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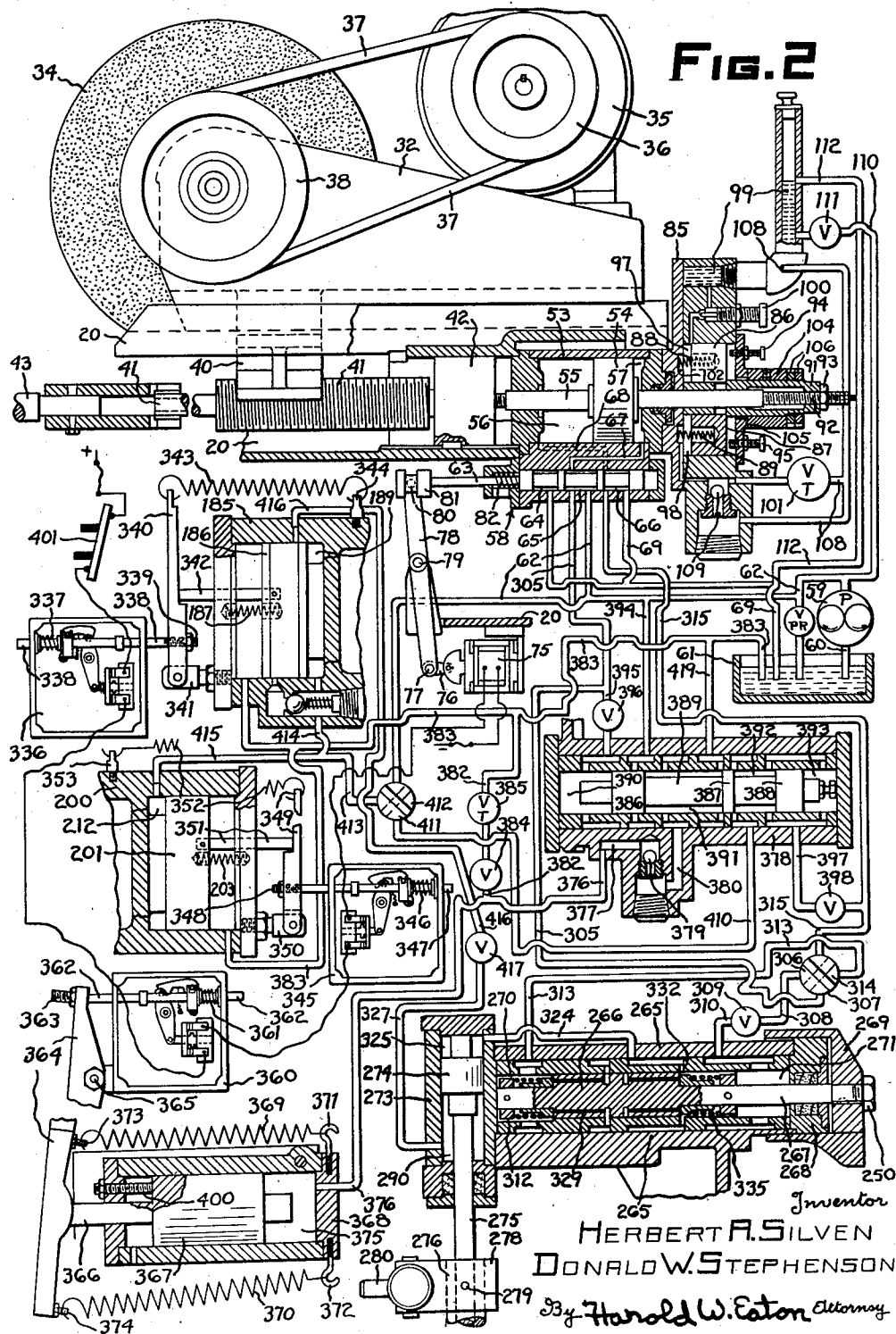
H. A. SILVEN ET AL

2,229,312

FULLY AUTOMATIC CYLINDRICAL GRINDING MACHINE

Original Filed June 1, 1939

5 Sheets-Sheet 2



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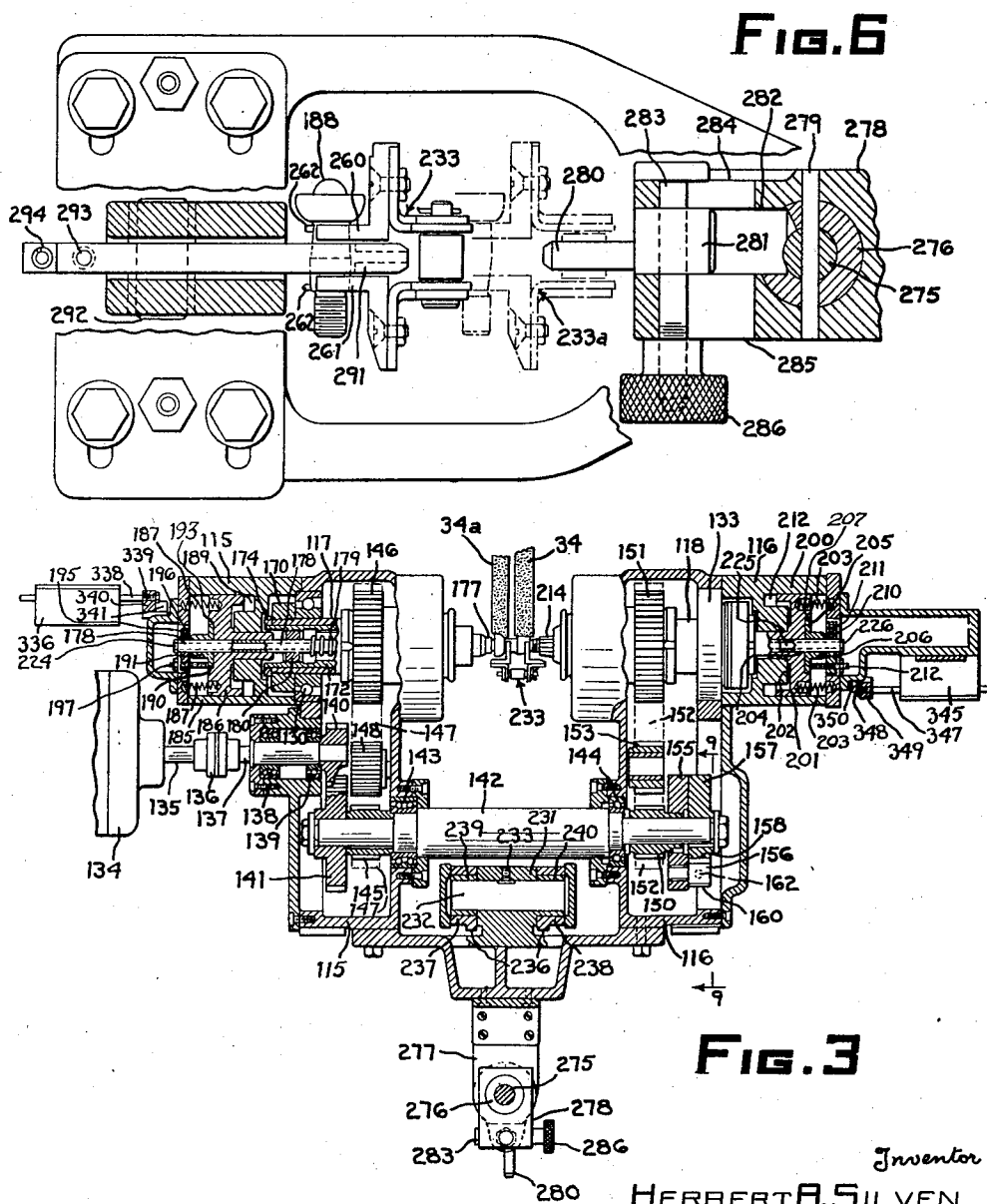
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5 Sheets-Sheet 3



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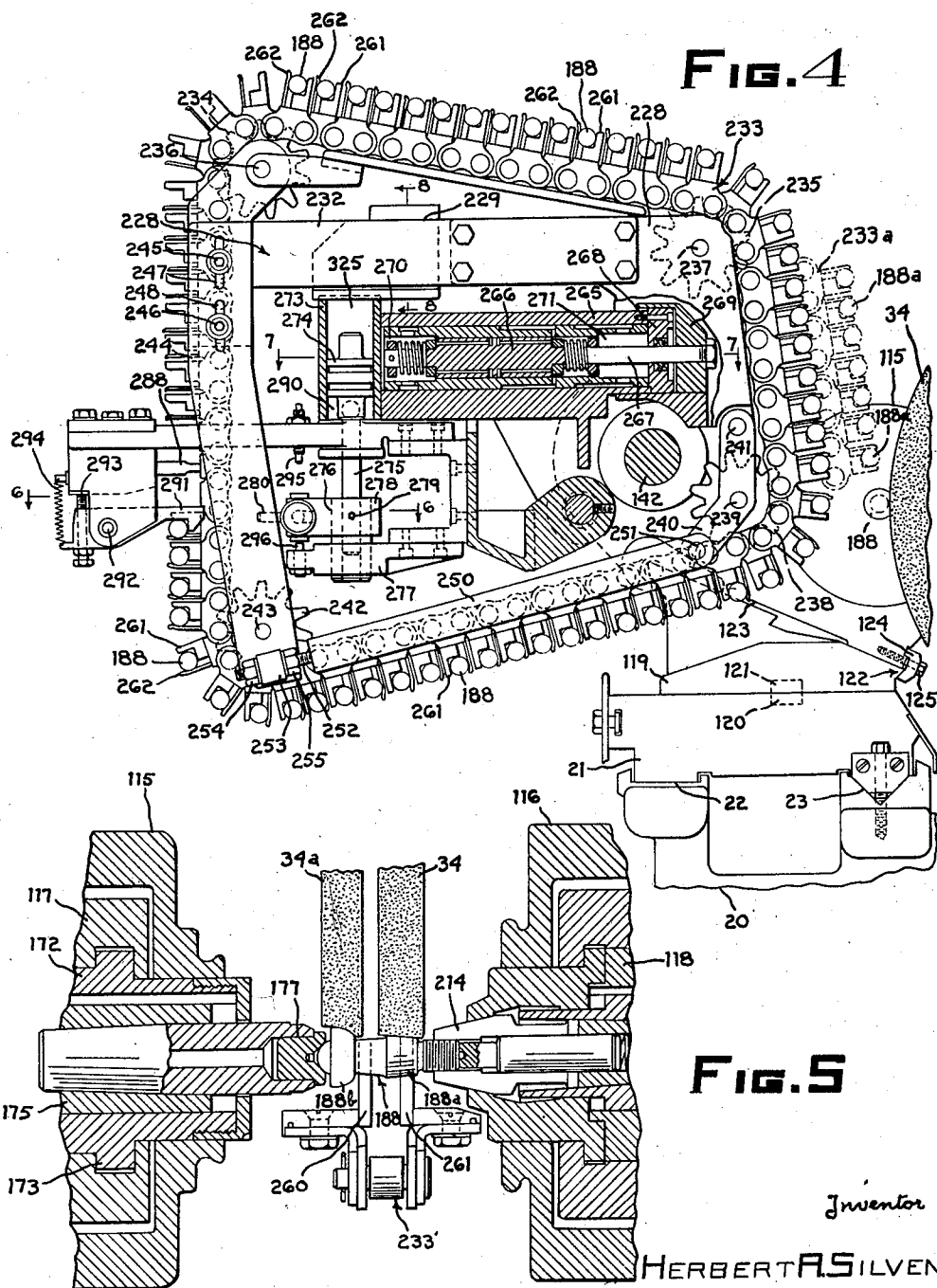
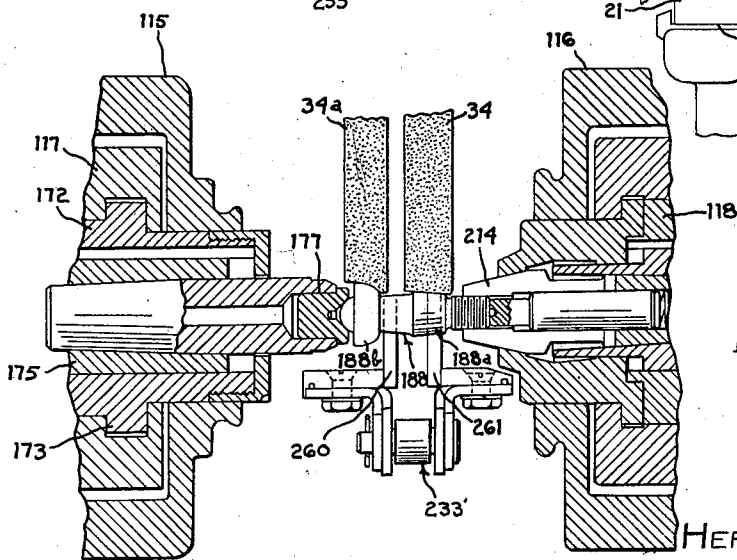
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FULLY AUTOMATIC CYLINDRICAL GRINDING MACHINE

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5 Sheets-Sheet 4



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FULLY AUTOMATIC CYLINDRICAL GRINDING MACHINE

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5 Sheets-Sheet 5

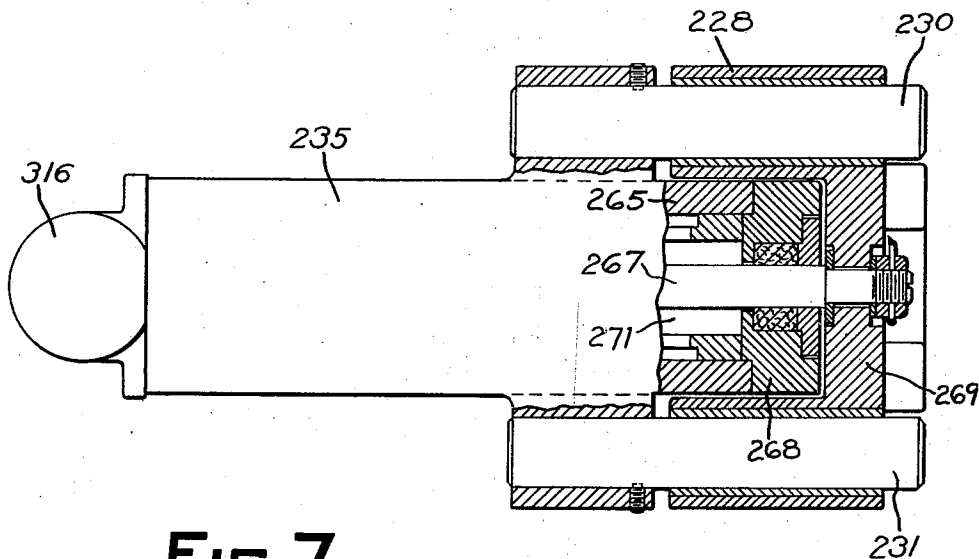


FIG. 7

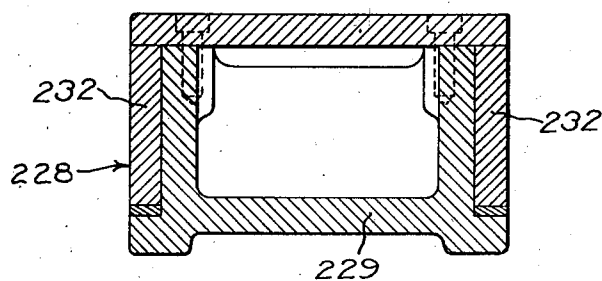


FIG. 8

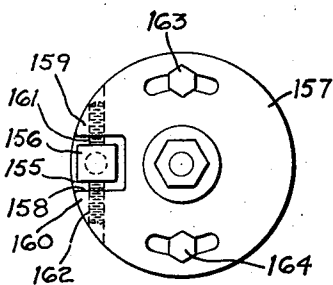


FIG. 9

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UNITED STATES PATENT OFFICE

2,229,312

FULLY AUTOMATIC CYLINDRICAL
GRINDING MACHINE

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10 Claims. (Cl. 51—105)

The invention relates to grinding machines, and more particularly to a full automatic grinding machine for grinding cylindrical work pieces.

One object of the invention is to provide a simple and thoroughly practical improved full automatic grinding machine. Another object of the invention is to provide a hydraulically actuated full automatic grinding machine in which the various mechanisms are provided with safety interlocks. A further object of the invention is to provide a full automatic hydraulically operated cylindrical grinding machine in which the various hydraulic control units are electrically interlocked.

Another object of the invention is to provide an automatic work loading mechanism or carrier which is provided with a plurality of work receiving pockets to convey unground work pieces into an operative position and to convey finish ground work pieces from a grinding position to a discharge position. A further object of the invention is to provide a transversely movable work carrier which supports a movable endless chain having a plurality of work receiving pockets or clips thereon for conveying work pieces to and from an operative position.

A further object of the invention is to provide a transversely movable work carrying apparatus having an endless chain movably supported thereon with a hydraulically operated mechanism to move said carrier transversely to and from an operative position to grip a ground work piece before the work supporting centers are withdrawn therefrom. A further object of the invention is to provide such a loading device with a hydraulically operated indexing mechanism to incrementally advance said chain each time the carrier is moved forward to grip a ground piece of work to convey an unground piece of work into operative position for the next grinding operation.

A further object of the invention is to provide an ejector mechanism which is arranged automatically to remove a finish ground work piece from the carrier chain on each forward movement of the work loading carrier. 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

shown one of various possible embodiments of the mechanical features of this invention.

Fig. 1 is a side elevation of a grinding machine embodying this invention, having a part of the base broken away to show the wheel feeding mechanism, and one of the work heads removed to more clearly illustrate the work loading mechanism;

Fig. 2 is a piping and electrical diagram showing the fluid pressure and electrical connections between the various operating units and control valves;

Fig. 3 is a horizontal sectional view through both of the work heads, taken approximately on the line 3—3 of Fig. 1;

Fig. 4 is an end elevation, on an enlarged scale, of the work loading mechanism, having parts broken away and shown in section;

Fig. 5 is a fragmentary horizontal sectional view, on an enlarged scale, through the work supporting spindles;

Fig. 6 is a fragmentary horizontal sectional view, on an enlarged scale, taken approximately on the line 6—6 of Fig. 4, showing the pin for indexing the work carrying chain and the work ejecting mechanism;

Fig. 7 is a fragmentary horizontal sectional view, on an enlarged scale, taken approximately on the line 7—7 of Fig. 4, showing the guide rod for supporting and guiding the transversely movable work carrier;

Fig. 8 is a fragmentary vertical sectional view, on an enlarged scale, taken approximately on the line 8—8 of Fig. 4, showing the guide or guideway for the transversely movable work carrier; and

Fig. 9 is a fragmentary cross sectional view, on an enlarged scale, taken approximately on the line 9—9 of Fig. 3.

A full automatic cylindrical grinding machine has been illustrated in the drawings, comprising a base 20 which supports a longitudinally adjustable table 21 on the usual flat way 22 and V-way 23. To facilitate longitudinal movement of the table 21 relative to the base 20, the table 21 is provided with a depending rack bar 24 which meshes with a gear 25. The gear 25 may be rotated in a manner similar to that disclosed in the prior United States Patent 2,117,917 to Silven dated May 17, 1938, to which reference may be had for details of disclosure not contained herein. This manual adjustment of the work supporting table 11 is merely for setting up the machine and is not considered to be a part of the present invention. Consequently, it has not been illustrated in detail.

The base 20 also supports a transversely movable grinding wheel slide 32 which is supported on the usual V-way and flat way (not shown) to facilitate a transverse adjustment or feeding movement of the slide 32 relative to the base 20. The slide 32 supports a rotatable wheel spindle 33 which in turn supports a rotatable grinding wheel 34. The wheel spindle 33 is journaled in suitable bearings (not shown) formed within the transversely movable slide 22. The grinding wheel spindle 33 may be rotated in any convenient manner such as, for example, an overhead drive shaft or a motor drive, such as an electric motor 35 mounted on the upper surface of the wheel slide 32. The motor 35 is provided with a multi-grooved driving pulley 36 which is arranged, by means of a multiple V-belt 37 to a multiple V-grooved pulley 38 mounted on the end of the wheel spindle 33, to rotate the grinding wheel 34 for a grinding operation.

The wheel slide 32 is arranged for a transverse feeding movement either manually for adjustment to compensate for wheel wear or in setting up the machine, or automatically during the automatic cycle of operation thereof. The wheel slide 32 is provided with a depending half nut 40 which meshes with or engages a rotatable cross feed screw 41 journaled in a slidably mounted bearing member 42 at one end and a bearing (not shown) at the other end. The forward end of the feed screw 41 is slidably keyed by means of a sleeve to the inner end of a rotatable shaft 43. The shaft 43 projects from the front of the machine base and is provided on its outer end with a gear 44 which meshes with a gear 45 supported on a shaft 46. A manually operable feed wheel 47 is also supported on the shaft 46 and is either formed integral with or fixedly mounted to the gear 45 so that rotation of the manually operable feed wheel 47 is transmitted through the gear 45 and the gear 44 to rotate the shaft 43 and thereby to rotate the feed screw 41 in either direction depending upon the direction of rotation of the feed wheel 47 to adjust the position of the wheel slide 32 as desired. This feed mechanism has not been illustrated in detail since it is not considered to be part of the present invention. For a more detailed disclosure of this feed mechanism, reference may be had to the U. S. patent to Silven No. 2,117,917, dated May 17, 1938 which discloses substantially the same type of feeding mechanism.

In order that the wheel slide 32 may be moved rapidly toward the work piece to grind the same automatically by the plunge-cut method, the feed screw 41 is connected through the bearing 42 with a piston rod 55. A fluid pressure cylinder 53 is arranged in axial alignment with the feed screw 41 and contains a slidably mounted piston 54 which is connected with the piston rod 55. A fluid pressure pump 59 which is driven by an electric motor or other suitable power drive serves to pump fluid through a pipe 60 from a reservoir 61 within the base 20. The pump 59 forces fluid under pressure through a pipe 62 to a main control or feed control valve 58. The main control valve 58 is preferably of a piston type comprising a valve stem 63 and a plurality of spaced pistons which form valve chambers 64, 65 and 66 therebetween. In the position of the valve 58 (Fig. 2), fluid under pressure enters the valve chamber 65 and passes out through a passage 67 into a cylinder chamber 57 to cause the piston 54 to move rapidly toward the left

(Fig. 2) to cause an infeeding movement of the wheel slide 32 and the grinding wheel 34. During the passage of fluid under pressure into the cylinder chamber 57, fluid is exhausted from a cylinder chamber 56, through a passage 68, into the valve chamber 66, and out through a pipe 69 which exhausts into the reservoir 61.

The valve stem 63 is held in a forward feeding position (Fig. 2) by means of an electric solenoid 75 which is connected by a link 76 and a stud 77 to the lower end of a pivotally mounted lever 78 supported on a stud 79. The upper end of the lever 78 is connected by a pin or stud 80 with a spool shaped member 81 mounted on the outer end of the valve stem 63. When the solenoid 75 is energized, the valve 58 is held in the position illustrated in Fig. 2. When the solenoid 75 is deenergized, the released compression of a spring 82 within the end of the valve casing serves to move the valve 58 quickly toward the right (Fig. 2) to reverse the position of the valve and to reverse the flow of fluid to and from the chambers 56 and 57 of the cylinder 53. The electrical apparatus for controlling the solenoid 75 will be described hereinafter.

Dash pot

The piston 54 and cylinder 53 mechanism, above described, serves to cause the grinding wheel 34 rapidly to approach or recede from the work piece. In order to reduce the rapid approaching movement to a predetermined grinding feed, it is desirable to provide a wheel feed regulator or controlling mechanism, such as a dash pot mechanism, which may be rendered effective when the grinding wheel 34 is about to contact with the surface of the work piece being ground. As illustrated in Fig. 2, an outwardly projecting casing 85 is fixed to the head of the cylinder 53 and contains a pair of diametrically spaced dash pot pistons 86 and 87. The dash pot pistons 86 and 87 normally are held in a rearward position by springs 88 and 89, respectively. During the rapid approach of the grinding wheel 34, the dash pot pistons are inoperative.

The piston rod 55 extends toward the rear of the machine and is provided at its outer end with a sleeve 91 which may be adjusted longitudinally on a threaded portion 92 on the piston rod 55 and locked in adjusted position thereon by a lock nut 93. The parts are so arranged that the sleeve 91 moves rearwardly when the piston rod 55 moves toward the rear. The dash pot pistons 86 and 87 are limited in their rearward movement by means of adjusting screws 94 and 95, respectively. When fluid under pressure is admitted to the cylinder chamber 57 to cause the grinding wheel 34 to move toward the work piece, the rapid approaching movement thereof continues until the end of the sleeve 91 engages the ends of the dash pot pistons 86 and 87, respectively. The continued movement of the piston 54 toward the left (Fig. 2) is resisted by the dash pot pistons 86 and 87, respectively, which force fluid under pressure from the dash pot chambers 97 and 98 into a reservoir 99. The dash pot chambers 97 and 98 are preferably interconnected with each other by the groove 102 and are arranged to exhaust fluid therefrom either through a needle valve 100 or an adjustable throttle valve 101 into the reservoir 99.

Positive stop

In order to grind a work piece to a predetermined size, it is necessary to feed the grinding

wheel 34 toward the work piece to grind the same and then to stop the infeed and allow the grinding wheel 34 to grind out or to allow the sparks to die out in order to round up the work so that it will be ground to a true cylindrical surface of a predetermined size. As illustrated in Fig. 2, the forward movement of the piston rod 55 causes a rapid approach until the sleeve 91 picks up the dash pot pistons 86 and 87 to cause a slow infeed which continues until an adjustable sleeve 104 engages a fixed surface 105 on the rear of the casing 85, thereby positively limiting the infeeding movement of the grinding wheel 34 and causing the wheel to dwell in contact with the work during the finish grinding period. The adjustable stop sleeve 104 surrounds the sleeve 91 and is held in adjusted position thereon by means of lock nuts 106.

The throttle valve 101 is connected by a pipe 108 with the reservoir 99. The pipe 108 also connects the reservoir 99 to a ball check valve 109 which remains closed during the forward feeding movement of the grinding wheel but which is opened upon the rearward movement of the grinding wheel 34 as the dash pot pistons 86 and 87 move to a rearward position to allow quick return of fluid to the dash pot chambers 97 and 98, respectively.

The dash pot mechanism is normally an independent fluid mechanism during the normal operation of the machine. In order readily to fill the reservoir 99 to maintain the desired quantity of fluid therein, a pipe 110 is connected between the pump 59 and reservoir 99. A valve 111 is located in the pipe 110 to control the flow of fluid through the pipe 110. An overflow pipe 112 is connected between the vertically extending portion of the reservoir 99 and the main reservoir 61 within the base 20 of the machine so that in case the fluid within the reservoir 99 rises above a desired level, the excess fluid will return directly to the reservoir within the base of the machine. Ordinarily the valve 111 is merely opened when it is desired to fill the reservoir 99 and then remains closed during the normal operation of the machine. If desired, however, in order to insure the fluid level within the reservoir 99 at all times, the valve 111 may be opened partially so that there will be a continuous flow of fluid into the reservoir 99, and in this case the overflow pipe 112 serves to prevent the fluid level rising above the desired point.

Work supporting and rotating mechanism

In order to grind the entire peripheral surface of a work piece automatically, it is desirable to provide means for supporting and driving the opposite ends of the work piece to center and support the work piece as well as to rotate it during the grinding operation. In the construction illustrated (Figs. 3 and 5), a pair of spaced work supporting heads 115 and 116 are mounted on a swivel table 119 which is provided on the work supporting table 21. The work heads 115 and 116 rotatably support a pair of aligned work supporting and rotating spindles 117 and 118, respectively.

The table 21 is provided with the usual swivel table 119 which is arranged to pivot on a central stud 120 set in the table 21 and projecting into a corresponding shaped aperture 121 in the swivel table 119. The upper surface of the swivel table 119 is formed with a dovetailed surface 122. The work head 115 is provided with a dovetailed surface 123 which mates with the surface 122 on

the swivel table 119. A clamping block 124 held in position on the work head 115 by a clamping screw 125 serves securely to lock the head 115 in position thereon. Similarly, the head 116 is provided with a dovetailed surface which mates with the surface on the swivel table 119, and a clamping block and clamping screw (not shown) securely clamp the work head 116 in position on the swivel table 119.

The spindles 117 and 118 are provided with a suitable driving mechanism so that they may be rotated in synchronism with each other so as to provide a uniform timed driving of opposite ends of the work piece. In the construction illustrated an electric motor 134 is mounted on the left-hand end of the swivel table 119. The motor 134 is provided with a motor shaft 135 which is connected by a coupling 136 with a rotatable shaft 137 journaled in bearings 138 and 139 in the head 115. The shaft 137 carries at its inner end a gear 140 which meshes with a gear 141 mounted on the end of a rotatable shaft 142. One end of the rotatable shaft 142 is journaled in a bearing 143 in the head 115 and the other end of the shaft 142 is journaled in a bearing 144 in the head 116. The shaft 142 is connected to simultaneously rotate the spindles 117 and 118, respectively. A sprocket 145 is keyed on the left-hand end of the shaft 142 (Fig. 3) and is connected with a sprocket 146 on the work spindle 117 by means of a link chain 147. An adjustably mounted idler sprocket 148 serves to take up any lost motion in the chain 147 and to maintain the chain in the desired driving tension.

Similarly, the other end of the shaft 142 is provided with a sprocket 150 which is connected with a sprocket 151 mounted on the rotatable work spindle 118 by means of a link chain 152. An idler sprocket 153 serves to tension the link chain 152 as desired. By means of this driving mechanism, the work supporting and rotating spindles 117 and 118 may be rotated in synchronism with each other.

It is desirable to provide a suitable adjustment in the driving mechanism so that the two spindles having specially shaped work supporting and driving centers may be timed accurately with each other and thereafter rotated in absolute synchronism with each other. To accomplish this result, the sprocket 150 is not fixed to the shaft 142 but is rotatably supported thereon. A plate 155 is mounted on and fixed to a hub projecting from the sprocket 150. The plate 155 supports a driving stud 156 which is arranged to drive a plate 157 which is fixedly fastened to the end of the drive shaft 142. The plate 157 is provided with a cut-out portion 158 which is of sufficient size and width to allow freedom of movement and adjustment of the stud 156 carried by the plate 155. A pair of opposed adjusting screws 161 and 162 which are carried by the projections 159 and 160, respectively, on the plate 157 serve to engage opposite sides of a squared end portion of the stud 156. By slacking off on one of the screws 161 or 162 and tightening the other screw, the plate 151 may be adjusted angularly relative to the plate 117 so as to time the work supporting spindle 118 in the desired relationship with the work supporting spindle 117.

In order to clamp or lock the plates 155 and 157 in adjusted position, a pair of clamping screws 163 and 164 are provided. These screws pass through elongated slots in the plates 157 and are screw threaded into the plate 155 so that the two plates may be rigidly locked in adjusted position

when desired, thus permitting timing of the work spindles.

Work spindles

5 The two aligned opposed work supporting heads 115 and 116 are substantially identical in construction, the only difference being that one is a right-hand head and the other a left-hand head. Consequently, only one of these heads has been
10 shown in detail in cross section. It should be understood, therefore, that the right-hand head (Fig. 3) is identical in construction and description with that described and illustrated in connection with the left-hand head. A collar 170 is
15 threaded onto the end of the spindle 117 and contains a plurality of spaced symmetrically arranged springs (not shown) which are arranged automatically to apply a tension to the parts of the antifriction ball bearing 130 so that lost motion between the bearing parts is taken up at all
20 times during the operation of the machine.

For convenience of assembly and manufacture, the spindle 117 is formed in two parts comprising the outer part 117 and an inner sleeve
25 172 (Fig. 5) which has a flange 173 engaging a correspondingly shaped aperture in the spindle 117. The other end of the sleeve 172 is threaded and a collar 174 fitted thereon serves to lock the spindle 117 and sleeve 172 so that they rotate
30 together. A sleeve 175 is slidably keyed within the sleeve 172 by means of a key (not shown). The outer end of the sleeve 175 is provided with a tapered aperture (Figure 5) adapted to receive the tapered portion of a work supporting and driving center 177. The center 177,
35 as illustrated in Fig. 5, is a female center which is adapted to support and grip a partial spherical surface on the end of a work piece. A sleeve 178 within the sleeve 175 serves to support a
40 spring 179. The spring 179 is located between a flange on the sleeve 178 and a collar 180 which is screw threaded within the sleeve 172. The compression of the spring 179 serves normally to hold the work supporting and driving center
45 177 and its supporting sleeve 175 toward the right (Fig. 3) into a driving position, as illustrated therein.

A fluid pressure cylinder 185 is formed either integral or fixedly mounted on the end of the
50 work head 115. The cylinder 185 contains a piston 186 which is slidably mounted therein and is normally held in a position toward the right (Fig. 3) by two springs 187 to aid in moving and holding the work supporting center 177 in a direction
55 toward the right to support and drive a work piece 188 having a frusto-conical surface 188a and a partial spherical surface 188b which are simultaneously ground to a predetermined size by spaced grinding wheels 34 and 34a, respectively.
60

To retract the center 177, fluid under pressure may be admitted to a cylinder chamber 189 within the cylinder 185, which serves to cause the sleeve 175 to be moved toward the left (Fig. 3)
65 against the compression of the springs 187.

The piston 186 is preferably connected with the sleeve 178 by a lost motion connection, such as by means of a flange 190 which is provided with an integral hub that is connected to the sleeve 178 by a screw having a cylindrical end
70 portion thereon engaging an elongated slot in the sleeve 178. The flange 190 is positioned within a recessed portion in the left-hand end of the piston 186 and is located between the bottom of the recess 193 (Fig. 3) and a plate (not
75

shown) which is fastened on the end of the piston 186. A collar 195 is fastened on the end of the sleeve 178 by means of a screw 196. The collar 195 is provided with an adjusting screw
5 197 which is arranged parallel with the sleeve 178 and which serves to adjust the amount of lost motion between the piston 186 and the flange 190. The piston 186 is arranged so that the sleeve 178 rotates therewithin and the lost motion connection between the piston and the sleeve
10 178 serves to allow the spindle to be rotated and the sleeve 178 to rotate freely without any friction between the flange 190 and the piston 186. The springs 187 serve normally to hold the piston 186 in the position illustrated in Fig. 15
3, that is, in a position toward the right, bearing against a thrust surface which is formed at one end of the cylinder 185. This work head construction is identical with that shown in the prior U. S. patent to Silven No. 2,117,917 and
20 consequently has not been shown in detail herein 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 the above-mentioned prior patent.
25

It will be readily apparent from the foregoing disclosure that the slidably mounted sleeve 175 within the work supporting spindle 117 is normally held in a position toward the right, that is, in operative position to support and drive
30 work piece 188 by means of the spring 179. The piston 186 is normally held in a position toward the right against the thrust surface at the end of the cylinder 185 by means of the springs 187. When it is desired to retract the center after
35 a work piece 188 has been ground, fluid under pressure is admitted to the cylinder chamber 189 to move the piston 186 toward the left against the compression of the springs 187 and to retract the sleeve 175 toward the left against the compression of the spring 179 to withdraw the work
40 supporting and rotating center 177 to an inoperative position. The fluid pressure system for controlling the admission of fluid to the cylinder 185 will be hereinafter described.
45

Similarly, the right-hand head 116 (Fig. 3) is provided with a spindle and sleeve construction identical with that above described in connection with the left-hand head 115. The right-hand head 116 is provided with a cylinder 200
50 having a piston 201 slidably mounted therein. The piston 201 is normally held in the position illustrated in Fig. 3, up against a thrust surface 202 (Fig. 3), formed at the inner end of the cylinder 200 by means of two springs 203. A lost
55 motion connection is provided to connect the piston 201 to a sleeve 204 within the spindle 118. This lost motion connection comprises a flange 205 having a hub 206 formed integral therewith. The flange 205 is located within a
60 recess within the end of the piston 201 and the flange 205 is located between the bottom of the recess and a plate (not shown) partially covering the end of the recess 207 (Fig. 3). The hub 206 is provided with a screw which has an inwardly projecting portion sliding within an elongated slot in the sleeve 204. A collar 210 is fixedly
65 mounted on the end of the sleeve 204 by means of a screw 211 and is provided with an adjusting screw 212 arranged to engage the flange 205 and adjust the position of the flange 205 relative to the sleeve 204 and thereby adjust the amount of lost motion between the flange 205 and the piston 201.
70

The spindle 118 is provided with an inner
75

longitudinally slidable sleeve similar to the sleeve 175 in the work head 115, which in turn supports a work supporting and rotating center 214. The center 214 (Fig. 5) is preferably a hollow collet which has a center aperture to engage and support a threaded portion on the work piece 188. The spindle 118 is rotatably supported by an anti-friction ball bearing, similar to bearing 130 in the work head 115, and the take-up for lost motion is the same. The centers 177 and 214 are shaped and arranged to grip, support and rotate the work piece to be ground.

While specially shaped centers 177 and 214 have been illustrated for supporting a partial spherical end surface and a threaded end portion, respectively, of the work piece 188, it should be understood that the shape and type of work supporting center utilized is determined by the shape of the ends of the work piece being ground. Any suitably shaped centers may be employed to center, support, and drivingly rotate the work piece.

Work loading device

In a machine of this type, in order to make it fully automatic in its cycle of operation, it is desirable to provide a work feeding and discharging mechanism for automatically conveying successive work pieces into alignment with the opposed work supporting and rotating centers 177 and 214, respectively, and similarly to convey work pieces therefrom to a discharge position after a grinding operation has been completed thereon. In order to reduce the idle time of the machine during the loading and unloading operation, it is desirable to provide a work loading device whereby a continuous succession of unground work pieces are arranged in close spaced relationship with each other whereby a new unground work piece 188 is in close proximity to the work centers when a ground work piece has been released therefrom, so that a slight movement of the loading apparatus will shift an unground work piece into alignment with the centers, thus loading and unloading the machine in a single movement of the work loading device.

In the construction illustrated, a work loading device is provided comprising a transversely movable work carrier frame 228 which is slidably supported by a guide block 229 and a pair of spaced parallel slide rods 230 and 231 (Fig. 7). The guide block 229 is of a substantially H-shaped cross-sectional area (Fig. 8). A pair of spaced parallel bars 232 which are formed as an integral part of the frame 228 engage and slide within the slide surfaces of the block 229.

The work carrier frame 228 serves as a support for a movable work conveyor which preferably comprises a continuous link chain 233 which is supported by a plurality of rotatable sprockets 234 and 235 supported on studs 236 and 237, respectively, which are carried by the transversely movable work carrier frame 228. A sprocket 238 is rotatably supported on a stud 239 which is in turn supported by a bell crank lever 240. The upper end of the bell crank lever is pivotally connected by means of a stud 241 with the transversely movable work loader frame 228 (Fig. 4).

A sprocket 242 is rotatably supported on a stud 243 which is in turn carried by a vertically adjustable supporting member 244 which is adjustably supported on the frame 228. Clamping screws 245 and 246 pass through elongated slots 247 and 248 in the vertically adjustable member

244 and are screw threaded into the transversely movable frame 228. The bell crank lever 240 is connected to a lever 250 by means of a stud 251. The other end of the link 250 is provided with an integral threaded portion 252 which passes through an aperture formed in a boss 253 which is either formed integral with or fixedly mounted on a vertically adjustable member 244. Clamping nuts 254 and 255 are provided on the threaded portion 252 and are arranged on opposite sides of the boss 253. It will be readily apparent from the foregoing disclosure that the link chain 233 passes around the four spaced rotatable sprockets 234, 235, 238 and 242, respectively, and may be readily tensioned as desired by vertically adjusting the vertically adjustable member 244 relative to the transversely movable carrier frame 228, and also by adjusting the nuts 254 and 255 to vary the effective length of the lever 250.

Each of the links of the chain 233 is provided with a work receiving pocket or clip comprising a pair of spaced work supporting members 260 and 261 (Figs. 5 and 6) which are shaped to support the workpiece 188 so that when it is presented in a position between the work supporting and gripping centers 177 and 214, the axis of the work piece 188 will be in substantial alignment with the axes of the work supporting and rotating spindles 117 and 118, respectively. As illustrated in Fig. 5 of the drawings, the work supporting member 260 engages and supports the neck or small diameter portion of the work piece 188 and the supporting member 261 engages and supports the frusto-conical portion of the work piece as it is conveyed to and from an operating position. A pair of springs 262 (Figs. 4 and 6) which are arranged in spaced relationship with the members 260 and 261 serve to hold a work piece in position on supporting members 260 and 261 of the link chain 233. By providing a work clip or pocket on each link of the chain 233, the work pieces 188 are arranged in close relationship with each other so that only a slight movement of the chain 233 is required to index the ground piece of work away from the centers and to present a new work piece in alignment therewith.

The work loader frame 228 is preferably moved transversely to an operating position to place a work piece in position in supporting engagement with the work gripping centers 177 and 214 and is then moved transversely to an inoperative position during the grinding operation. This transverse movement of the work loading device is preferably hydraulically actuated by a mechanism comprising a fluid pressure cylinder 265. A piston 266 is slidably mounted within the cylinder 265 and has a piston rod 267 formed integral therewith. The piston rod 267 passes through a cylinder head 268 having a fluid tight packing which serves as a partial bearing support for the piston rod 267. The end of the piston rod is connected to a portion 269 of the transversely movable work carrier member 228. The cylinder 265 is either formed integral with or fixedly mounted on a bracket which is fixedly supported on the work heads 115 and 116. When fluid under pressure is admitted to a cylinder chamber 270, the piston 266 is caused to move toward the right (Fig. 4) to cause a forward movement of the transversely movable work carrying device 228 so that the parts move into a broken line position with the work piece 188 assuming the position 188a so that the work piece

188 is moved into axial alignment with the work supporting centers 177 and 214. Similarly, when fluid under pressure is admitted to the cylinder chamber 271, the work carrier frame 228 is moved toward the left (Fig. 4) to move the link chain 233 and the work supporting clips into the full line position as indicated in Fig. 4.

An indexing mechanism is provided automatically to index the link chain 233 to shift an unground piece of work from an operative position after the work centers 177 and 214 have withdrawn and to present an unground work piece in position in alignment with the centers for the next grinding operation. This mechanism preferably comprises an hydraulically operated indexing mechanism comprising a fluid pressure cylinder 273 having slidably mounted therein a piston 274. The piston 274 is connected to or formed integral with one end of a piston rod 275 which, as illustrated, extends in a substantially vertical direction. A sleeve 276 is supported on the lower end of the piston rod 275 and the sleeve 276 is slidably mounted within a bracket 277 (Fig. 4) which is fixedly mounted to the stationary frame of the loading apparatus. A bracket 278 is carried by the sleeve 276 and both of these members are fixed relative to the piston rod 277 by means of a pin 279. The bracket 278 serves as a support for an index finger or pin 280. The index pin or finger 280 is carried by a slidably adjustable member 281 which is arranged to be adjusted within a slot 282 (Fig. 6) formed in the bracket 278. A clamping bolt 283 passes through elongated slots 284 and 285 (Fig. 6) formed in the bracket 278 and passes through a hole within the member 281. A nut 286 is screw threaded onto the end of the clamping bolt 283 and serves to clamp the indexing stud or finger 280 in an operative or inoperative position. As shown in full lines in Fig. 6, when it is desired to withdraw the stud or finger 280 to an inoperative position, the nut 286 is loosened and the bracket 281 slid toward the right, the bolt 283 sliding longitudinally within the elongated slots 284 and 285 to withdraw the index finger so that it is out of the path of the work loader conveyor chain 233.

When the work loader is in an inoperative position, that is with the link chain 233 and parts in a rearmost position (Figs. 4 and 6), a stationary locating or stop stud 288 (Fig. 4) is in an operative position projecting between the spaced rollers on the link chain 233 to hold the chain against movement. When the carrier 228 moves toward an operative position so that one of the work supporting clips engages the ground piece of work 188, the link chain 233 moves from the full line position (Fig. 6) out of the path of the fixed chain locating stud 288 and the chain moves into a broken line position 233a with the link chain 233 in engagement with the index finger or pin 280. During the forward movement of the work carrying frame 228, one of the clips on the chain is moved into position to grip the ground work piece 188, after which the work supporting centers 177 and 214 move in an axial direction away from each other to release the ground work piece therefrom, at which time fluid is admitted to a cylinder chamber 290 at the lower end of the cylinder 273 to cause an upward movement of the piston 274 which produces an upward movement of the index pin or stud 280 to move the link chain 233 in a clockwise direction on its supporting sprockets 234, 235, 238 and 242 to present the next unground work piece into an operative position in alignment with the work centers 177 and

214, respectively. It will be readily apparent from the foregoing disclosure that inasmuch as the work supporting clips on the link chain 233 are in close relationship with each other, only a short indexing movement of the chain is required to shift a ground work piece from alignment with the centers and to shift a new unground work piece into position with respect to said centers.

The ground work pieces are intermittently picked up by the clips on the chain and carried to a position remote from the grinding position where they are automatically ejected or discharged by means of a discharge or ejector pawl 291 (Figs. 1 and 4) which is pivotally mounted on a stud 292 carried by the fixed frame of the loading attachment. An adjustable stop screw 293 carried by the ejector pawl 291 serves to limit the rocking movement of the ejector pawl 291 in a clockwise direction, thus locating the pawl in the desired position. A tension spring 294 serves normally to maintain the stop screw 293 in a fixed position to locate the ejector pawl 291. When the transversely movable work carrier frame 228 is moved rearwardly, that is, toward the left (Fig. 4), after the chain 233 has been indexed, the ejector member 291, due to its angled surface, rides up over a ground piece of work as the work moves rearwardly in a horizontal path until the ejector member 291 assumes the position illustrated in Fig. 4. On the next forward movement of the transversely movable work carrier member 228, the finish ground work piece is held by the ejector member 291 and its supporting clip is withdrawn therefrom and the finish ground work piece dropped into a chute or container (not shown) located below the loading device on the front of the machine base. It will be readily apparent from the foregoing disclosure that work pieces 188 are loaded into position on the chain at a position above the sprocket 234 and the work pieces are indexed intermittently as successive work pieces are ground until the finish ground work piece is ejected by the ejector member or pawl 291.

A pair of adjustable stop screws 295 and 296 are provided to limit the movement of the index finger or pawl 280 (Figs. 1 and 4). By manipulation of the stop screw 295, the pawl 280 may be adjusted to align it with the spaces in the chain 233, and by manipulation of the adjusting screw 296 the chain 233 may be advanced a precise amount, namely one link, accurately to locate the unground work piece in alignment with the work gripping centers 177 and 214.

The admission to and exhaust of fluid from the cylinders 265 and 273 is controlled in timed relation with the operation of the other mechanisms of the machine so that when a work piece has been ground to the required extent and the grinding wheel recedes to an inoperative position, the work carrier 228 moves forward to grip the ground piece of work. The centers 177 and 214 then withdraw to release the ground piece of work and the chain 233 is then indexed to present the next unground work piece for a grinding operation.

In the position of the parts as shown in the diagram in Fig. 2, fluid under pressure from the pump 59 passes through the pipe 62 into the chamber 65 of the valve 58 and passes out through a pipe 305, through a passage 306 in a valve 307, through a pipe 308 and a valve 309 and a pipe or passage 310, into the cylinder chamber 271 within the cylinder 265 to move the pis-

ton 266 together with the piston rod 267 and plate 269 carrying the work carrying head 228 toward the left (Figs. 2 and 5) to withdraw the work carrying head 251 into its rearward or inoperative position as shown. During the movement of the piston 266 toward the left, fluid within the cylinder chamber 270 exhausts through a pipe or passage 313 and a valve chamber 314 in the valve 307 and passes through a pipe 315 to the valve chamber 66 in the valve 53 and through the exhaust pipe 69 into the reservoir 61.

The valve 309 is adjusted to regulate the speed of movement of the work carrying head 228 to time it with the movement of the work centers 177 and 214 and also to reduce the force of the blow of the piston 266 at each end of the stroke to obtain smoothness and quietness of operation.

Fluid under pressure entering the cylinder chamber 271 passes through a pipe or passage 324 into a cylinder chamber 325, which serves to produce a downward movement of the piston 274 and the chain index finger or pin 280 from the position illustrated in Fig. 2 into the position illustrated in Fig. 4. During the downward movement of the piston 274, fluid is exhausted from a cylinder chamber 290, through a pipe or passage 327, in a manner to be hereinafter described.

The valve 307 is normally inoperative and remains in the position illustrated in full lines in Fig. 2, except when it is desired to set up the work carrying frame 228 and its associated mechanism when the same may be manually operated to move the work carrying frame 228 independent of the other mechanisms of the machine.

When the wheel feed control valve 53 is shifted into its reverse position, the direction of flow of fluid under pressure to the cylinder 265 is changed so that fluid under pressure passes through a pipe 313 into the cylinder chamber 270 to cause the piston 266 to move toward the right (Figs. 2 and 4) so as to move the work carrying frame 228 into an operative position.

Electrical control and interlock

In a machine of this type, it is desirable to provide suitable interlocks between the various mechanisms of the machine to insure safe operation thereof, without endangering the operator or damaging the work pieces 188 passing there-through. It is desirable to provide an electrical interlock between the work gripping centers 177 and 214 and the wheel feed control valve 53 so that the solenoid 75 cannot be energized unless both of the work gripping centers are in an operative position in engagement with the work piece 188 to be ground. The mechanisms of the machine, as shown diagrammatically in Fig. 2, are in a grinding position. A trip switch 336 is normally held in a closed position by means of a spring 337. An actuating plunger 338 is arranged in the path of an adjustable screw 339 carried by a pivotally mounted lever 340 mounted on a stud 341 fixed to the end of the cylinder 185 of the work head 115. A rod 342 is fixed to the piston 186 and projects through an aperture within the end cover of the cylinder 185 and is arranged to engage the lever 340. A spring 343 having one of its ends connected to the upper end of the lever 340 and its other end connected to a stud 344 fixed to the top of the cylinder 185 serves normally to maintain the lever 340 in engagement with the rod 342. In the position of the parts shown, Fig. 2, the switch 336 is closed. When fluid under pressure is admitted to the

cylinder chamber 189 to cause the piston 186 to move toward the left to withdraw the work centers 177 and 214 to an inoperative position, the rod 342 rocks the lever 340 in a counterclockwise direction, which serves to move the switch actuating plunger 338 toward the left, Fig. 2, to trip the switch 336 and thereby break the circuit.

A similar safety connection including a normally closed trip switch 345 is normally held in a closed position by means of a spring 346. An actuating plunger 347 is arranged in the path of an adjustable screw 348 carried by a pivotally mounted lever 349 mounted on a stud 350 fixed to the end of the cylinder 200 of the work head 116. A rod 351 is fixed to the piston 201 and projects through an aperture within the end cover of the cylinder 200 and is arranged to engage the lever 349. A spring 352 having one of its ends connected to the upper end of the lever 349 and its other end connected to a stud 353 serves normally to maintain the lever 349 in engagement with the rod 351. In the position of the parts shown in Fig. 2, the switch 345 is closed. When fluid under pressure is admitted to the cylinder chamber 212 to cause the piston 201 to move toward the right (Fig. 2) to withdraw the work center 214 to an inoperative position, the rod 351 rocks the lever 349 in a clockwise direction which serves to move the switch actuating plunger 347 toward the right (Fig. 2) to trip the switch 345 and thereby break the circuit.

A similar trip switch 360 is operatively connected to be actuated by a cycle timing valve to be hereinafter described. The switch 360 is normally held in an open position by means of a spring 361 and is provided with an actuating plunger 362 which is arranged in the path of an adjustable screw 363 which is mounted in the upper end of a rock arm 364. The rock arm 364 is pivotally mounted on a stud 365. The lower end of the rock arm 364 is arranged to engage a plunger 366 which extends from and is formed integral with a piston 367 of a cycle timing cylinder 368.

Cycle timing piston and cylinder

The cycle timing piston 367 and cylinder 368 serve to control the admission of fluid under pressure to the work head actuating cylinders 185 and 200 in timed relation with the other mechanisms of the machine. The piston 367 is normally held in a right-hand position (Fig. 2) by means of a pair of springs 369 and 370 which are connected between studs 371 and 372, respectively, on the cylinder casing, and the other ends of which are fastened to studs 373 and 374 on the rock arm 364. These springs normally tend to rock the rock arm 364 in a counterclockwise direction. A cylinder chamber 375 within the cylinder 368 is connected by a pipe 376 with a passage 377 in a cycle timing valve 378. The passage 377 is connected by a ball check valve 379 with a passage 380 which enters a valve chamber 391 within the piston type cycle timing valve 378.

The pipe 376 leading from the cycle timing piston and cylinder 368 also connects with a pipe 382 which in turn is connected with an exhaust pipe 383 to exhaust fluid into the reservoir 61. A valve 384 is located in the pipe line 382 and serves to close off the exhaust from the cycle timing valve when desired in setting up the machine for grinding a given work piece 188. An adjustable throttle valve 385 is also located in

the pipe line 382 and serves to adjust and control the rate of exhaust from the cycle timing piston and cylinder 368 and thereby to control the cycle of operation. When the fluid is exhausted from the chamber 375 in the cycle timing piston and cylinder 368 by the piston 367, the ball check valve 379 is closed by back pressure of the fluid so as to allow fluid to exhaust only through the pipe 376 to the needle valve 385 in the pipe line 382 to exhaust through the pipe 383.

Cycle timing valve

The cycle timing valve 378 is preferably a piston type valve comprising the valve pistons 386, 387 and 388 which are formed integral with a valve stem 389, thus forming valve chambers 390, 391, 392 and 393.

As shown in Fig. 2, fluid under pressure from the pump 59 passes through the pipe 62 and through a pipe 394 which connects with the valve 378. In the position of the parts as shown, the valve piston 386 closes the port for the pipe 394. Fluid under pressure passing into the control valve 58 passes out through a pipe 395 and through a pipe 396 and a throttle valve 396 into the valve chamber 390 to move the cycle timing valve to the right-hand position, as shown in Fig. 2. The valve 396 serves to control the rate of admission of fluid to the valve chamber 390 and thereby controls the rate of movement of the cycle timing valve. During this movement of the cycle timing valve, fluid within the chamber 393 exhausts through a pipe 397, an adjustable throttle valve 398 and a pipe 315, which exhausts fluid through the valve chamber 66 and returns it through the pipe 69 to the reservoir 61. The valves 396 and 398 serve to control the rate of movement of the cycle pilot valve.

When the main control valve 58 is reversed and fluid under pressure is admitted to the pilot valve chamber 393 to shift the pilot valve 378 toward the left, fluid under pressure passing through the pipe 394 may enter the valve chamber 391 and pass through the passage 380, the ball check valve 379, the passage 377, the pipe 376, into the cycle timing piston and cylinder 368 to cause the piston 367 to move toward the left, thereby rocking the rock arm 364 so that the released compression of the spring moves the switch plunger 362 toward the right (Fig. 2) which in turn closes the switch 360. At the same time, the released compression of the springs serves to move the pistons 186 and 291 simultaneously toward each other so that the work spindles grip the next work piece, thereby closing trip switches 336 and 345, which closes the circuit and serves to energize the solenoid 75 to shift the control valve 58 so as to start the infeeding movement of the grinding wheel.

An adjustable stop screw 400 on the cycle timing cylinder 368 serves to limit the movement of the piston 367 toward the left and thereby permits adjustment of the capacity of the cycle timing piston and cylinder so as to admit the desired amount of fluid to obtain the cycle of operation desired.

A push button 401 is provided in the electrical circuit to stop and start the cycle of operation. This switch 401 is connected in series with the normally closed trip switches 336, 345 and the normally open trip switch 360.

Operation

The operation of this machine is readily apparent from the foregoing disclosure. When it

is desired to start the machine in operation, a control button on the front of the machine base is actuated to start the wheel rotation, a push button is actuated to start the fluid pump, and a push button is actuated to start the work drive motor 134. The push button switch 401 is then actuated to start the cycle of operation. The switch 401 is connected in series with the trip switches 336, 345 and 350 and serves to energize the solenoid 75 which shifts the control valve 58 into the position shown in Fig. 2 to start a forward feeding movement of the grinding wheel 34. Assuming a work piece to be already located on the work centers, fluid under pressure entering the valve chamber 65 passes into the cycle pilot valve chamber 390 to shift the cycle pilot valve 378 into the position illustrated in Fig. 2. The grinding wheel 34 advances to grind the work 188 to the required size and the extent of the grinding operation, that is, infeed and dwell, is determined by the adjustment of the cycle timing piston and cylinder 368 which meters fluid from the valve chamber 375 through the variable throttle valve 385 into the exhaust. When the cycle timing piston 367 has moved toward the right a sufficient distance during the grinding operation, the trip switch 360 is opened, thereby breaking the circuit and deenergizing the solenoid 75 which releases the compression of the spring 82 and returns the feed control valve 58 to its reverse position so that fluid under pressure is admitted through the valve chamber 65 into the cylinder chamber 56 to cause a rearward movement of the grinding wheel 34. The shifting of the feed control valve 58 admits fluid under pressure through the pipe 315 and the pipe 397 into cycle pilot valve chamber 393 to start the cycle pilot valve 378 moving toward the left and at the same time passes fluid through the passage 314 in valve 307 and through the pipe 313 into the cylinder chamber 270 to move the work carrying member 228 forward simultaneously to grip the ground piece of work 188.

When fluid is admitted through the pipe 397 into the pilot valve chamber 393 to cause the cycle pilot valve 378 to move toward the left, fluid is also admitted from the pipe 397 into the pilot valve chamber 392 and passes out through a pipe 410 which passes fluid through a passage 411 in a valve 412. Fluid entering the valve chamber 411 passes through a pipe 413 and a pipe 414 into the cylinder chamber 189 of the cylinder 185 and also passes through a pipe 415 into the cylinder chamber 212 of the cylinder 200 to cause the work gripping centers 177 and 214 simultaneously to move away from each other out of gripping engagement with the work piece 188. Fluid under pressure is admitted to the cylinder chambers 189 and 212 only instantaneously while the timing valve 378 is being moved toward the left.

The speed of movement of the cycle pilot valve 378 as governed by the valves 396 and 398 is such as to allow time for the work centers 177 and 214 to be disengaged from the work piece 188, and the work carrier chain 233 to be indexed to remove the finished work piece 188a into alignment with the work centers 177 and 214 before the valve piston 388 covers the port to cut off fluid from the pipe 410.

During the period while the work gripping centers are separated, a pipe 416 is uncovered by movement of the piston 186 toward the left (Fig. 2) which serves to admit fluid under pressure through a valve 417 and pipe or passage 75

327 into cylinder chamber 290 to move the piston 274 upwardly, thereby to shift the ground piece of work 188 into a discharge position 188 and simultaneously to move a new piece of work 188a into axial alignment with the work gripping centers. The arrangement above described is such that the passage of fluid into the cylinder chamber 290 through the valve 417 is controlled in timed relation with movement of the pistons 186 and 201 which actuate the work gripping and rotating spindles.

When fluid under pressure is cut off from the pipe 410, the released compression of the springs 187 and 203, the spring 179 in the work supporting head 115, and a similar spring in the work head 116 serve rapidly to move the work spindles simultaneously toward each other to engage the work centers 147 and 214 with the unground work piece 188a. This movement serves rapidly to exhaust fluid from the work spindle cylinder chambers 189 and 212 in the cylinders 185 and 200. Any leakage of fluid by the pistons 186 and 201 is exhausted by an extension of the pipe 383 into the reservoir 61. The movement of the work spindles into an operative position serves to close the trip switches 335 and 345. The trip switch 360 being already closed, thereby completes the circuit to energize the solenoid 75 to shift the feed control valve 53 so as to move the grinding wheel 34 toward the work piece 188. At the same time, pressure in the pipe 305 passes through a passage 395 in a valve 397, through the pipe 308, the valve 309 and the pipe 310, into a cylinder chamber 271, to move the work carrier frame 228 to an inoperative position, as shown in full line in Fig. 4. The radially extending holes 32 are uncovered when the piston 226 reaches its left-hand position (Figs. 2 and 4), and fluid passes from the cylinder chamber 271 through the pipe or passage 324 to the cylinder chamber 325 to move the piston 274 and index pin 289 downwardly into the position shown in Fig. 4. During the downward movement of the piston 274, fluid is exhausted from the cylinder chamber 290 through the pipe 416, a ball check valve in cylinder 185, and through the pipe 414, the pipe 413, the valve 412, the pipe 410 and the pipe 419, into the reservoir 61.

The valve 412 is provided to facilitate independent movement of the work supporting centers 177 and 214 in setting up and adjusting the machine elements. During the normal operation of the machine under control of the automatic cycle control mechanism, the valve 412 remains in the position illustrated in Fig. 2. If it is desired manually to operate the pistons 186 and 201 independent of the cycle control mechanism, the valve 412 is shifted in a clockwise position into the position illustrated in dotted lines in Fig. 2 so that fluid under pressure from the pump 59 is admitted to the cylinder chambers 189 and 212, respectively, to withdraw the work supporting centers independently of the cycle control.

This cycle of operation is then continued on successive pieces of work. By manipulation of the various control valves, the timing of the movement of the various hydraulically actuated parts may be regulated as desired to obtain the desired coordination in the movement of the various parts of the machine.

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 successfully achieved. As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment 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.

This application is a continuation of our co-pending application Serial No. 276,852 filed June 1, 1939.

We claim:

1. In an automatic cylindrical grinding machine having a pair of opposed aligned work supporting and rotating spindles, means operatively connected simultaneously to move each of said spindles and arranged to cause them to approach or recede from each other to grip, support and rotate a work piece, means synchronously to rotate said spindles, and a work loading device comprising a transversely movable work carrier head, means including a piston and cylinder to move said head transversely, a plurality of spaced work receiving pockets, an endless chain to support said pockets on said head, means to move said head transversely to grip a work piece supported on said spindles, an indexing mechanism including a piston and cylinder to index said movable support relative to said head simultaneously to transfer said work pieces, and connections between one of said spindles and said endless chain indexing mechanism whereby said second cylinder is rendered inoperative until said spindles have moved to an inoperative position.

2. In an automatic cylindrical grinding machine having a pair of opposed aligned work supporting and rotating spindles, means synchronously to rotate said spindles, means including a piston and cylinder to move each of said spindles toward and from each other, and a work loading device having a transversely movable work carrier head, a piston and cylinder to move said head transversely, a movable endless chain supported on said carrier head, a plurality of spaced work receiving pockets on said chain, means including a piston and cylinder to index said chain so as to shift the work pieces intermittently into alignment with said spindles and into a discharge position, a control valve to admit fluid to said first cylinder to move the work carrier head transversely, a cycle timing valve actuated by said main control valve, connections between said cycle timing valve and said spindle actuating cylinders to control the movement of said spindles in timed relation with the movement of said work head, and fluid pressure connections between one of said spindles and said endless chain actuating cylinder which are arranged to render the indexing cylinder inoperative until the work spindles have separated and moved to an inoperative position.

3. In an automatic cylindrical grinding machine having a pair of aligned work supporting and rotating spindles, means including a fluid pressure piston and cylinder operatively connected to move said spindles toward and from each other, a work loading mechanism comprising a transversely movable work carrier head, a plurality of spaced work receiving pockets, an endless chain movably supported on said head and serving as a support for said work receiving pockets, means including a piston and cylinder to move said head transversely to grip a ground

piece of work supported on said spindles, means including a piston and cylinder to index said chain so as to remove the ground piece of work and to present a new piece of work into axial alignment with the work supporting spindles, and a hydraulic interlock between said spindle actuating cylinders and said endless chain operated cylinder whereby said latter cylinder is rendered inoperative until the work spindles have separated to release a ground piece of work.

4. In an automatic cylindrical grinding machine, a work loading device having a transversely movable work carrier, a plurality of sprockets rotatably supported thereon, an endless chain supported by said sprockets, a plurality of work receiving clips on said chain, a fluid pressure piston and cylinder operatively connected to move the carrier transversely to and from an operative position, an index pin engageable with said chain when said carrier is moved in one direction, and means including a second piston and cylinder to traverse said pin to index said chain successively to present a plurality of work pieces for a grinding operation.

5. In an automatic cylindrical grinding machine, a work loading device having a transversely movable work carrier head, a plurality of sprockets rotatably supported thereon, an endless chain supported by said sprockets, a plurality of work receiving clips on said chain, a fluid pressure piston and cylinder to move said carrier transversely to and from an operative position, an indexing mechanism including a movable index pin engageable with said chain when the work carrier is moved forward, and means including a second piston and cylinder to traverse said index pin to index said chain and present the next work piece in operative position.

6. In an automatic cylindrical grinding machine, a work loading device having a transversely movable work conveyor, a plurality of sprockets rotatably supported thereon, an endless chain supported by said sprockets, a plurality of work receiving clips on said chain, a fluid pressure piston and cylinder to move said carrier transversely to and from an operative position, an index pin engageable with said chain when the work carrier is moved in one direction, means including a second piston and cylinder to traverse said index pin to index said chain to present successive work pieces for a grinding operation, and an ejector member on said work loading device which is arranged positively to eject a ground work piece from a clip on said chain when the carrier moves transversely toward an operative position.

7. In an automatic cylindrical grinding machine, a work loading device having a transversely movable work carrier head, a plurality of sprockets rotatably supported thereon, an endless chain supported by said sprockets, a plurality of work receiving clips on said chain, a fluid pressure piston and cylinder to move said carrier transversely to and from an operative position, means including a second piston and cylinder to index said chain successively to present a plurality of work pieces for a grinding operation, and means including an adjustable stop to limit the movement of said second piston so as to ad-

just the extent of said indexing movement so as to align the work piece in an operative grinding position.

8. In an automatic cylindrical grinding machine, a work loading device having a frame fixedly mounted on said grinding machine, a transversely movable work carrier head supported on said frame, a plurality of rotatable sprockets supported on said carrier, an endless chain supported on said sprockets, at least one of said sprockets being adjustable relative to the others to tension said chain, a plurality of work receiving clips on said chain, means including a fluid pressure piston and cylinder to move said carrier transversely to and from an operative position, and an indexing mechanism including a movable indexing pin and a fluid pressure piston and cylinder operatively connected to traverse said pin to index said chain so as to successively present a plurality of work pieces for a grinding operation.

9. In an automatic cylindrical grinding machine, a work loading device having a frame fixedly mounted on said grinding machine, a transversely movable work carrier supported on said frame, a plurality of rotatable sprockets supported on said carrier, an endless chain supported on said sprockets, at least one of said sprockets being adjustable relative to the others to tension said chain, a plurality of work receiving clips on said chain, means including a fluid pressure piston and cylinder to move said carrier transversely to and from an operative position, an indexing mechanism including a movable indexing pin and a fluid pressure piston and cylinder operatively connected to traverse said pin to index said chain so as to successively present a plurality of work pieces for a grinding operation, and an ejector member on said frame which is arranged to eject a ground work piece from a clip on said chain when said carrier moves transversely toward an operative position.

10. In an automatic cylindrical grinding machine, a work loading device having a frame fixedly mounted on said grinding machine, a transversely movable work carrier supported on said frame, a plurality of rotatable sprockets supported on said carrier, an endless chain supported on said sprockets, at least one of said sprockets being adjustable relative to the others to tension said chain, a plurality of work receiving clips on said chain, means including a fluid pressure piston and cylinder to move said carrier transversely to and from an operative position, an indexing mechanism including a movable indexing pin and a fluid pressure piston and cylinder operatively connected to traverse said pin to index said chain so as to successively present a plurality of work pieces for a grinding operation, and a pivotally mounted ejector member on said frame which is arranged to engage a ground work piece when the carrier moves to an inoperative position and to eject said work piece when said carrier moves toward an operative position.

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CERTIFICATE OF CORRECTION.

Patent No. 2,229,312.

January 21, 1941

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 10, first column, line 49-50, claim 6, for the word "transverse" read --traverse--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of May, A. D. 1941.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.