are in turn supported in a hollow rotatable sleeve 143 which is in turn rotatably supported within an aperture 144 formed within a table reversing apron 145 which is fixedly mounted on the front of the machine base 40.

The roller 138 is rotatably mounted on the

upper end of a stud 146 which is fixedly mounted relative to the reversing lever arm 136. The roller 138 is arranged in the path of a cam face 147 formed on a table dog 148 which is adjustably supported by means of a T-slot 149 formed in the front edge of the work supporting table 41. The roller 139 is rotatably mounted on the upper end of a vertically movable stud 150 which is slidably supported within an aperture adjacent to the end of the arm 137 of the reversing lever 135. The roller 139 is shown in its lower position, in which position it lies in the path of a cam face 151 formed on a table dog 152 which stops the table movement toward the left (Figs. 1, 5 and 12) after a grinding operation has been completed, to facilitate a loading operation. When the grinding cycle is started, the roller 139 is moved upwardly into the position (Fig. 14), in which position the roller 139 lies in the path of a cam 153 formed on a table dog 154. It should be noted that the cam face 147 of the dog 148 and the cam face 153 of the dog 154 are arranged in different horizontal planes so that there is no conflict between the actuating rollers 138 and 139, respectively.

A lever 155 is adjustably fixed to the lower end of the rock shaft 140 (Fig. 6). The other end of the lever 155 supports a shoe 156 which is operatively connected in a manner to be hereinafter described to actuate the reversing valve 90.

A load and fire mechanism is provided for rapidly shifting the pilot valves 115 and 117 in opposite directions. The load and fire mechanism, as illustrated, may comprise an arrow-pointed, spring-pressed plunger 157 supported in the apron 145 which is arranged to engage a roller 158 which is in turn rotatably supported by a stud 159 carried by the lever 155 (Figs. 6 and 7). It will be readily apparent from the foregoing disclosure that when the table 41 approaches either end of its stroke, either the table dog 148 or 154 will rock the reversing lever 135 to rock the rock shaft 140 so as to rock the lever 155. During the initial rocking movement of the lever 155, the roller 158 will ride up one side of the arrow-pointed plunger 157 to compress the spring. After the roller 158 rides over the high point of the arrow point 157, the released compression of the spring will rapidly shift the arm 155 together with the rod 164 to shift the pilot valves 115 and 117 into a reverse position.

The reversing valve 90 is provided with a pair of end caps 160 and 161 which enclose the ends and are provided with downwardly projecting portions which are formed integral with the pilot valves 115 and 117. The pilot valves 115 and 117 are preferably piston type valves having slidably mounted pistons 162 and 163, respectively. The valve pistons 162 and 163 are interconnected by means of a slidably mounted rod 164 which is arranged so that the pilot valves may be simultaneously shifted by movement of the rod 164. A pair of stop collars 165 and 166 are fixedly mounted on the rod 164 and serve to limit its endwise movement. A spool 167 is fixedly mounted on the rod 164 (Fig. 2). The spool 167 is provided on its under side with a groove which mates with an upwardly extending portion of the shoe 156. It will be readily apparent from the foregoing disclosure that when the table dogs 148 and 154, through the reversing lever 135, rock the shaft 140, the rocking motion will be transmitted through the lever 155 and the shoe 156 to produce an endwise movement of the rod 164 so as to shift the pilot valves 115 and 117 to

reverse the position of the reversing valve 90.

A passage 168 is provided in the end cap 169 to connect the pilot valve 115 with an end chamber 169 formed at the left-hand end of the reversing valve 90. In the position of the pilot valve 115, fluid under pressure from the small capacity pump 104 passes through the pipe 114, through the pilot valve 115, the passage 168, into the end chamber 169 to move the reversing valve stem 95 toward the right into the position shown in Fig. 2. A pipe 170 is connected between the pilot valve 115 and the reservoir 102 to facilitate exhaust of fluid from the end chamber 169 when the pilot valve 115 is shifted into the reverse position.

Similarly, a passage 171 is provided in the end cap 161 to connect the pilot valve 117 with an end chamber 172 formed at the right-hand end of the reversing valve 90. In the position of the valve 90 shown in Fig. 2, the end chamber 172 and passage 171 are connected through the pilot valve 117 with an exhaust pipe 173 so that fluid within the chamber 172 may readily exhaust into the reservoir 102.

When the table 41 reaches the other end of its reciprocatory stroke, the table dogs 148 and 154 are arranged to rock the reversing lever 135, the rock shaft 140, and the lever 155 to move the rod 164 toward the left (Fig. 2) simultaneously to move the pilot valves 115 and 117 toward the left, which movement serves to admit fluid under pressure from the pipe 116, through the pilot valve 117, the passage 171, into the end chamber 172 to move the valve stem 95 into its reverse position. During this movement of the reversing valve 90, fluid within the chamber 169 may exhaust through the passage 168, the pilot valve 115, and the pipe 170, into the reservoir 102. The exhaust pipes 170 and 173 are connected to a common exhaust pipe 174 which passes exhaust fluid into the reservoir 102. An adjustable throttle valve 175 is provided in the exhaust pipe 174 by means of which the speed of shifting movement of the reversing valve 90 under the influence of fluid under pressure may be accurately and precisely controlled to obtain the desired table reversal.

The reversing lever 135 is normally actuated automatically in timed relation with the movement of the table 41 to control the length of its reciprocatory stroke. If desired, in setting up the machine or for certain grinding operations, the table reversing mechanism may be manually controlled. A manually operable table control lever 180 is rotatably supported by a stud 181 (Figs. 4 and 5). A gear segment 182 which is fixedly mounted on the lever 180 meshes with a gear segment 183. The gear segment 183 is formed integral with the lower end of the stud 146 which is supported adjacent to the end of the arm 136. It will be readily apparent from the foregoing disclosure that when the manually operable table control lever 180 is shifted in a clockwise direction (Fig. 4) into broken line position 180a, the gear segment 182, through the gear segment 183, shifts the reversing lever 135 in a counterclockwise direction, which movement is transmitted through the rock shaft 140 and the lever 155, manually to shift the pilot valves 115 and 117 and thereby to shift the reversing valve 90 into its reverse position. By manually shifting the control lever 180 between the full line position and the broken line position 180a (Fig. 4), the table may be manually controlled as desired.

Start and stop valve

In order readily to control the starting and stopping of a grinding cycle, a stop and start valve 190 is provided. This valve 190 is a piston type valve comprising a valve stem 191 having formed integrally therewith valve pistons 192 and 193. A pipe 194 connecting with a valve chamber located between the valve pistons 192 and 193 (Figs. 2 and 4) is connected with the pipe 91 which connects with the cylinder chamber located between the valve pistons 97 and 98 of the reversing valve 90. A pipe 195 connects the end chamber of the stop and start valve 190 with the reservoir 102 so that any fluid within these chambers may readily exhaust into the reservoir 102. A pipe 196 is connected at one end to the chamber located between the valve pistons 192 and 193 of the stop and start valve 190 and connects with the pipe 93 (Figs. 2 and 4). A pipe or passage 197 is connected between the stop and start valve 190 at one end and at the other end with the valve chamber located between the valve pistons 98 and 99 of the reversing valve 90, so that in the position illustrated in Fig. 3 a manual traverse of the table 41 is facilitated by a by-passing of fluid between the cylinders 80 and 81.

The valve stem 191 of the stop and start valve 190 is preferably manually controlled by means of a manually operable control lever 200 (Figs. 1 and 4) mounted on the front of the machine base. The lever 200 is fixedly mounted on the upper end of the rotatable sleeve 143. An arm 201 is fixedly mounted adjacent to the lower end of the sleeve 143 so that the lever 200, the sleeve 143, and the arm 201 function as a bell crank lever. The arm 201 is connected by a stud 202 with one end of a link 203. The other end of the link 203 is connected by means of a stud 204 with the valve stem 191. It will be readily apparent from the foregoing disclosure that when the lever 200 is moved in a counterclockwise direction (Fig. 4), from the full line position to the broken line position 200a, the parts will be rocked to cause an upward movement of the valve stem 191.

A plurality of ports 205 arranged in a staggered relationship are formed in the sleeve of the stop and start valve 190 and serve as a speed controlling device for the table 41, whereby the exhausting fluid from the table cylinders 80 or 81 may be readily controlled to regulate the speed of the table 41. In order to facilitate adjustment of the valve 190 to regulate the table speed, a stop mechanism is provided comprising a stop lug or pin 206 (Fig. 4) which is fixedly mounted to a flange or collar 207 carried by the valve stem 191. The stop pin 206 is arranged so that it moves in the path of a rotatably adjustable stop cam 208 (Fig. 4). The cam 208 is fixedly mounted on the inner end of a rotatable shaft 209 which is rotatably supported within the apron 145. An actuating knob 210 is mounted on the outer end of the camshaft 209 and is arranged so as to facilitate adjustment of the cam 208 to determine and adjust the speed of movement of the table 41. This mechanism has not been illustrated in detail in the present application, since it is not considered to be a part of the present invention. This speed adjusting mechanism is fully shown and described in my prior U. S. pending application Serial No. 326,224 filed March 27, 1940.

Interlock—Hand and hydraulic table traverse

It is desirable to provide an interlocking mechanism between the manually operable mechanism and the hydraulically operated table reciprocating mechanism so that the hydraulic movement of the table 41 cannot be started unless the hand traversing mechanism is in an inoperative position. The upper end of a rock arm 211 (Fig. 4) is connected by means of a stud 212 with one end of a link 213. The other end of the link 213 is connected by a stud 214 with the link 203. An arcuate slot 215 (Fig. 4) is cut through the housing surrounding the cylindrical bore 68, and into the slidably mounted sleeve 67 which supports the hand traverse mechanism for movement into and out of operative position. When the hand traverse mechanism is in an inoperative position, that is, when the gear 63 is in the full line position (Fig. 4) out of mesh with the rack bar 62, the arcuate slot 215 in the sleeve 67 is aligned with the portion of the arcuate slot 215 through the housing surrounding the sleeve 67. In this position of the hand traverse mechanism, the manually operable stop and start lever 200 may be readily operated to actuate the stop and start valve stem 191 to start a grinding cycle.

During the rearward movement of the stop and start valve 190, the link 213 is moved toward the left, which movement swings the rock arm 211 in a counterclockwise direction so that its enlarged arcuate lower portion slides out of the arcuate slot 215. The hand traverse mechanism may be manually rendered operative by sliding the gear 63 into position 63a (Fig. 4) into mesh with the rack bar 62. If the hand traverse mechanism is in an operative position, the stop and start lever 200 cannot be actuated due to the fact that the arcuate slot 215 in the sleeve 67 is out of line with the slot through the housing so that when the rock arm 211 is moved in a clockwise direction, the lower end thereof will engage the periphery of the sleeve 67 and serve as a stop to prevent shifting the stop and start valve 190 to start a grinding cycle. It will be readily apparent from the foregoing disclosure that an interlock is provided whereby the manually operable cycle stop and start valve 190 is rendered inoperative when the hand traverse mechanism is in an operative position. The hand traverse mechanism is similarly rendered inoperative when the stop and start valve is in an operative position.

Vertical feed

A feeding mechanism is provided for moving the vertically movable slide 48 to adjust the position of the grinding wheel 55 relative to the work table 41 and the work piece to be ground. This mechanism has not been illustrated in detail in the present application, since it is not considered to be a part of the present invention. For details of disclosure not contained herein, reference may be had to my pending U. S. application Serial No. 326,224 filed March 27, 1940. This feeding mechanism may comprise a nut and screw feed mechanism including a rotatable feed screw 220 (Fig. 1).

A manually operable mechanism is provided on the front of the machine base comprising a manually operable hand wheel 221 which is rotatably supported on a stud 222 which is in turn supported in an apron 223 on the front of the machine base 40 (Fig. 19). The hand wheel 221 is connected through a micrometer feed adjusting mechanism 224 by means of a pinion 225 with a gear 226 which is also rotatably supported on the

stud 222. A gear 227 is formed integral with the gear 226 and meshes with a gear 228 which is rotatably supported on a rotatable shaft 229 which is rotatably supported in bearings 230 in the apron 223 at one end. The rotatable shaft 229 is operatively connected to rotate the vertically arranged feed screw 220. Reference may be had to my prior application for a disclosure of these driving connections. A clutch 231 is connected between the shaft 229 and the gear 228, whereby the gears may be connected to or disconnected from the shaft 229. In the position of the parts illustrated in Fig. 19, the clutch 231 is shown in engagement so that a rotary motion of the hand wheel 221 will be transmitted to rotate the shaft 229 and the feed screw 220 to cause a vertical adjustment of the vertically movable slide 48.

A fluid operated mechanism is provided to supplement the operable vertical adjustment of the grinding wheel, comprising the fluid motor 129 which is operatively connected to cause a rotary movement of the feed screw 220. The starting and stopping of the fluid motor 129 (Fig. 2) is controlled by the control valve 128. It is desirable to provide a control mechanism whereby the hand wheel 221 may be rendered inoperative during a power adjustment of the vertically movable slide 48. A yoked member 232 is pivotally supported on a stud 233. The yoke 232 is provided with a pair of opposed shoes 234 and 235 which ride within a groove 236 formed in an integral hub of the gear 228 (Fig. 19). It will be readily apparent from the foregoing disclosure that when the yoke 232 is rocked in a clockwise direction (Fig. 19), the gear 228 will be slid out of mesh with the gear 227 and the clutch 231 will be disengaged, thus disconnecting the hand wheel 221 from the shaft 229.

A stop abutment 237 (Fig. 22) is provided on the micrometer feed adjusting mechanism 224 carried by the hand wheel 221 which is arranged to engage a slidably mounted stop 238 which is supported in a bracket fixed on the apron 223. If desired, the stop member 238 may be moved upwardly into position 238a (Fig. 22) so that it is out of the path of the stop abutment 237. When the stop 238 is in the full line position indicated in Fig. 22, it lies in the path of the stop abutment 237 and serves to limit the rotary motion of the hand wheel 221 to facilitate a downward adjustment of the grinding wheel 55 to a predetermined position.

A control knob 240 is mounted on the outer end of a rotatable shaft 241. The inner end of the shaft 241 supports a downwardly extending arm 242 which is connected by means of a stud 243 and a spool-shaped member 244 with a valve stem 245 which controls the fluid motor 129. The valve 128 is operatively connected so that the motor 129 may be rotated in either direction to cause an upward or downward movement of the vertically movable slide 48.

It is desirable to provide a suitable interlock between the clutch actuating yoke 232 and the control valve 128. An arm 246 is formed integral with the yoke-shaped member 232 and serves as a bell crank lever. The arm 246 is provided with a stud 247 which rides on a cam 248 which is fixedly mounted to be rotated with the control knob 240. It will be readily apparent from the foregoing disclosure that when the knob 240 is rocked either in one direction or the other to cause a vertical adjustment of the slide 48, the rotation of the cam 248 will cause an upward movement of the stud 247 to rock the bell crank lever 246—232 to disengage the clutch 231 so as to disconnect the

hand wheel 221 from the shaft 229. The rotary motion of the knob 240 in disengaging the clutch 231 will also be transmitted through the lever 242, spool 244, and valve stem 245 to actuate the control valve 128 to start the fluid motor 129 in either direction, depending upon the direction of rotation of the control knob 240.

Cross feed—Wheel slide

The transversely movable wheel slide 50 is arranged so that it may be moved transversely by means of a manually operable traversing or feeding mechanism or, if desired, the grinding wheel slide 50 may be fed transversely by an intermittently incremental movement actuated by and in timed relation with the work table reciprocation to advance the grinding wheel 55 automatically at the ends of the reciprocatory stroke of the table 41. A further transverse movement is provided whereby the wheel slide 50 may be continuously moved transversely at a slow uniform rate during a grinding wheel truing operation. These various means of traversing the grinding wheel slide transversely have not been illustrated in detail since these mechanisms are identical in construction with that shown in my prior U. S. pending application, Serial No. 326,224 filed March 27, 1940, to which reference may be had for details of disclosure not contained herein.

The grinding wheel slide 50 may be traversed longitudinally by means of a hand wheel 250 which operates a rack and gear mechanism, as in my prior application. A hydraulically operated mechanism is provided whereby an intermittent cross feed may be obtained at each table reversal, or a very slow speed for truing. The selector valve 120 (Fig. 2) is controlled by a manually operable control knob 251 (Figs. 1 and 2). The selector valve 120 has been indicated in its three positions in Fig. 2. The control valve 120 shows the valve in position to facilitate automatic transverse feeding at the ends of the table stroke. The control valve 120, as indicated in Fig. 2 as 120a, shows the valve positioned for a hand traversing operation, in which fluid may readily by-pass between opposite ends of the cross feed cylinder 121. The position of the valve 120, designated 120b (Fig. 2), shows the valve positioned for producing a slow continuous transverse movement of the grinding wheel 55 and its supporting wheel slide 50 during a grinding wheel truing operation.

The cross feed reverse control valve 118 may be actuated manually by means of a control knob 252 (Figs. 1 and 2) whereby the fluid under pressure to the opposite ends of the shuttle type reversing valve 119 may be shifted to reverse the direction of movement of the fluid to and from the cross feed cylinder 121.

In case automatic cross feed is desired at the ends of the table stroke, a rotary type reversing plate 253 (Fig. 1) is provided having a pair of adjustable dogs 254 and 255 which are operatively connected in a manner identical with that shown in my prior pending application above referred to, automatically to shift the valve 118 after the grinding wheel 55 has traversed transversely to the predetermined extent to reverse its direction of traverse. These features are not considered to be a part of the present invention and, therefore, it is not deemed necessary to illustrate the mechanisms in detail. The operation of the hydraulically operated wheel slide has, however, been illustrated diagrammatically in Fig. 2 and the controls therefor have been illustrated on the front elevation of the machine shown in Fig. 1.

Pressure relief

In order to conserve power and prevent undue heating of the oil due to "wire drawing" of the oil when the table 41 is stationary, a control mechanism is provided whereby the normal operating pressure within the system may be reduced to substantially zero by allowing fluid from the pressure pumps to pass substantially unrestricted back to the reservoir. As shown in Figs. 2 and 3, the pressure pipe 106 from the large capacity pump 103 is connected to a check valve 260. The check valve 260 is provided with a movable valve member 261 which is normally urged to a closed position by means of a spring 262. Similarly, the pressure pipe 111 from the small capacity pump 104 is operatively connected to a check valve 263 having a movable valve member 264 which is normally urged toward a closed position by means of a spring 265. The check valves 260 and 263 are connected by pipes 266 and 267, respectively, with a chamber 268 of a relief valve 270. The relief valve 270 is of a balanced pressure type, comprising a valve member 271 and a seat 272 therefor. A piston 273 is formed integral with the valve member 271. A bleeder hole 274 passes through the piston 273 and serves to allow fluid under pressure to pass therethrough into a valve chamber 275. The valve chamber 275 is connected by means of a passage 276 with a ball check valve 277 which is normally held in a seated or closed position by means of a spring 278. An adjusting screw 279 is provided for adjusting the compression of the spring 278 as desired.

In order to reduce the pressure in the fluid system of the machine to substantially zero, a venting control is provided for relieving the pressure within the valve chamber 275. The passage 276 (Fig. 3) is connected with a passage 280. The passage 280 is in turn connected by a pipe 281 with a venting control valve 282. The valve 282 is a piston type valve comprising a valve stem 283 having formed integrally therewith valve pistons 284 and 285.

In the position of the parts (Figs. 2 and 3), fluid under pressure from the relief valve chamber 268 passing through the bleeder aperture 274 into the valve chamber 275 may pass out through the passage 276, the passage 280, the venting pipe 281, into a valve chamber 286 located between the valve pistons 284 and 285 of the venting control 282, and passes out through an exhaust pipe 287 into the reservoir 102. While the venting control valve 282 remains in the position illustrated in Fig. 2, fluid pressure is admitted from the relief valve chamber 275 so that the fluid under pressure from the pumps 103 and 104 passing through the pipes 106 and 111 and through the check valves 260 and 263, respectively, causes the relief valve piston 273 to move upwardly into the position illustrated in Fig. 3 so as to raise the relief valve 271 from the seat 272 so as to allow substantially the full capacity of the fluid pumps 103 and 104 to pass outwardly through an exhaust pipe 288 into the reservoir 102.

The valve 282 is normally biased to an uppermost or closed position by means of a spring 290 which is contained within an aperture formed within the valve piston 285. The valve stem 283 may be latched in a downward or venting position by means of a pivotally mounted latch 291 which is pivotally supported by a stud 292. The stud 292 is fixedly supported on the lower end of a rod 293 which is slidably journaled within an aperture 294 formed in the apron 145. Compression

springs 295 and 296 are provided for exerting a pressure on the pivotally mounted latch 291 tending to hold it in the position shown in Fig. 8.

It is desirable that the venting valve 282 be automatically opened when the work table 41 moves into a loading position so that the pressure within the fluid system is automatically vented when the work table comes to a stopped position. In order to accomplish this desired result, a cam 297 is adjustably fixed to the loading dog 152. A follower member 298 is fixedly mounted on the upper end of the plunger 293 and is arranged in the path of the cam 297 so that when the table 41 moves toward a loading position, the cam 297 will move the follower 298 together with the plunger 293 and latch 291 downwardly to shift the valve stem 283 of the venting control valve 282 downwardly against the compression of the spring 299. Thus fluid within the relief valve chamber 275 may pass through the venting pipe 281 and the venting control valve 282 and out through the exhaust pipe 287, thus venting the system and allowing the relief valve piston 273 to move upwardly under the influence of fluid under pressure to raise the valve member 271 from the seat 272 so that substantially the full capacity of fluid under pressure from the pumps 103 and 104 may pass outwardly through the pipe 288 into the reservoir 102. This venting of the system when the table 41 is stopped in a loading position prevents wire drawing or forcing fluid through a portion of the system against unnecessary pressures.

The compression springs 295 and 296 serve normally to exert a pressure tending to hold the latch 291 in an operative position, such as that shown in Fig. 8. A compression spring 299 is interposed between the lower end of the plunger 293 and the valve 282, exerting an upward pressure on the plunger 293.

When it is desired to start the movement of the work supporting table 41, it is necessary first to close the venting control valve 282. In the preferred construction, this is accomplished by movement of the table start and stop lever 200. The arm 201 carried by the sleeve 143 is provided with an outwardly extending arm 300 which is provided with an adjustable screw 301 which is arranged to swing in the path of a lug 302 which is formed integral with and projects from the latch member 291. When the table stop and start lever 200 is moved in a counterclockwise direction into position 200a (Fig. 4), this movement swings the screw 301 into position 301a (Fig. 9) to trip the latch 291. When the latch 291 is tripped, the released compression of the spring 299 moves the valve stem 283 upwardly to close the venting control valve 282, thus preventing escape of fluid under pressure from the chamber 275 of the relief valve 270. As the pressure passes through the bleeder hole 274 into the chamber 275 of the relief valve 270, the pressure on opposite sides of the pistons 273 equalize and together with the compression of the spring contained within the upper portion of the piston 273 causes a downward movement of the piston to move the valve member 271 into engagement with its seat 272, thus closing the relief valve 270. As the pressures become equalized, the check valve members 261 and 264 are automatically closed due to the compression of the springs 262 and 265, respectively, combined with the equalized pressure within the spring chambers. The control lever 200 may then be moved from position 200a into full line position 200 (Fig. 4), which

movement serves again to open the stop and start valve 190 to start the movement of the table 41.

After a predetermined grinding operation has been completed, the roller 139 carried by the arm 137 of the reversing lever 135 may be manually depressed out of the path of the cam 153 so that on the next table stroke toward the left, the dog 154 and the cam 153 will pass by the roller 139 so that the roller 139 lies in the path of the cam 151 of the dog 152 to rock the reversing lever 135 to reverse the table reversing valve 90. The stud 150 supporting the roller 139 is arranged for a vertical movement. The lower end of the stud 150 is pinned to a slidably mounted sleeve 305 which is slidably mounted within the arm 137. A pin 306 passes through the sleeve 305 and its projecting end is arranged to slide within a slot 307 formed in the lever 137. A slidably mounted plunger 308 is supported in the lower end of the sleeve 305. The pin 306 passes through an elongated slot formed in the plunger 308. A compression spring 310 is interposed between the stud 150 and the upper portion of the stud 308 and serves normally to exert an upward pressure on the stud 150. The lower end of the stud 308 slides upon the upper surface of the cam follower member 298.

When it is desired to move the roller 139 out of the path of the cam 153 to facilitate movement of the table 41 to a loading position, a lever 311 fixedly supported on the upper end of the stud 150 is moved downwardly until the pin 306 moves out of the slot 307. The lever 311 is then rocked clockwise (Fig. 4) to position the pin 306 in engagement with a notch 312 (Figs. 16 and 18) which serves to hold the roller 139 in its lowermost position. This downward positioning movement of the roller 139 into the position shown in Fig. 16 serves to move the valve stem 283 of the venting control valve 282 downwardly but does not move it sufficiently to allow passage of fluid from the venting pipe 281 into the exhaust pipe 287. In this position of the parts, the table 41 continues its movement toward the left until the cam 297 engages the follower 298 and moves the follower together with the plunger 293 downwardly to open the venting control valve 282. This movement serves in a manner above described to open the relief valve 270 so that the parts assume the position shown in Fig. 3 to allow substantially the full capacity of the pumps 103 and 104 to exhaust through the pipe 288 into the reservoir 102.

When it is desired to again start the reciprocatory movement of the work table 41, the lever 311 is shifted to release the roller 139 from its depressed position, that is, by swinging the pin 306 into alignment with the elongated slot 307. The main control lever 200 may then be moved in a counterclockwise direction into position 200a, which movement serves to trip the latch 291 to release the compression of the spring 299 which closes the venting control valve 282. The control lever 200a is then moved in a clockwise direction into full line position 200 (Fig. 4) to open the stop and start valve 190 to start the movement of the table 41.

Operation

The operation of this machine will be readily apparent from the foregoing disclosure. Assuming a work piece 315 to have been mounted upon the table 41 for a grinding operation and the various parts including the table reversing

dogs 148 and 154 have been previously adjusted together with the loading dog 152, and the motor driven duplex fluid pumps including the large capacity pump 103 and the smaller capacity pump 104 together with the grinding wheel 55 have been set in motion by the electric control switches 316 and 317, respectively (Fig. 1), the operation may be started by manipulation of the lever 31 and the control lever 200. The control lever 200, as above explained, is first moved into position 200a to trip the venting control valve 282, which serves to close the pressure relief valve 270. The control lever 200 may then be immediately shifted in a clockwise direction into the full line position (Fig. 4) to open the stop and start valve 190, which movement starts the reciprocatory movement of the table 41.

After each reciprocation of the table 41, as controlled by the table reversing valve 90, fluid from the small capacity pump 104 is automatically diverted from the table reciprocation cylinders 80 and 81 to the indexing cylinder 121 and a measured quantity of fluid, as controlled by the metering valve 123, is allowed to exhaust from the exhaust end of the cylinder 121 to index the grinding wheel 55 transversely so as to present its operative face to a new portion of the work piece 315 on the next reciprocatory stroke. This operation is continued to effect the desired grinding operation while the grinding wheel 55 is indexed across the work piece 315 to the desired extent, after which it may be automatically reversed and indexed in the reverse direction on successive reciprocations of the table 41. If it is desired to feed the grinding wheel 55 downwardly, this may be accomplished by rotation of the manually operable feed wheel 221.

After a predetermined grinding operation has been completed, the roller 139 is depressed by movement of the lever 311 to move the roller 139 out of the path of the cam 153 on the reversing dog 154 to allow the table 41 to move toward the left into loading position so that the ground work piece 315 may be readily removed from the machine and replaced with a new piece to be ground. As the table 41 moves toward a loading position, the cam 297 engages the follower 298 to depress the plunger 293, which movement serves to depress the valve stem 283 to open the venting control valve 282, which movement serves to move the valve 271 of the relief valve 270 upwardly away from the seat 272 (Fig. 3) which allows substantially the full capacity of the fluid pumps 103 and 104 to pass directly through the exhaust pipe 288 into the reservoir 102.

After the ground work piece 315 has been removed from the table 41 and a new work piece to be ground is mounted thereon, the grinding operation may be started again by first shifting the control lever 200 to trip and close the venting control valve 282 in a manner previously described, after which the control lever 200a is shifted into the full line position 200 to position the stop and start valve 190, as illustrated in Fig. 4, which movement again starts the reciprocatory movement of the table 41.

The reciprocatory movement of the table 41 may be stopped at any time during the operation of the machine by shifting the control lever 200 from the full line position into the broken line position 200a (Fig. 4) to close the stop and start valve 190. When the lever 200 is in the position 200a, the rock arm 211 is disengaged and, if desired, the operator may push the hand traverse wheel 73 to shift the gear 63 into position 63a

into mesh with the rack bar 62 and thereafter to effect a manual traversing or adjusting movement of the work table 41 as desired.

If it is desired to adjust the position of the grinding wheel 55 vertically through a considerable distance, this may be accomplished by the fluid pressure operated lifting mechanism controlled by the knob 240. The control valve 128 may be actuated in either direction to start the fluid motor 129 to raise or lower the grinding wheel 55, as desired.

It will thus be seen that there has been provided by this invention apparatus in which the various objects hereinabove set forth together with many thoroughly practical advantages are successively achieved. As many possible embodiments may be made of the above invention and as many changes might be made in the embodiments above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a grinding machine having a longitudinally reciprocable table, a fluid pressure piston and cylinder to reciprocate said table, a fluid pressure system including a motor driven fluid pump to supply fluid under pressure to said cylinder, a reversing valve to control the admission of fluid under pressure to opposite ends of said cylinder, a pair of pilot valves supported on opposite ends of said reversing valve, each of which is arranged to control the admission to and exhaust of fluid from an end chamber in opposite ends of said reversing valve, means including a rod operatively connected to and arranged simultaneously to actuate said pilot valves, and a table actuated reversing lever operatively connected to actuate said rod to shift the pilot valve and thereby to shift the reversing valve so as to reverse the table movement.

2. In a grinding machine having a longitudinally reciprocable table, a fluid pressure piston and cylinder to reciprocate said table, a fluid pressure system therefor including a motor driven fluid pump to supply fluid under pressure to said cylinder, a reversing valve in said system, a table actuated pilot valve to control said reversing valve, a balanced type relief valve in said system normally to maintain a predetermined operating pressure in said system, and a table actuated venting valve to vent an open said relief valve automatically to reduce the pressure in said system substantially to zero when the table is stopped in an inoperative or loading position.

3. In a grinding machine having a longitudinally reciprocable table, a fluid pressure piston and cylinder to reciprocate said table, a fluid pressure system therefor including a motor driven fluid pump to supply fluid under pressure to said system, a reversing valve in said system, a table actuated pilot valve to control said reversing valve, a balanced type relief valve in said system normally to maintain a predetermined operating pressure in said system, a venting control valve operatively connected to said relief valve, and means including a table dog to actuate said venting control valve when the table moves to a loading position to vent and open said relief valve to thereby reduce the pressure in said system to zero.

4. In a grinding machine having a longitudinally reciprocable table, a fluid pressure piston and cylinder operatively connected to reciprocate said table, a fluid pressure system therefor

including a motor driven fluid pump to supply fluid under pressure to said cylinder, a reversing valve in said system, a table actuated pilot valve operatively connected to control the reversing valve, a manually operable stop and start valve in said system, a balanced type relief valve in said system normally to maintain a predetermined operating pressure in said system, a venting control valve operatively connected to vent and open said relief valve, a table dog having a cam operatively connected to actuate said reversing valve automatically to reverse the flow of fluid to said cylinder when the table reaches a loading position, and a cam on said dog to actuate said venting control valve to reduce the pressure in said system to zero to stop said table.

5. In a grinding machine having a longitudinally reciprocable table, a fluid pressure piston and cylinder to reciprocate said table, a fluid pressure system therefor including a motor driven fluid pump to supply fluid under pressure to said cylinder, a reversing valve in said system, a table actuated pilot valve to control said reversing valve, a manually operable start and stop valve in said system, a balanced type relief valve in said system normally to maintain a predetermined operating pressure in said system, a venting control valve operatively connected to vent and open said relief valve, a table dog operatively connected to actuate said reversing valve automatically to reverse the flow of fluid to said cylinder when said table reaches a loading position, said table dog being arranged simultaneously to actuate said venting control valve to reduce the pressure in said system to zero to stop the movement of the table.

6. In a grinding machine having a longitudinally reciprocable table, a fluid pressure piston and cylinder to reciprocate said table, a fluid pressure system therefor including a motor driven fluid pump to supply fluid under pressure to said cylinder, a reversing valve in said system, a balanced type relief valve in said system normally to maintain a predetermined operating pressure in said system, and a table actuated venting valve to vent and open said relief valve automatically to reduce the pressure in said system to zero, means including a latch to hold said venting control valve in an open position, and a manually operable control lever to release said latch to start the movement of said table.

7. In a grinding machine as claimed in claim 6, the combination with the parts and features therein specified, of a latch to hold said venting control valve in an open position, a manually operable lever to actuate said table start and stop valve, and means actuated by movement of said lever to release said latch so as to close the venting control valve when the table movement is started.

8. In a grinding machine as claimed in claim 6, the combination with the parts and features therein specified, of a spring actuated latch automatically to latch and hold said venting control valve when it is opened, a manually operable lever to actuate the table stop and start valve, and means actuated by movement of said lever to release said latch so as to close the venting control valve and thereby to close the relief valve before the table movement may be started.

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