

Oct. 28, 1941.

A. J. STRONG

2,260,843

CENTERLESS GRINDING MACHINE

Filed July 24, 1940

4 Sheets-Sheet 1

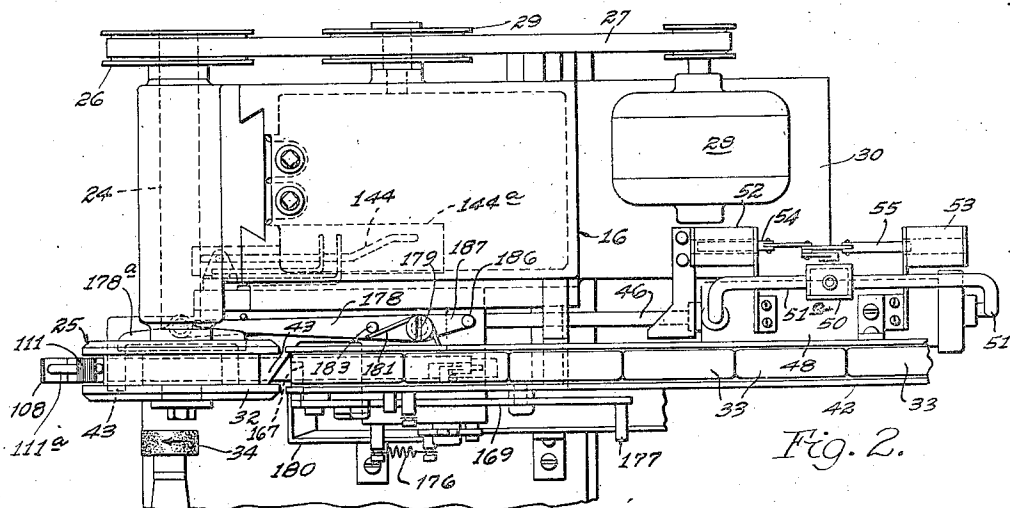


Fig. 2.

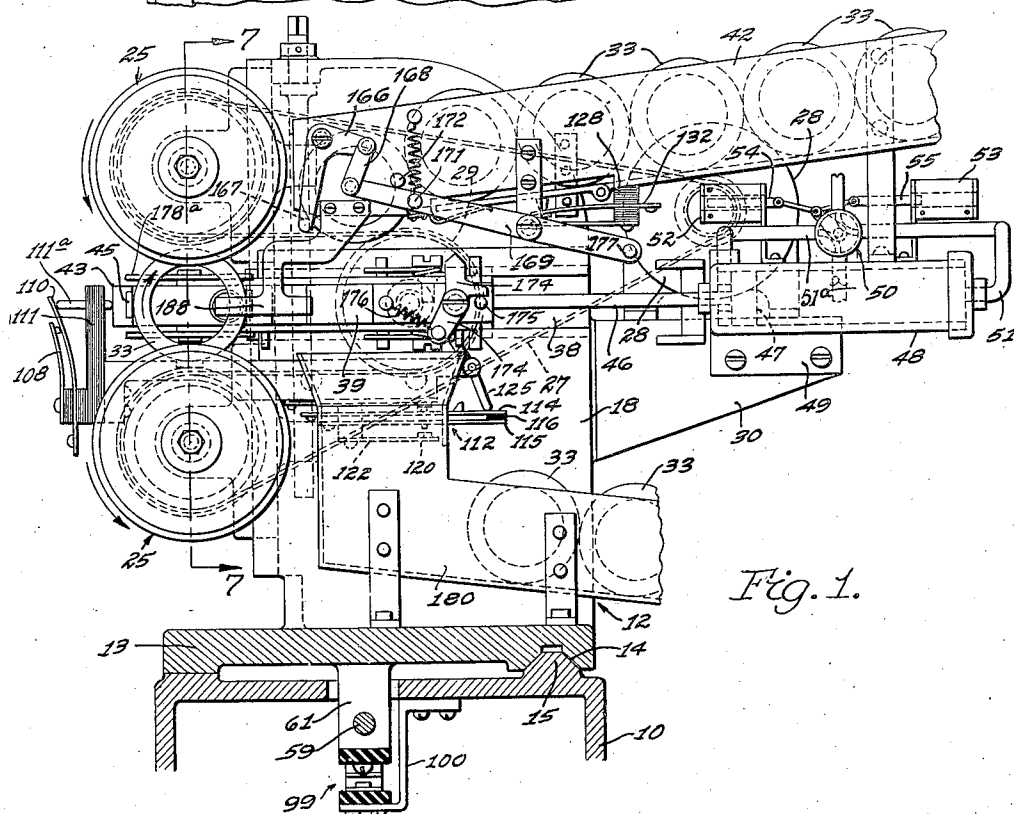


Fig. 1.

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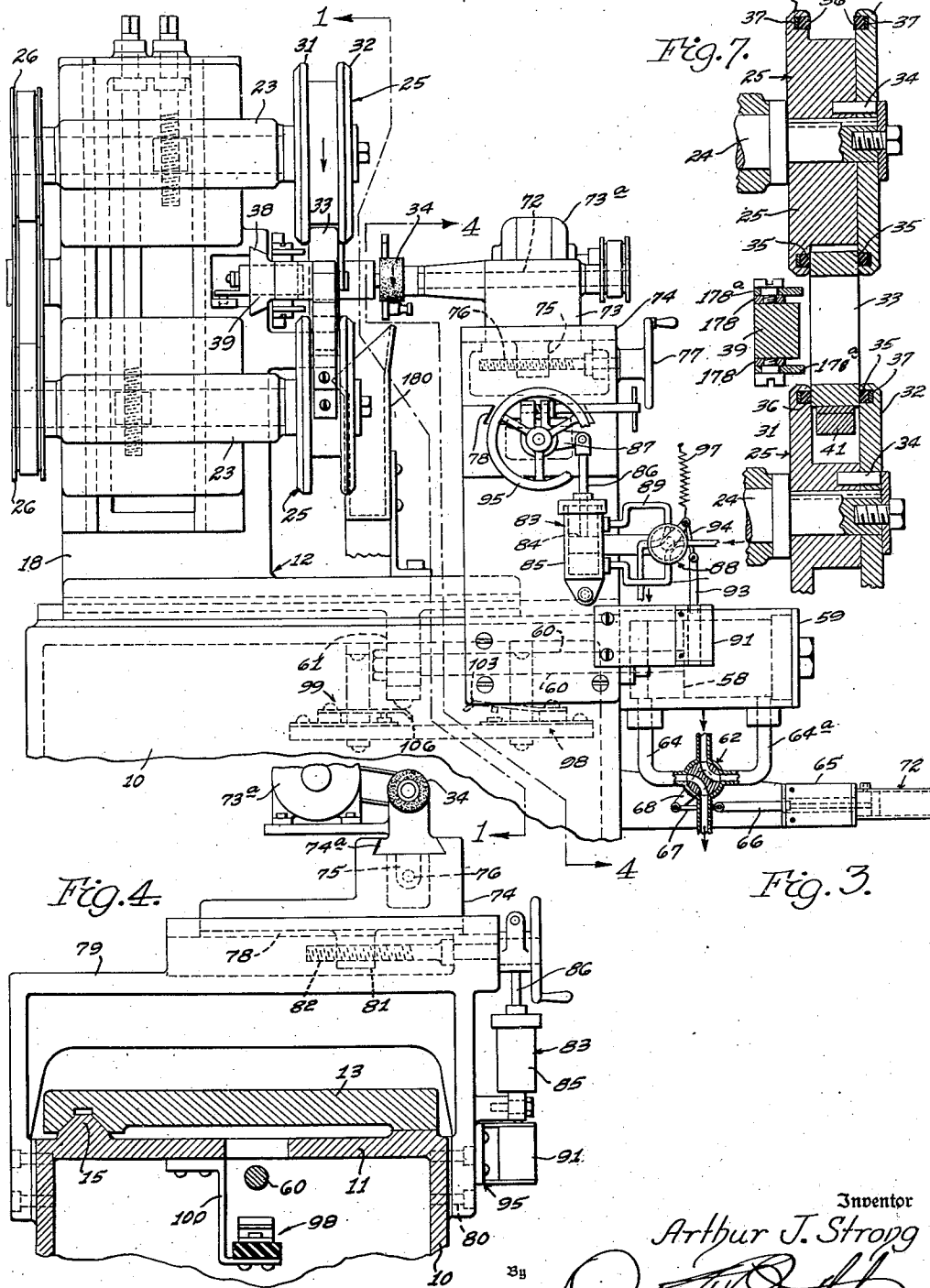
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4 Sheets-Sheet 3

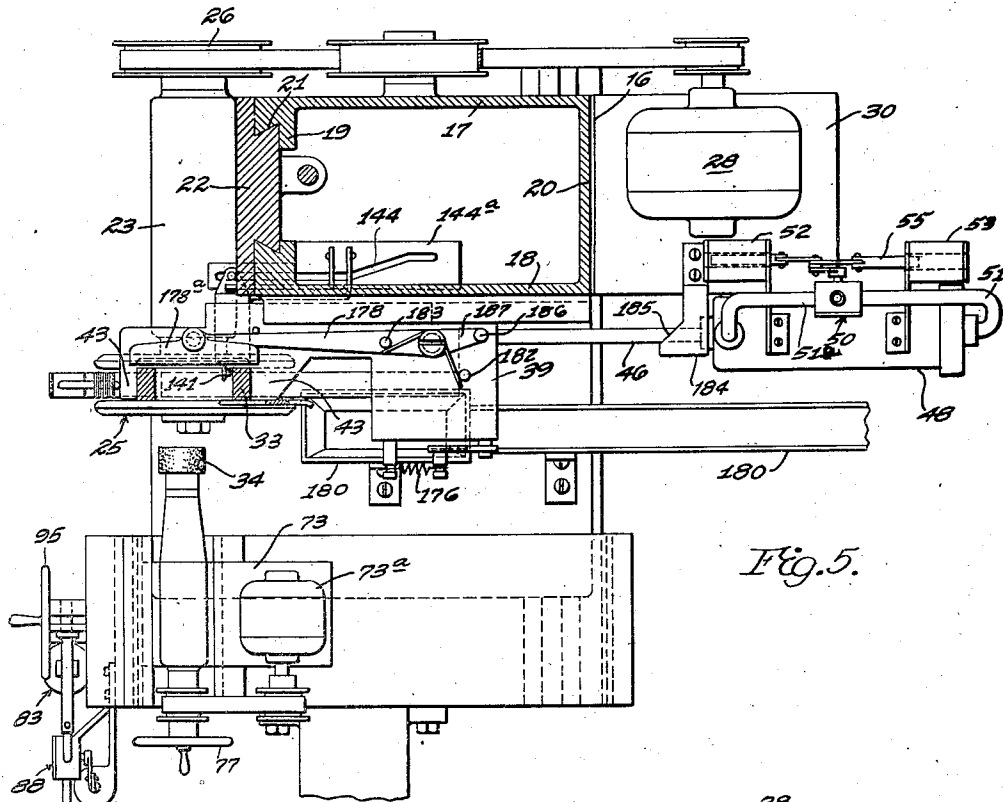


Fig. 5.

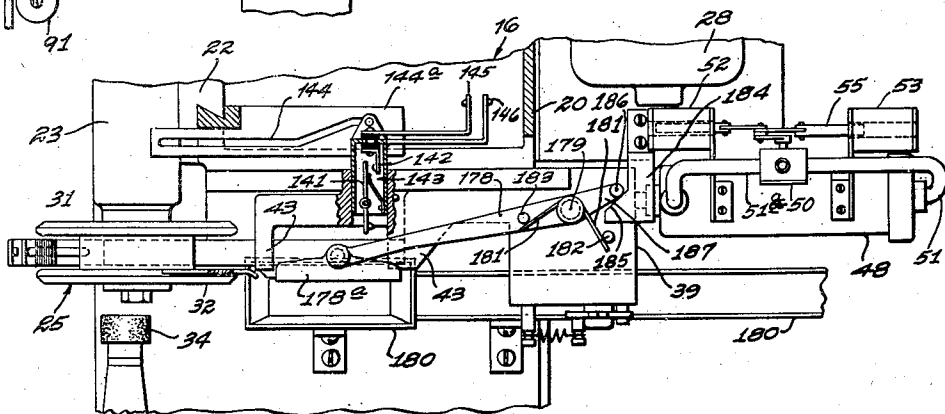


Fig. 6.

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4 Sheets-Sheet 4

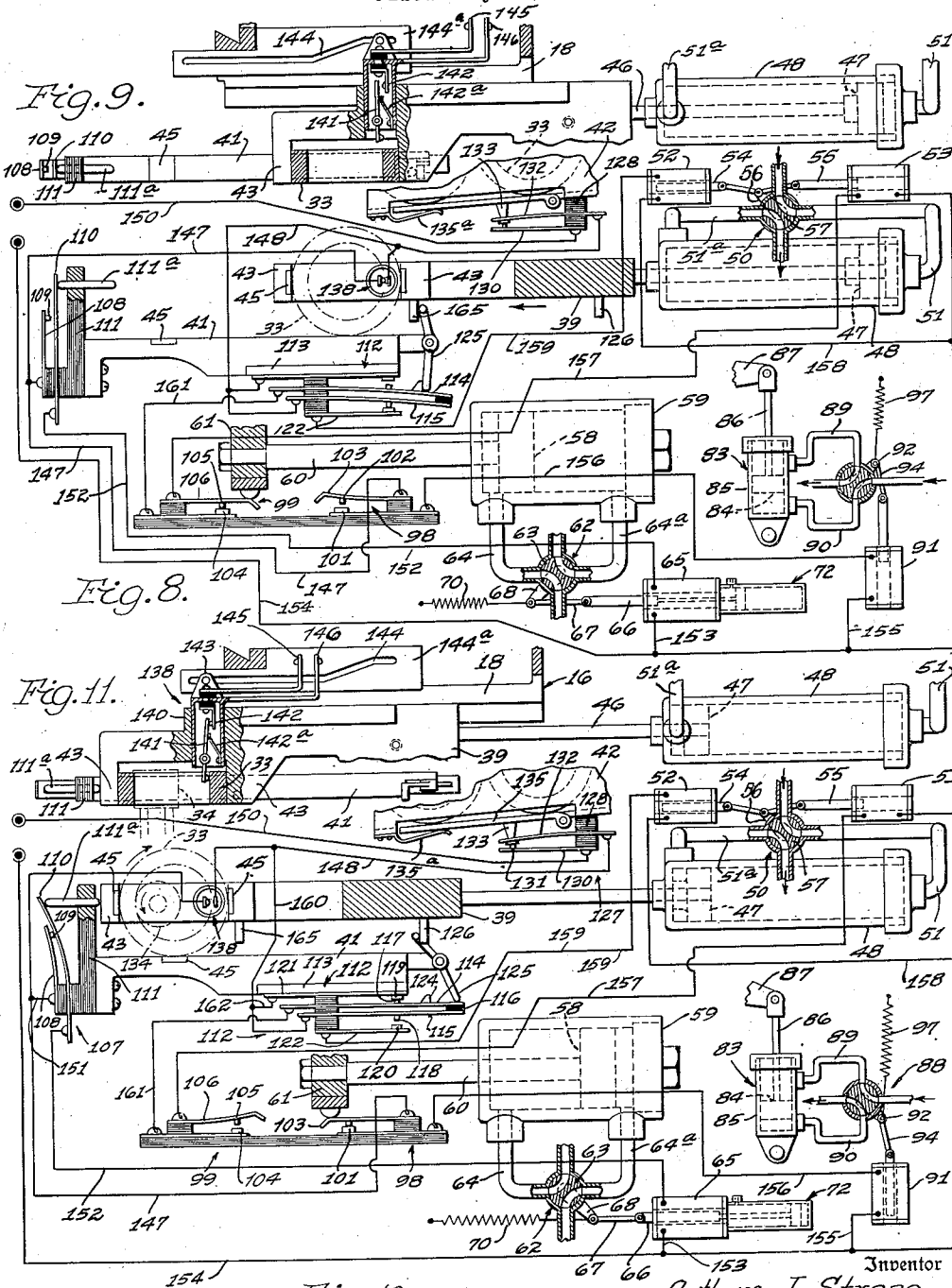


Fig. 10.

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UNITED STATES PATENT OFFICE

2,260,843

CENTERLESS GRINDING MACHINE

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Application July 24, 1940, Serial No. 347,109

11 Claims. (Cl. 51—103)

This invention relates generally to grinding machines.

It is an object of the present invention to provide a new and improved so-called centerless grinding machine which will grind internal surfaces of rings in a manner to insure true concentricity of the inner and outer surfaces of the rings.

Another object of the invention is to provide a new and improved grinding machine in which the material to be ground is fed automatically to drive means therefor, which rotates the material relative to a grinding tool.

A further object of the invention is to provide for a grinding machine new and improved control means for controlling the operation of feeding work pieces to drive means therefor and controlling operation of the machine, including control of the amount of material removed in a grinding operation.

Other objects of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings in which:

Fig. 1 is a side view of the machine partly broken away and in section, taken along the line 1—1 of Fig. 3;

Fig. 2 is a fragmentary top plan view of the machine;

Fig. 3 is a fragmentary end view of the grinding machine;

Fig. 4 is a fragmentary view of the machine shown partly in vertical section, taken along the line 4—4 of Fig. 3;

Fig. 5 is a top view partly in section of the grinding machine;

Fig. 6 is a fragmentary top view shown partly in section of the grinding machine;

Fig. 7 is a sectional view of driving members of the grinding machine; and

Figs. 8 to 11 inclusive are substantially diagrammatical views to illustrate the control system of the machine and various steps of operation from the feeding of work pieces to the machine to the removal of the ground work pieces therefrom.

Referring to the drawings by characters of reference, the grinding machine shown includes a substantially rectangular base 10 having an upper surface or bed 11 on which an upper, supporting structure or carriage 12 is supported for sliding movement crosswise or transversely of the base. The upper structure 12 includes a horizontal base portion 13 which is provided in the underside thereof with an elongated guide recess 14 which

receives a track 15 of the bed 11 for slidably guiding the upper structure on the bed. Integral with and extending upwardly from the base portion 13 there is a supporting column 16 which, as shown in Fig. 5, is preferably hollow, having side walls 17 and 18 and end walls 19 and 20. The column end wall 19 is provided with a preferably dovetailed vertical slideway 21 in which is slidably received and guided, a supporting plate 22.

Externally of the column 16, a pair of vertically spaced hollow bosses 23 are provided which may be integral with the slide plate 22 and extend transversely of the column 16. A pair of shafts 24 are journaled respectively in the hollow bosses 23 and have corresponding end portions thereof projecting externally of the bosses beyond or past the column side wall 18 to which end portions are respectively secured a pair of vertically spaced drive members or rollers 25. The opposite ends of the shafts 24 project externally of the bosses, and secured respectively to these ends of the shafts is a pair of pulleys 26 which may be driven via a continuous belt 27 by an electric motor 28, the belt 27 preferably being tightened by an idler pulley 29. The electric motor 28 is carried by and externally of the column 16 on a suitable platform 30 which may be rigidly secured to the column end wall 20 by any suitable means.

Each of the rollers 25 is provided with spaced side flanges 31, 32 adapted to receive therebetween a ring member 33 to be ground. As shown in detail in Fig. 7, the side flanges 32 are preferably removable and may be rigidly secured to the roller proper by pins 34. Adjacent their outer peripheral edges, the flanges are provided in the opposed faces thereof with continuous or circular recesses 35 in which gripping members, preferably rubber rings 36, are inserted, which rubber rings are preferably stiffened by circular backing rings 37 secured thereto. When a work piece or metallic ring 33, such as a bearing race, is positioned between the flanges 31, 32 of the rollers 25, the rubber gripping rings thereof are slightly compressed to increase the cooperating frictional forces for rotating the ring 33, during which rotation the ring is ground either internally or externally, or both, by a suitable grinding wheel 34. It will be understood that the work piece or ring 33 is driven or rotated solely by reason of the frictional drive of the rollers 25 against the opposite surfaces of the ring.

As is more clearly shown in Fig. 1, a horizontal guideway 38 is provided in the column side wall 16 for slidably receiving and guiding a reciprocal

carrier or holder member 39 for feeding and holding the work pieces or rings 33 to the drive rollers 25. Immediately below the carrier member 39, an elongated supporting member 41 is provided for the rings 40, which supporting member 41 is rigidly secured to the column side wall 18. A conveyor or magazine 42 is provided and arranged to supply the rings 33 by gravity to the carrier member 39, which is provided with a yoke portion including a pair of spaced, rigid arms or projections 43 between which a socket is provided for the rings 33. In Fig. 1, for example, the carrier member 39 is shown holding a ring 33 in position to be rotated by the rollers 25 but when the member 39 is drawn back to what may be termed its starting position, the space between the arms 43 is immediately below the outlet of the magazine or in position to receive the next ring 33. It will be seen that the yolk arms 43 and the supporting member 39 provide bearing surfaces which permit rotation of a ring 33 positioned in the yoke but prevent bodily movement of the ring during the grinding operation, and since the ring is gripped on opposite sides thereof by the drive rollers 25, concentricity of the inner and outer peripheries is assured after the grinding operation is completed. Preferably the opposed faces of the yolk arms 43 and the upper surface of the supporting member 41 are provided with hardened inserts 45 to reduce wear.

The member 39 is connected by a connecting rod 46 to a piston 47 in a hydraulic cylinder 48, which may be rigidly secured to the motor platform 30 by a suitable bracket 49. This hydraulic power means is controlled by a valve 50 which is connected to opposite ends of the cylinder 48 by conduits 51. Any suitable type of valve operable to establish communication alternately between a source of fluid pressure and opposite ends of the cylinder may be employed to reciprocate the ring carrier and holder 39. In the present instance, the valve 50 is actuated in opposite directions by a pair of oppositely acting solenoids 52 and 53, the plungers or cores 54 and 55 of which are connected to a common operating arm 56 of the valve member, as at 57. In Figs. 8 and 9, the valve member 57 has been moved by the solenoid 52 to the position which will permit fluid to escape from the cylinder 48 via the conduit 51a and will permit the fluid under pressure to enter the cylinder 48 via the conduit 51 to act against the piston 47 and move it to the left. In Figs. 10 and 11, the piston has been moved to the left and the carrier 39 has positioned the ring 40 carried thereby between the flanges 31, 32 of the drive rollers 25, movement of the carrier to the left being limited by engagement of the piston 47 with the left end wall of the cylinder 48. When the other solenoid, or solenoid 53 is energized, it actuates the valve member 50, which reverses the application of fluid pressure on the piston 47, causing the ring or work piece carrier 39 to be drawn back to its starting position shown in Figs. 8 and 9.

As previously mentioned, the upper supporting structure 12 on which the carrier is mounted is slidable on the base 10 transversely thereof. This provides for positioning the work piece or ring 33 held by the carrier 39 over the grinding wheel 34 which then extends into the ring, the axis of rotation of the grinding wheel being parallel with the axis of the ring. Preferably, the transverse or reciprocal movement of the upper structure 12 is accomplished by a hydraulically operated piston 58 in a cylinder 59 which may be

mounted rigidly on the base 10 beneath the bed 11 thereof. Rigidly secured to the piston 58 is one end of a push rod 60, of which the other end is rigidly secured to a depending integral boss 61 of the upper structure base 13, see Fig. 1, 8 or 10.

Supply of fluid pressure to opposite sides of the piston 58 is controlled by a valve 62 having a rotatable valve member 63 controlling the ports of the valve. As shown, the valve 62 is the same as the previously described valve 50 and may be of any suitable type operable to direct the fluid pressure against one end of the piston 58 and later against the other end of the piston 58 to reciprocate the piston. The ports of the valve 62, which are both inlet and outlet ports, are connected respectively to opposite ends of the cylinder 59 by suitable conduits 64 and 64a. A solenoid 65 is provided to rotate the valve member 63 in a direction to establish communication between the source of fluid pressure and the left end of the cylinder 59, as seen in Figs. 8 and 10, the reciprocal core 66 of the solenoid 65 being connected by a link 67 to an operating lever arm 68 of the valve member 63. A helical coil spring 70 may be provided and have one end attached to the operating valve arm 68 to rotate the valve member 63 in the opposite direction upon deenergization of the solenoid 65. When the solenoid 65 rotates the valve member 63 to establish communication between the source of fluid pressure and the left end of the cylinder 58, the upper structure 12 is moved by the fluid pressure toward the grinding wheel 34 to position the work piece or ring 33 in the carrier 39 such that the work piece surrounds the grinding wheel 34. After the grinding operation is completed, the solenoid 65 is deenergized, which permits the spring 70 to rotate the valve member 63 to a position establishing communication between the source of fluid pressure and the right hand end of the cylinder 59 with the result that the upper structure 12 is moved away from the grinding wheel 34. For a reason which will be hereinafter explained, it is desired that the solenoid, upon being energized, has a delayed action, and to this end, the solenoid is provided with a dash pot 72, although other types of solenoids having other means for providing delayed actions may be employed.

The grinding wheel 34 is secured to and adjacent one end of a rotatable horizontal shaft 72 which is journaled in a standard 73 and may be driven by an electric motor 73a which is also mounted on the standard 73. The standard 73 is mounted on a second standard 74 in a dovetailed slideway 74a for adjustment movement toward and away from the work piece or ring 33 held by the carrier 39. Depending into the standard 74, an integral boss 75 of the upper standard 73 is provided with a threaded bore to receive a rotatable screw 76 which may be rotated by a hand wheel 77 to slide the upper standard 73 on the lower standard 74 to adjust the position of the grinding wheel relatively to the ring 33. The lower standard 74 is slidably mounted in a dovetailed slideway 78, Figs. 3 and 4, provided in the top or bed of a lower standard 79 which straddles the upper base 13 and is rigidly secured by bolts 80 to the lower or main base 10 of the machine. As shown, the standard 74 is arranged to move longitudinally of the ring carrier member 39 or to move transversely of the axis of the ring 33, this movement being provided to bring the periphery of the grinding wheel up

against the inner wall surface of the ring. This movement is preferably obtained by a power element 83, preferably a hydraulic power means including a pressure responsive piston 84 in a cylinder 85 which may be rigidly mounted on one side of the lower or fixed standard 79. A boss 81 integral with the standard 74 depends into the lower or fixed standard 79 and is provided with a threaded bore to receive a rotatable screw 82 for sliding the upper standard 74 on the lower or fixed standard 79.

The power element piston 84 is integral with an upwardly extending push rod 86 which is pivoted at its upper end to a lever 87, secured on and to the outer end of the screw 82, thus operatively connecting the screw to the power element 83. A two-way valve 88 is provided for controlling the power element 83 and is connected by conduits 89 and 90 to the power element cylinder 85 at opposite ends of the piston 84, the valve in turn being connected by suitable conduits to a source of fluid pressure. A solenoid 91 is provided to actuate the valve 88 which is provided with an operating arm 92 connected to the solenoid core 93 by a link 94. The solenoid 91 may be rigidly mounted on the lower or fixed standard 79 by a bracket 95. A hand wheel 96 for the screw 82 may be provided for initially adjusting the position of the standard 74 and consequently the position of the grinding wheel 34 prior to operation thereof by the power element 83. A helical coil spring 97, connected to the valve operating arm 92, may be provided to operate the valve in the opposite direction or to return it to the position from which it is moved by the solenoid 91.

A pair of spaced switches 98 and 99 are provided and are actuated in accordance with the movement of the upper structure toward and away from the grinding wheel by the power element 59. The switches 98 and 99 may be mounted respectively on a pair of brackets 100, secured to and depending from the underside of the main base 10, see Figs. 3, 4 and 10. The switch 98 comprises, in general, a contact member 101 cooperable with a contact member 102 carried by and adjacent one or the free end of a flexible switch blade 103. Similarly, the switch 99 comprises, in general, a contact member 104 cooperable with a contact member 105 which is carried by a flexible blade 106. A switch 107 is mounted on one end of the support 41 and is actuated by the carrier 39, the switch 107 comprising a flexible blade 108 carrying adjacent the free end thereof a contact member 109. Cooperable with the contact member 109 there is a flexible blade-like contact member 110 which is arranged in spaced relation to the blade 108. The two flexible blades 108 and 110 are secured to an electric insulating base 111 which is rigidly secured to the end of the support 41. The insulator 111 extends upwardly above the support 41 and is provided with an aperture therethrough in which a pin 111a is disposed having one end engaging the flexible blade 110, the other end of the pin being engageable by the adjacent end of the carrier member 39. The carrier member 39 also actuates a second switch 112 which is mounted on an electric insulating plate 113 which is secured to the underside of the supporting member 41. The switch 112 comprises a pair of vertically spaced, flexible blades 114, 115 which are held separated at their free ends by electric insulation 116. On opposite sides thereof the blades 114 and 115 respectively are pro-

vided with contact members 117 and 118 which respectively cooperate with contact members 119 and 120, of which the contact member 119 is mounted on a plate 121 which is secured to the underside of the insulation 113. The other contact member 120 is covered by a flexible blade 122, the blade 122 and the blades 114 and 115 being insulated from each other by electric insulating material 123. An upwardly extending abutment member 124 is provided on the upper blade for engagement by an arm 125 which is pivoted intermediate its ends on the supporting member 41, the upper end of the pivoted arm 125 being arranged for engagement by a depending lug 126 on the carrier 39.

Another switch, designated in general by the numeral 127, is provided and functions to stop the machine in the event that the magazine 42 becomes empty of the work pieces or rings 33. To this end, the switch 127 is mounted on the underside of the magazine 42 and is held in closed circuit position solely by the weight of one of the rings 33 in the magazine. Electric insulating material 128 is secured to the underside of the magazine 42 and secured to the insulating material there is a horizontal metallic plate 130 to which a contact member 131 is secured. A flexible blade 132 is secured at one end thereof to the insulator 128 and the blade 132 carries adjacent the free end thereof a contact member 133 which is cooperable with the contact member 131. Disposed in an opening in the bottom of the magazine 42 there is a lever 135 on which the rings 33 rest, which lever is pivoted adjacent one end thereof to the magazine 42. Adjacent its free end the lever 135 is held up by a leaf spring 135a which is secured to the underside of the magazine, and intermediate its ends, the lever 135 is provided with a downwardly directed extension 136 which engages the blade 132 to hold the blade down and the switch contacts together. Another switch 138 is provided and controls or determines the amount of material removed from each of the ring members 33. This switch 138 is carried by the carrier in the yoke of which is provided a transverse hole in which a tubular casing 139 for the switch is slidably received and guided. Pivoted to and within the casing 139 there is a switch arm 141 which is cooperable with a contact member 142 which is secured to and within the casing. One end of the operating arm 141 projects externally of the casing 140 for engagement with the inner surface of one of the rings 33 when the ring is positioned ready to be ground, the ring thus holding the switch closed. When the switch is closed, the arm 141 engages and tensions a leaf spring 142a which then acts to open the switch and becomes effective after the desired amount of material has been removed from the ring.

The closed end of the casing 140 is provided with an extension which carries a pin 143 which serves as a cam follower and engages in a cam slot 144 provided in a plate-like cam member 144a. The cam member is fixed relatively to the work carrier 39 and the slot 144 is provided with an offset to retain reciprocal movement of the switch 138 as a unit. It will be seen that as the carrier moves to the left from the position shown in Fig. 9 to the position shown in Fig. 11, the switch 138 is moved in toward the carrier until the switch operating arm extends into the ring 33 in contact with the inner surface thereof. The switch 138 is provided with terminals 145, 146, of which the terminal 145 is connected by a lead

wire 147 to the blade of the switch 98, and the other terminal 146 is connected by a lead wire 148 to the blade 132 of the switch 127, the switch contact member 131 being connected to one of the main terminals by a lead wire 150. A lead wire 151 connects the contact member 109 of the switch 107 to the lead wire 147 and a lead wire 152 connects the switch blade 110 to one terminal of the solenoid 65. From the other terminal of the solenoid 65, a lead wire 153 is connected to the second of the main lead wires 154. A lead wire 155 connects one terminal of the solenoid 91 to the main lead wire 154, the other terminal of the solenoid being connected by a lead wire 156 to the switch contact 101. The main lead wire 154 is connected to one terminal of the solenoid 53 and the other terminal of the solenoid is connected by a lead wire 157 to the blade 107 of the switch 99. Similarly, the solenoid 52 has one terminal thereof connected by a lead wire 158 to the main lead wire 154 and its other terminal is connected by a lead wire 159 to the switch contact member 120. From the terminal of the switch blade 115, a lead wire 160 connects to the lead wire 148, and from the switch blade 114 a lead wire 161 connects to the terminal of the switch contact member 104, the wire 160 being connected by a lead wire 162 to the terminal of the contact member 119. It will be noted that the solenoids 65 and 91 are in parallel circuit. The solenoid 65 is connected in series circuit with the switch 107 and the solenoid 91 is in series circuit with the switch 98 and the switch 107. Also the switch 113 is in series circuit with each of the solenoids 52 and 53 and switches 127 and 138 are in series circuit with each other and with the switches 107 and 99 and with the solenoids 52 and 53.

Referring now to the magazine 42, a bell crank lever 166 is pivoted to one side of the magazine, adjacent the outlet thereof, and has a depending arm to the lower end of which is secured a laterally extending pin 167 which engages the ring 33 at the magazine outlet to prevent its discharge therefrom until the lever is pivoted in a clockwise direction, facing Fig. 1. The other arm of the bell crank lever 166 is connected by a link 168 to one end of a lever 169. The lever 169 is pivoted intermediate its ends to a bracket 170 which is rigidly secured to the magazine 42. Between the lever fulcrum and the link 168 the lever is provided with a pin 171 to which is attached one end of a coil spring 172, the other end of the spring being anchored to the magazine. The spring 172 acts to pivot the lever 169 in a clockwise direction and through the link 168 to pivot the bell crank lever 166 in a counter-clockwise direction which movement is limited by a stop pin 173, secured to the magazine 42. A pawl 174 is pivoted to the carrier 39 adjacent the rear end thereof and is held against a stop member 175 by a helical coil spring 176. When the carrier is returned to its starting position, the pawl engages a laterally extending pin 177 carried by the lower, free end of the lever and pivots to pass by the pin. When the carrier member 39 again moves toward the drive rollers 25, the pawl 174 engages the pin 177 and pivots the lever 169 in a clockwise direction which moves the lower arm of the bell crank lever 166 away from the ring 33 at the magazine opening thus permitting the ring 33 to descend by gravity onto the support 41 between the arms 43 of the carrier yoke.

A lever 178 is pivoted intermediate its ends by a pin 179 to the top of the carrier member 75

39 and one end of the lever 178 positions between the yoke arms 43. To this end of the lever 178 is pivoted a pair of plate-like members 178a which are adapted to engage a finished ring 33 and eject it from the yoke or from between the arms 43 thereof when the lever 178 is pivoted in a counter-clockwise direction facing Fig. 6. The ejected rings 33 may fall into a second magazine or conveyor 180. A pair of tensioned springs 181 wrapped around the pin 179 have ends thereof abutting a pin 182 on the carrier 39 and the other ends thereof abutting a pin 183 on the lever 178, the springs 181 acting to pivot the lever in a direction to move the plate member 178a back between the yoke arm 43, see Fig. 6. The lever 178 is swung in the opposite direction by a cam member 184 having an inclined cam surface 185 engageable by a pin 186 carried by a relatively short arm 187 of the lever 178. A guide member 188 is rigidly secured to the magazine 42 and is arranged to guide a ring in the yoke of the carrier 39 between the flanges of the rollers 25.

In general the machine operates as follows:

The carrier 39 receives a ring 33 from the magazine 42 and moves the ring to be ground to the left, facing Figs. 9 and 10, such movement being limited by engagement of the power element piston 47 with the end of its cylinder. This positions the ring 33 between the flanges of the drive rollers 25. When the ring is moved to this position, the entire upper structure moves transversely of its base to position the ring 33 over the grinding wheel 34 and then the support 79 of the grinding machine is moved longitudinally of the carrier 39 to bring the grinding wheel 34 against the inner surface of the ring 33. After the grinding operation is completed, the grinding wheel is first moved away from the inner surface of the ring 33 and then the upper structure moves to withdraw the ring from the grinding wheel 34, after which the carrier 39 moves back toward its starting position.

In Fig. 8, the parts of the machine are shown in the positions they will assume at the start of the operation. It will be noted that the lower blade 115 of the switch 113 is being held in contact with the contact member 131 by the lever 125, which is pivoted and releasably held by the extension 126 of the carrier 39. This completes the following circuit to the solenoid 52: From the main lead wire 150 through the switch 127 which is held closed by the rings 33 in the magazine 42, lead wires 148, 160, switch blade 115, contact 120, lead wire 159, solenoid 52, and lead wire 158 to the other main lead wire 154. When the solenoid 52 is energized, it acts to move and hold the valve member 57 in the position shown in Fig. 9, in which position of the valve fluid pressure is acting to move the carrier 39 to the left. Upon movement of the carrier 39 to the left, the pawl 174 on the ring carrier 39 engages the pin 177 of the lever 169 and pivots the lever in a clockwise direction, Fig. 1, which through the link 168 pivots the lever 166 in a clockwise direction thus moving the stop pin 167 to permit the ring 33 at the magazine opening to descend onto the support 41 between the arms 43 of the carrier 39. The carrier 39 moves the ring 33 to the left until the piston 47 is stopped by its engagement with the cylinder end wall. During this movement of the carrier 39, the switch 138 carried thereby is moved toward the ring 33 by reason of the follower riding in the

cam slot 144 and the outer end of the switch operating arm 141 engages the inner surface of the ring to be ground. As the carrier 39 moves to the left, the switch blades 114 and 115 are released thereby, and, flexing upwardly, the upper blade 114 engages its contact member 119. This, however, does not complete a circuit for the reason that switch 99, in series with switch 113, is in open circuit position. Just prior to the stopping of the carrier movement, the carrier 39 engages the pin 111a and closes the switch 107 which closes the following circuit: From the main lead wire 154 through the solenoid 65, lead wire 152, switch blade 110, contact 109, switch 138, lead wire 148, switch 127 to the other main lead wire 150. When the solenoid 65 is energized it moves the valve member 63 to the position shown in Fig. 10, which permits the fluid pressure to act on the piston 58 and move the piston to the right which through the rod 60 moves the entire upper structure 12 of the machine over toward the grinding machine to position the ring 33 over the grinding wheel 34. As the piston 58 moves to the right, the switch 99 is permitted to open and the switch 95 is engaged by the abutment carried by and adjacent the end of the piston rod 60. When the switch 98 is closed, the circuit of the solenoid 91 is closed, which circuit is as follows: From the main lead wire 154 through lead wire 155, solenoid 91, lead wire 156, switch 98, lead wire 147, switch 138, lead wire 148, switch 127, to the other main line 150. When the solenoid 91 is energized, it actuates the valve member 57, which then directs the fluid pressure against the upper end of the piston 84. The piston 84 then moves downwardly, and, operating the lever 87, moves the upper grinding wheel support 79 longitudinally of the carrier 39 to position the grinding wheel against the inner surface of the ring 40. After a predetermined desired amount of material has been removed from the inner surface of the ring 33, the switch 138 will open the circuits of the solenoids 65 and 91. This deenergizes the solenoids, thus permitting their springs 70 and 97 to actuate respectively the valves 62 and 88, but, due to the delayed action of the solenoid 65 because of the dash pot 72, the spring 97 actuates the valve 88 before valve 62 is actuated. The spring 97 rotates the valve member to the position shown in Fig. 8, in which position the fluid pressure acts against the underside of the piston 84 which moves the piston upwardly to pivot lever 87 which rotates screw 82 to move the grinding wheel 34 away from the inner surface of the ring 40. The spring 70 now acts to move the valve member 63 from the position shown in Fig. 10 to the position shown in Fig. 6, which reverses the direction of fluid flow to the power element cylinder 59. The fluid pressure now acts against the right end of the piston 58 and moves the piston to the left which permits the switch 98 to open. This moves the entire upper structure 12 away from the grinding wheel 34, and during this movement the depending abutment carried by the boss 51 engages the flexible switch blade 106, making contact between the contact members 104 and 105. This closes the circuit of the solenoid 53, which circuit is as follows: From the main lead wire 154 through the solenoid 53, lead wire 137, blade 106, contacts 105, 105, lead wire 161, switch blade 114, contacts 117, 119, lead wires 162, 149, switch blade 132, contacts 133, 131, blade 130 to the other main lead wire 150.

While I have shown and described my invention in detail it is to be understood that the same is to be limited only by the appended claims for many changes may be made without departing from the spirit and scope of the invention.

What I claim is:

1. In a grinding machine having a grinding means for grinding a surface of a ring member, supporting means for engagement by the outer periphery of the ring member, a holder for holding the ring member in a position for the grinding operation, and a pair of spaced rotatable drive members each having spaced outer peripheral flanges between which the opposite sides of the ring member are engaged to rotate the ring member on its outer periphery on said supporting means.

2. In a grinding machine having a grinding wheel for grinding a ring member, supporting means for engagement by the outer periphery of the ring member, a pair of spaced drive members having flanges for engaging opposite sides of and rotating the ring member, a reciprocal holder for the ring member, said holder being operable to position the ring member between the flanges of said drive members and to withdraw the ring member upon completion of the grinding operation, and means controlling reciprocation of said holder.

3. In a grinding machine having a grinding wheel for grinding a ring member, supporting means for engagement by the outer periphery of the ring member, a pair of spaced drive members having spaced outer peripheral flanges to engage opposite sides of and rotate the ring member during the grinding operation, a reciprocal holder operable to position the ring member between the flanges of said drive members and to withdraw the ring member upon completion of the grinding operation, said holder being movable laterally toward the grinding wheel, and means controlling said lateral movement and actuated by reciprocal movement of said holder.

4. In a grinding machine having a grinding wheel for grinding a ring member, a movable carriage, supporting means on said carriage for engagement by the periphery of the ring member, a pair of spaced drive members on said carriage, said drive members having spaced outer peripheral flanges to receive the ring member therebetween, said flanges engaging opposite sides of the ring member for frictionally rotating the ring member during the grinding operation, a holder for the ring member and carried by said carriage, said holder being movable in one direction to position the ring member between the flanges of said drive members, means controlling reciprocation of said holder, said carriage being movable transversely to the direction of movement of said holder for moving the ring member toward the grinding wheel and means controlling movement of said carriage and operable in accordance with movement of said holder.

5. In a grinding machine having a grinding wheel for grinding a ring member, a movable carriage, supporting means on said carriage for engagement by the outer periphery of the ring member, a pair of spaced drive members on said carriage, said drive members having spaced outer peripheral flanges to receive the ring member therebetween and engage opposite sides thereof to rotate the ring members during the grinding operation, a container for a plurality of the ring members and having an outlet, a holder member on said carriage for one of the ring members

and movable in one direction to a position beneath the outlet of said container to receive a ring member, said holder being movable in the opposite direction to position the ring members carried thereby between the flanges of said drive members, said carriage being movable transversely to the movement of said holder to move the ring member toward the grinding wheel, means controlling movement of said carriage and actuated by said holder, and means controlling the outlet of said container and actuated by said holder.

6. In a grinding machine having a grinding wheel for grinding a ring member, a movable carriage, supporting means on said carriage for engagement by the outer periphery of the ring member, a pair of spaced drive members on said carriage, said drive members having spaced outer peripheral flanges to receive the ring member therebetween and engage opposite sides thereof to rotate the ring members during the grinding operation, a container for a plurality of the ring members and having an outlet, a holder member on said carriage for one of the ring members and movable in one direction to a position beneath the outlet of said container to receive a ring member, said holder being movable in the opposite direction to position the ring members carried thereby between the flanges of said drive members, said carriage being movable transversely to the movement of said holder to move the ring member toward the grinding wheel, means controlling movement of said carriage and actuated by said holder, and means controlling the outlet of said container and actuated by said holder and means for discharging the ground ring member from said holder end actuated by movement of said holder toward said first-named position.

7. In a grinding machine having a grinding wheel for grinding a ring member, supporting means for engagement by the outer periphery of the ring member, a drive member having flanges for engaging opposite sides of and rotating the ring member, a reciprocal holder for the ring member, said holder being operable to position the ring member between the flanges of said drive member and to withdraw the ring member upon completion of the grinding operation, and means controlling reciprocation of said holder.

8. In a grinding machine having a grinding wheel for grinding a ring member, supporting means for engagement by the outer periphery of the ring member, a drive member having spaced outer peripheral flanges to engage opposite sides of and rotate the ring member during the grinding operation, a reciprocal holder operable to position the ring member between the flanges of said drive member and to withdraw the ring member upon completion of the grinding operation, said holder being movable laterally toward the grinding wheel, and means controlling

said lateral movement and actuated by reciprocal movement of said holder.

9. In a grinding machine having a grinding wheel for grinding a ring member, a movable carriage, supporting means on said carriage for engagement by the periphery of the ring member, a drive member on said carriage, said drive member having spaced outer peripheral flanges to receive the ring member therebetween, said flanges engaging opposite sides of the ring member for frictionally rotating the ring member during the grinding operation, a holder for the ring member and carried by said carriage, said holder being movable in one direction to position the ring member between the flanges of said drive member, means controlling reciprocation of said holder, said carriage being movable transversely to the direction of movement of said holder for moving the ring member toward the grinding wheel and means controlling movement of said carriage and operable in accordance with movement of said holder.

10. In a grinding machine having a grinding wheel for grinding a ring member, a movable carriage, supporting means on said carriage for engagement by the outer periphery of the ring member, a drive member on said carriage, said drive member having spaced outer peripheral flanges to receive the ring member therebetween and engage opposite sides thereof to rotate the ring members during the grinding operation, a container for a plurality of the ring members and having an outlet, a holder member on said carriage for one of the ring members and movable in one direction to a position beneath the outlet of said container to receive a ring member, said holder being movable in the opposite direction to position the ring members carried thereby between the flanges of said drive member, said carriage being movable transversely to the movement of said holder to move the ring member toward the grinding wheel, means controlling movement of said carriage and actuated by said holder, and means controlling the outlet of said container and actuated by said holder and means for discharging the ground ring member from said holder end actuated by movement of said holder toward said first-named position.

11. In a grinding machine having a grinding wheel for grinding a work piece, drive means for rotating the work piece during the grinding operation, a reciprocal holder for the work piece, said holder being movable in one direction to position the work piece in driving relation with said drive means and movable in the opposite direction to withdraw the work piece, switch means controlling reciprocation of said holder and actuated thereby, said holder also being movable laterally to move the work piece toward said grinding wheel, and switch means controlling lateral movement of said holder and actuated thereby.

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