

June 30, 1936.

G. W. BINNS

2,045,894

GRINDING MACHINE

Filed Dec. 2, 1931

6 Sheets-Sheet 1

Fig. 1

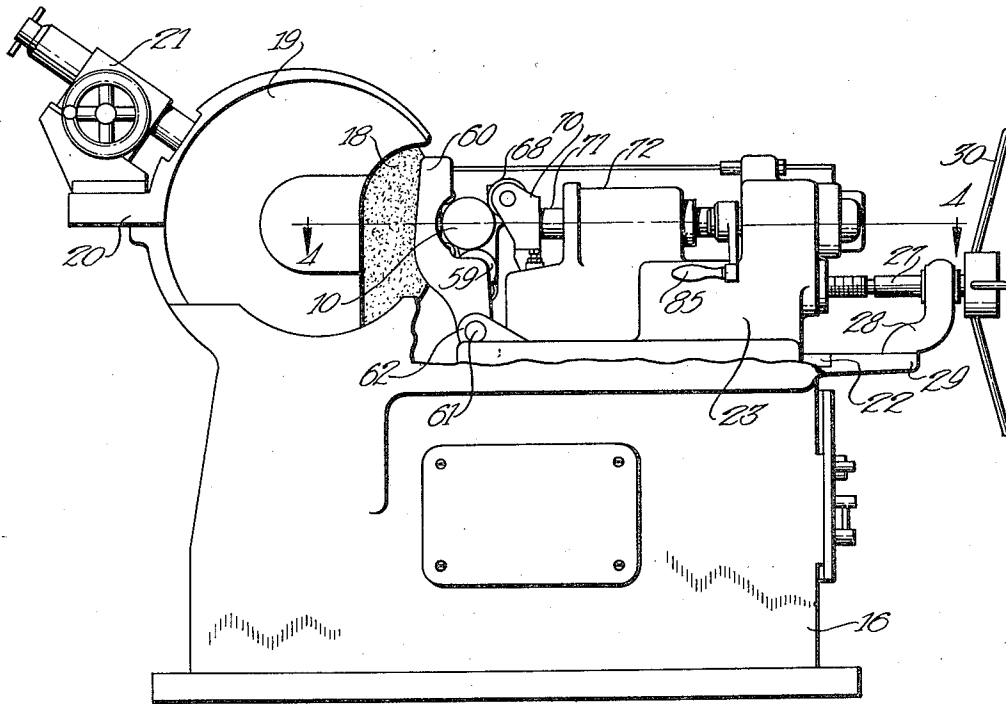
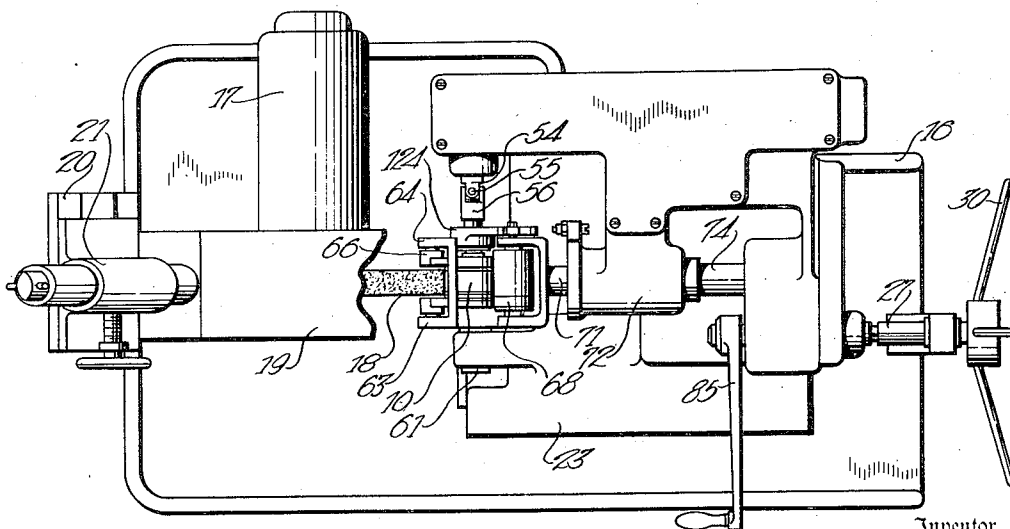


Fig. 2

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6 Sheets-Sheet 2

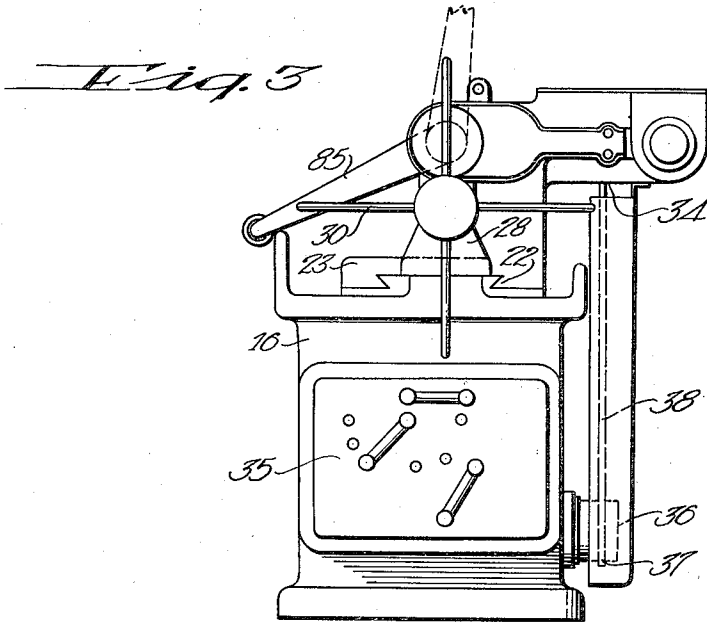
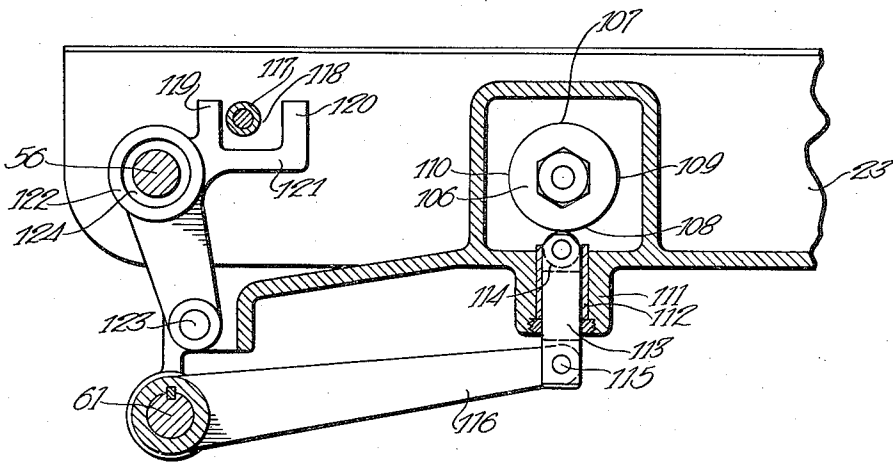


Fig. 8

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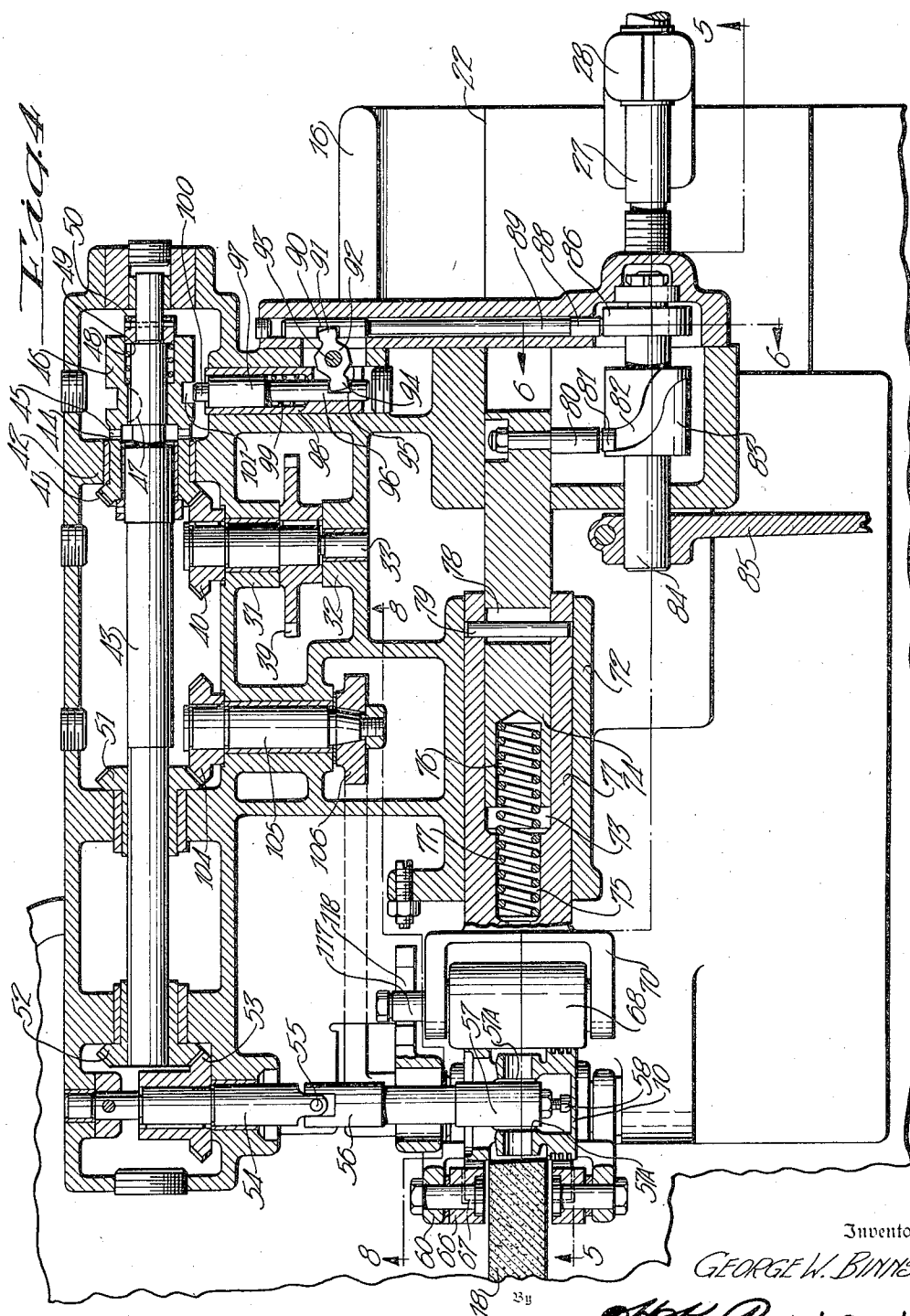
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GRINDING MACHINE

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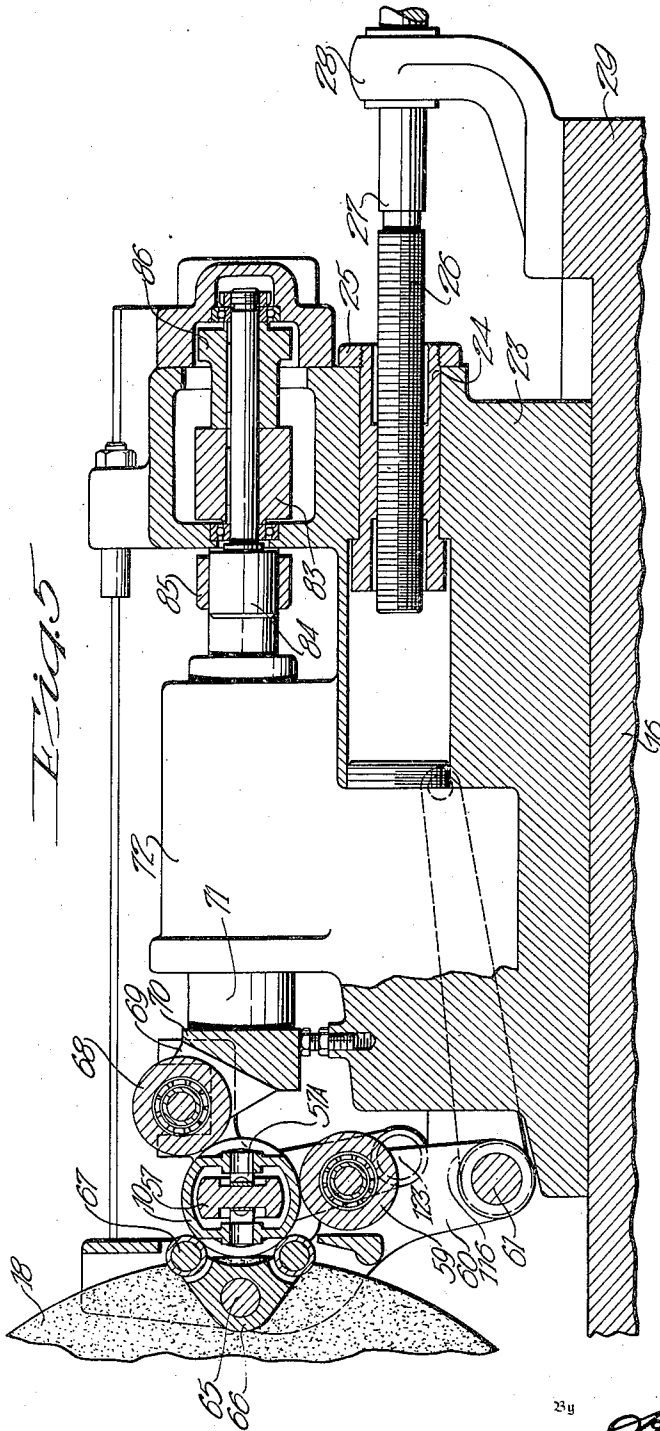
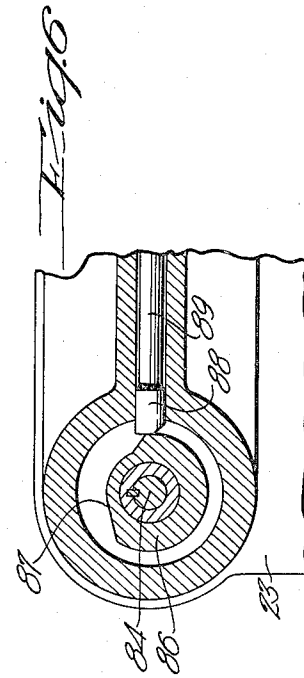
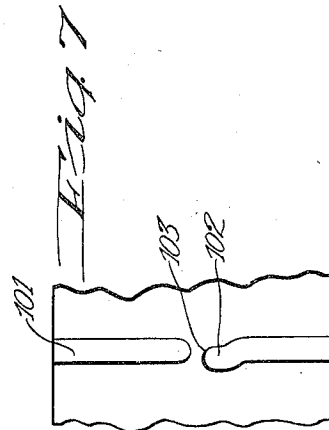
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GRINDING MACHINE

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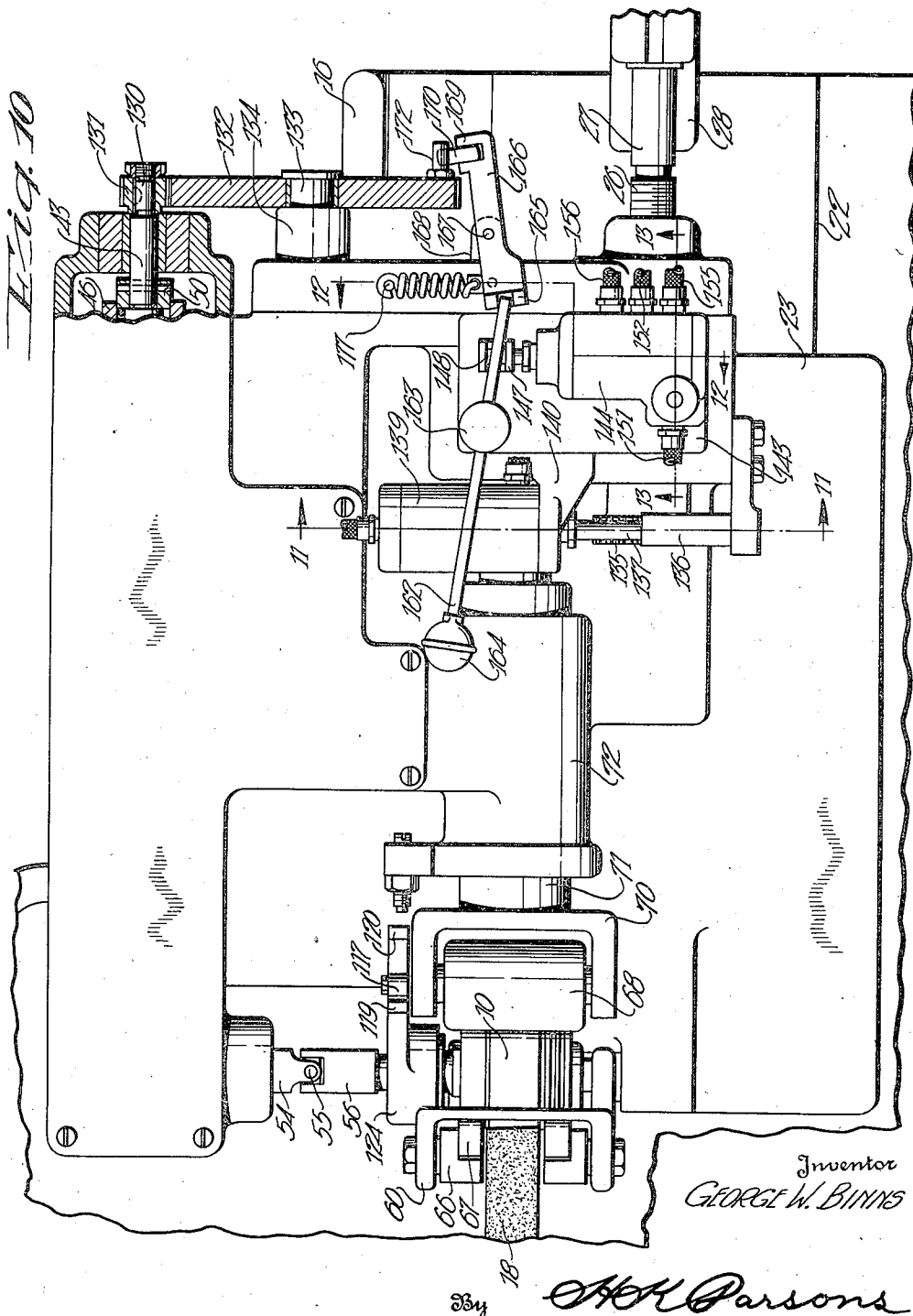
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GRINDING MACHINE

Filed Dec. 2, 1931

6 Sheets-Sheet 6



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2,045,894

GRINDING MACHINE

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Application December 2, 1931, Serial No. 578,539

18 Claims. (Cl. 51—103)

This invention relates to improvements in machine tools and especially to improvements in a grinding machine.

An object of the invention is the provision of a grinding machine for effecting an intermittent contact between the work and grinding wheel for spot grinding around the periphery of a cylindrical article.

Another object of the invention is the provision of a grinding machine for variably relieving or under-cutting sides of cylindrical articles.

Another object of the invention is the provision of a grinding machine for accomplishing the results above set forth so timed that the relieved or under-cut portions will bear a definite relation to other portions of the work piece.

A further object of the invention is the provision of a grinding machine for relieving the skirt of internal combustion engine pistons at definite predetermined points relative to the remainder of the piston.

A still further object is the provision of a semi-automatic grinding machine for accomplishing the objects above set forth.

Other objects and advantages of the present invention should be readily apparent by reference to the accompanying drawings illustrating the invention taken in connection with the accompanying specification and it is to be understood that any modifications may be made in the exact structural details there shown and described within the scope of the appended claims without departing from or exceeding the spirit of the invention.

In the drawings:

Figure 1 is a front elevation of a grinding machine embodying improvements of this invention.

Figure 2 is a top plan view of the machine shown in Figure 1.

Figure 3 is an end elevation of the machine shown in Figures 1 and 2.

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

Figure 5 is a vertical sectional view taken on line 5—5 of Figure 4.

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

Figure 7 is a fragmentary view of one of the cams in development.

Figure 8 is a sectional view taken on line 8—8 of Figure 4.

Figure 9 is an elevational view of an internal combustion engine piston showing the relieved portions ground by this machine.

Figure 10 is a fragmentary top plan view of

the machine shown in Figure 1 including certain modifications.

Figure 11 is a sectional view taken on line 11—11 of Figure 10.

Figure 12 is a sectional view taken on line 12—12 of Figure 10.

Figure 13 is a sectional view taken on line 13—13 of Figure 10.

Figure 14 is a diagrammatic view of the hydraulic circuits involved in this invention.

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

As was noted above the principal object of this invention is the relieving of cylindrical parts at definite points around its external surface. As shown in Figure 9 the work piece 10 is provided with the undercut or relieved portions 11 and 12 which are duplicated on opposite sides and lie adjacent the connecting rod wrist pin holes or pads 13. It will be noted that the end 14 of the skirt is left cylindrical as well as the piston ring land portion 15. This intermittent or spot grinding is accomplished by feeding the work toward and from the grinding wheel twice during each revolution of the work.

A machine for accomplishing the purposes of this invention may comprise a bed 16 having rising therefrom at one end thereof the pedestal bearing 17 in which is journaled a spindle for a grinding wheel 18. The grinding wheel is rotated in a clockwise direction at a high grinding rate of speed and is inclosed within a suitable guard or housing 19 secured to the bearing 17. A bracket 20 is secured to the housing 19 and supports for movement relative thereto a truing mechanism 21 whereby the active face of the grinding wheel may be properly conditioned or formed. The bed 16 is further provided on its upper surface with guideways 22 for guiding the carriage 23 longitudinally of the bed 16 toward and from the grinding wheel 18. In order to adjust the carriage 23 relative to the ways 22 it has secured therein a sleeve nut 24 held against movement relative to the carriage by means of a nut 25 threaded thereon. Meshing with the threads of the sleeve nut 24 are the threads 26 of an adjusting screw 27 journaled in a bracket 28 secured in any desirable manner to an extension 29 of the bed 16. Secured to the screw 27 beyond the bracket 28 is a pilot or hand wheel 30 whereby the said screw may be actuated.

The carriage 23 is provided within its peripheral bounds with bosses 31 and 32 in which is journaled a stud 33. The stud 33 lies above an

opening 34 in the carriage 23 which opening is beyond the rear wall of the bed 16. The bed 16 incloses a change speed or gear box 35 which terminates in a shaft 36 projecting exteriorly of the machine. The initial power may be derived from any suitable source such as the counter shaft, individual motor or the like for rotating the shaft 36 at the desired speed depending upon the adjustment or engagement of the transmission gears within the speed box 35. Secured to the shaft 36 is a sprocket 37 about which is trained a sprocket chain 38 which is also trained about a second sprocket 39 secured to the stud 33. The stud 33 has secured to its one end a bevel pinion or gear 40 meshing with a complementary bevel gear or pinion 41 journaled in a bearing 42 formed integral with the slide 23. The gear 41 is adapted to be clutched to a drive shaft 43 journaled in the slide and from which the power or motion is taken for operating the several parts about to be described.

From the foregoing it will be noted that the sprocket 39 may be operated at various speeds for rotating the driven shaft 43 so that the several parts controlled thereby are operated at different desirable speeds depending entirely on the work being operated upon as well as on the desires or wishes of the operator.

In order to effect the rotation of drive shaft 43 the bevel pinion or gear 41 is provided on its rear surface with clutch teeth 44 adapted to mesh with complementary clutch teeth 45 formed on the adjacent end of slidable clutch member 46 keyed or otherwise slidably connected as at 47 with the driven shaft 43. The clutch member 46 is provided with a counter-bore 48 in which is received a spring 49 abutting on one end with the base of the counter-bore and on the other end with a collar 50 pinned or otherwise secured to the shaft 43.

As illustrated in Figure 4, the clutch teeth 44 and 45 are in contact with one another whereby the shaft 43 is driven for rotating bevel gears or pinions 51 and 52 splined to the shaft 43. The bevel pinion 52 meshes with and drives a complementary bevel gear 53 keyed or otherwise secured to the section 54 of a universally jointed shaft journaled in bearings integral with the slide 23. The section 54 has a universal joint 55 connected to the work driving shaft section 56 which has on its forward end a work driving head 57. This head 57 as shown in the drawings is of a width to fit between the opposed faces of the wrist pin lugs 13 and effect a driving connection with the piston or work 10 thereby. The head 57 is further provided with an adjustable screw or bolt 58 forming a stop for limiting the movement of the piston or the head 57 by engaging the inner surface of the piston head. The head 57 is provided on its longitudinal sides with springs 57-A to take up any play between the said head and the work as well as permit a slight relative movement between the work and head when desired.

The work or piston 10 is supported during the grinding operation by a roll 59 journaled at its opposite ends in a forked frame 60 pivoted at 61 to lugs 62 carried by the carriage 23. The arms 63 and 64 of the frame 60 flank the sides of grinding wheel 18 and each has pivoted thereto as at 65 a two-fingered arm 66. Each of the fingers of the arm 66 carries a roller 67 adapted to engage the cylindrical portions 14 and 15 of the piston. A roller 68 carried by the fork 69 of a plunger head 70 engages the work 10 at a point above center and on the opposite sides to

that which contacts with the grinding wheel 18. By reference to Figure 5 the position of the several rollers will be readily perceived. From this it will be seen that the roller 59 is in a position to take the thrust of the grinding wheel as it removes the stock from the piston and the said roller 59 acts as a work rest or support. The roller 68 effects the lateral shifting of the work toward the grinding wheel and maintains contact between the work and work supporting roller 59 as well as the guide rollers 67 but yields during the lateral shifting of the work as will later appear.

The pressure roller 68 and its supporting head 70 are secured to or made integral with a plunger 71 slidably mounted in a bearing sleeve 72 rising from the carriage 23. The plunger 71 has formed therein a bore 73 receiving the forward portion of a sliding rod 74. The plunger 71 is provided ahead of the bore 73 with a counter-bore 75 of a diameter less than the diameter of the bore 73. In axial alignment with the relatively small diameter bore 75 the rod 74 is provided with a counter-bore 76 of the same diameter as the bore 75. Received in the bores or sockets 75 and 76 is a coiled spring 77 abutting on the opposed bases of said sockets and affording a yieldable connection between the slide rod 74 and plunger 71. The slide rod 74 is provided intermediate its ends with a slot 78 through which a pin 79 extends. The pin being carried by the plunger 71 so that after a limited movement of the rod 74 in either direction the plunger 71 is actuated thereby. This rod 74 carries at its rear end a pin 80 having on the end thereof a roller 81 received in a cam groove 82 of a barrel cam 83 secured to shaft 84 journaled in bearings provided by the slide 23. The shaft 84 extends beyond the bearings and has secured to its extended portion a lever 85 adapted to be manually actuated for effecting the oscillation of the cam 83 and the axial reciprocation of rod 74 and plunger 71.

In the operation of the machine the lever 85 is oscillated from the position shown in Figure 2 in a clockwise direction through substantially 90° at which time the lever 85 stands in a substantially vertical position. It is desired that shaft 43 and all parts operated therefrom be stopped when the work piece is being replaced on the work driving head 57. For this reason the connecting and disconnecting clutch 46 is operated by the hand lever 85. This control mechanism comprises a cam 86, see Figure 6, keyed or otherwise secured to the other end of the shaft 84. The cam 86 is provided with an interrupted periphery as shown at 87 which cooperates with the nose 88 of a rod 89 adapted to be axially shifted laterally of the carriage 23. The other end of the rod 89 is provided with a notch 90 receiving the ball end 91 of a link 92 pivoted intermediate its end to a vertical stud 93 carried by the carriage 23. The link 92 is provided on its other end with a ball portion 94 receiving in a notch 95 formed in a plunger 96. The plunger 96 is provided with a head 97 received in a guide sleeve 98. The sleeve 98 also incloses a coiled spring 99 which abuts on one end with a head 97 of the plunger and on the other end with the base of the counter-bore receiving the said head 97. The rear end of the plunger 96 is provided with a nose 100 adapted to enter a cam groove 101 formed in the clutch member 46. The cam groove 101 is shown in development in Figure 7 and as will be noted therein is provided on its

one end with an offset portion 102. The offset portion 102 is such that when the nose 100 of plunger 96 is within the groove it effects a shifting of the clutch member 46 to the right as seen in Figure 4 for disengaging the clutch teeth 44 and 45. It will further be noted that the cam groove 101 terminates in a vertical wall 103 which when engaged by the nose 100 of the plunger 96 stops further coasting or rotation of the clutch 46 and consequently the shaft 43 for arresting all movement of the parts.

The bevel pinion or gear 51 splined on the shaft 43 intermediate its ends and above referred to, meshes with a complementary bevel gear or pinion 104 keyed or otherwise secured to a stud 105 journaled in suitable bearings provided by the carriage 23. The stud 105 has secured to its other end a cam 106, see Figure 8, having diametrically opposed high portions 107 and 108 joined by diametrically opposed low portions 109 and 110. The carriage 23 is provided beneath the cam 106 with a boss 111 for a guide sleeve 112 through which is axially shifted a plunger 113. The plunger 113 has rotatably journaled on its upper end a roller 114 adapted to contact with the periphery of the cam 106. The other end of the plunger 113 has pivoted at 115 one end of an arm 116 which is keyed or otherwise secured at its other end to the pivot shaft 61 of the forked frame 60. The rotation of the cam 106 effects the oscillation or rocking movement of the work controlling frame 60 for retracting the work periodically from the grinding wheel against the resistance of the plunger feed spring 77 which causes the work to feed toward the grinding wheel as the low spots of the cam 106 register with the plunger 113.

At the conclusion of the grinding operation when the handle or lever 85 is oscillated in a clockwise direction, the cam groove 82 retracts the slide rod 74 pulling with it the plunger 71. This plunger 71 as noted above, carries the head 70 for the pressure roller 68 which head 70 has extending beyond it the shaft or stud 117 of the roller 68 which is positioned within the space 118 formed by arms 119 and 120, see Figure 8. These arms 119 and 120 are integral with the arm 121 of a bell crank 122 which is pivoted at 123 to the carriage 23. At the junction of the arms of the bell crank 122, it is provided with an enlarged bore 124 through which passes the section 56 of the work driving shaft. From this it will be seen that as the rod 74 is retracted it carries with it the plunger 71 and through the roller shaft extension 117 and arm 121 oscillates the work driving shaft section 56 about the universal joint 55 for properly positioning the said shaft for work removal and insertion relative to the driving head 57.

The complete operation of the machine is as follows:

With the parts in a retracted position a work piece is mounted on the driving head 57 with the sides thereof engaging the opposed faces of the wrist pin bosses 13. The handle or lever 85 is now actuated from a vertical position shown in dotted lines in Figure 3 in a counter-clockwise direction. This movement first oscillates the barrel cam 83 for causing the roller 68 to engage the work and shift same nearly to a grinding position. At this time the interrupted cam 86 registers with the slide rod 89 so that the spring 99 may expand for oscillating the link 92 in a clockwise direction and shift the rod 89 to the right as seen in Figure 6. This oscillation of the

link 92 retracts the plunger 96 withdrawing its nose 100 from the cam groove 101 in the clutch member 46. This release of the clutch 46 permits the spring 49 to expand and effect a driving engagement between the clutch teeth 44 and 45. Since the sprocket 39 is being constantly rotated, the shaft 43 will immediately rotate after engagement of the clutch teeth. The rotation of the shaft 43 causes through the inter-meshing of pinions 52 and 53 the rotation of the work 10. Simultaneously with the rotation of the work 10 the cam 106 is rotated through the bevel gears or pinions 51 and 104 for oscillating the arm 116 and effecting the feed and retraction of the work relative to the grinding wheel. It will be seen that the parts are so inter-coupled that the work makes two feeding and retracting movements toward and from the grinding wheel for each rotation thereof since the cam 106 is rotated at the same speed as the work and since it is provided with a double throw spaced 180° apart for synchronizing the said movement of the work toward and from the wheel with its rotation.

The modified machine shown in Figures 10 to 14 inclusive illustrates a power controlled mechanism requiring only so much of the attention of the operator as is necessary to initiate the automatic operation thereof by manually shifting a hydraulic control valve. The driven shaft 43 is extended through and beyond the end bearing of the carriage 23 as shown at 130 in Figure 10. A pinion 131 is secured to the end of the shaft extension 130 and meshes with a large gear 132 loosely journaled on a stud 133 driven into or secured to a boss 134 on the carriage 23. The only other change from the mechanism above described is the replacement of the handle 85 on the cam shaft 84 by a rack pinion 135 which meshes with a rack 136 secured to or formed on a piston rod 137. The piston rod 137 is carried by an hydraulically actuated piston 138 inclosed within a cylinder 139 secured by a bracket 140 to the upper surface of the slide 23. The piston rod 137 is extended beyond the rack 136 and forms a pilot or guide 141 slidable through an aperture formed in a bracket 142 secured to the forward face of the carriage 23.

Mounted on the upper surface of the carriage 23 is a base or block 143 having integral therewith a valve casing 144 inclosing a spool valve 145. The spool valve 145 is pinned or otherwise secured to a valve rod 146 which extends beyond the casing 144 at one end and is provided with a head 147 in which is formed an annular groove 148. The valve casing 144 has formed therein ports 149 and 150 respectively connecting with a pressure source and reserve tank by means of conduits 151 and 152 extending therefrom. The valve casing is further provided with ports 153 and 154 respectively connected as by conduits 155 and 156 with the opposite ends of the piston cylinder 139. The pressure port 149 communicates with a port 157 which is controlled by a throttle valve 158 and connects with a longitudinal port 159 communicating at its opposite ends through ports 160 and 161 with the interior of the valve casing 140. The pressure from the port 160 is directed by the valve spool into the conduit 155 for actuating the piston 138 in one direction and the exhaust fluid behind the piston is exhausted through the conduit 156 and spool valve to the exhaust port and conduit 150 and 152. When the spool valve 145 is shifted to its other position the pressure from the port 161 is then directed by the spool valve to the conduit 156 for

actuating the piston in the other direction, at which time the exhaust is had from the cylinder through the conduit 155, valve 145 to the conduit 152.

5 It will be understood that actuation of the piston to the right as seen in Figure 11 effects the operation of the parts in the same manner that the oscillation of the lever 85 from a vertical position to a horizontal position and that a
10 reverse movement of the piston retracts the parts to their initial positions.

The valve 145 is actuated by means of a lever 162 which is secured in a pivoted stud 163 and has on its one end the knob 164. The lever 162
15 has a shoe depending from it received in the annular groove 143 of valve stem head 147 and its other end in the bifurcated end 165 of a lever 166. The lever 166 is pivoted at 167 to a boss 168 extending outwardly from the carriage 23. The other end of the lever 166 is also bifurcated
20 as at 169 and has rotatably journaled therein roller 170. The roller 170 is adapted to be engaged, for oscillating the lever 166, by a stud 171 projecting from the side of the large gear 32.

25 In the lug 168 nearest the forked end 165 of the lever there is provided a socket 172 in which is mounted a detent 173 actuated outwardly by means of a spring 174 abutting on one end with the base of the socket 172 and on the other end
30 with the under side of the detent 173. The lever 166 is provided with a socket 175 on its under surface and adapted to receive the detent 173 for holding the lever in one position against the yielding resistance of a spring 176 secured at one
35 end to the lever 166 and anchored at its other end 177 to the carriage 23.

The operation of the power actuated mechanism is as follows: After placing a work piece on the driving head 57 the operator actuates the
40 valve handle 162 in a clockwise direction as seen in Figure 10. This shifts the valve 145 inwardly and through the end of the handle 162 oscillates the arm 166 in a counter-clockwise direction. This movement of the valve lever 162 initiates
45 movement of the piston 138 for rotating the rack pinion 135 and thereby setting in motion the various parts of the mechanism. The initiation or rotation of the shaft 43 also rotates the pinion 131 which is meshed with the gear 132. As shown
50 in the drawings a ratio of eight to one exists between the gear 132 and pinion 131 whereby the shaft 43 will make eight revolutions to one revolution of the gear 132. At this time the spring pressed detent 173 is holding the valve
55 lever 162 in its operative position. As soon as the gear 132 makes a complete revolution, the stud 171 thereon engages the roller 170 and actuates the arm 166 in a clockwise direction thereby freeing said arm of the restraint placed thereon by
60 the detent 173 whereupon the spring 176 oscillates it in a clockwise direction about the pivot 167 for shifting the valve control lever 162 to its other position causing the hydraulic fluid to be connected with the other side of the piston 138
65 and effecting its reverse actuation. This reverse movement of the piston 138 is the equivalent of oscillating the handle 185 in a counter-clockwise direction and effecting the retraction of the parts. As soon as the piston reaches the limit of its
70 rearward movement the clutch is disengaged as above described, thereby stopping further rotation of all the parts pending the manual shifting of the lever 162 rearwardly after the finished work piece has been replaced.

75 It will be noted that this modification provides

the same amount of grinding time for each work piece, thereby insuring successive work pieces being produced in identical condition and finish.

What is claimed is:

1. In a grinding machine of the class described, 5 the combination of a bed, a grinding wheel rotatably supported thereby, a work rotating and feeding mechanism including a slide mounted on the bed, supporting and pressure rolls on the slide, yielding means for urging the pressure roll
10 in the direction of the work to maintain contact between the work and supporting roll and grinding wheel, and additional power operated means for periodically retracting the work from the grinding wheel against the yielding urge of the
15 pressure roll.

2. In a grinding machine of the class described, the combination of a bed, a grinding wheel rotatably supported thereby, a work rotating and feeding mechanism including a slide mounted on
20 the bed, supporting and pressure rolls on the slide, yielding means for urging the pressure roll in the direction of the work to maintain contact between the work and supporting roll and grinding wheel, additional power operated means for
25 periodically retracting the work from the grinding wheel against the yielding urge of the pressure roll, said power retracting means consisting of a cam rotated at the same speed as the work for controlling the engagement of the work and
30 grinding wheel.

3. In a grinding machine for spot grinding the cylindrical surface of a cylindrical work piece the combination of a bed, a grinding wheel rotatably mounted thereon, a power rotated head
35 connected with the work for rotating same, means peripherally supporting the work for rotation while being driven by the head, yielding means urging the work into engagement with its support and the grinding wheel, power means for retracting
40 the work periodically from the grinding wheel against the yielding resistance of pressure means, a power source normally disconnected from the work rotation and work retraction means, a yieldingly actuated clutch for connecting
45 the power source with the said power actuated means, and a lever for connecting and disconnecting the clutch with the power source.

4. In a grinding machine for spot grinding the cylindrical surface of a cylindrical work piece the combination of a bed, a grinding wheel rotatably mounted thereon, a power rotated head connected with the work for rotating same, means
50 peripherally supporting the work for rotation awhile being driven by the head, yielding means urging the work into engagement with its support and the grinding wheel, power means for retracting the work periodically from the grinding wheel against the yielding resistance of pressure
55 means, a power source normally disconnected from the work rotation and work retraction means, a yieldingly actuated clutch for connecting the power source with the said power actuated means, a lever for connecting and disconnecting the clutch with the power source, and means operated
60 by the lever for initially actuating the pressure roll.

5. In a work rotation and feeding mechanism of the class described, the combination of a driven shaft, a work driving head connected with the
70 work and driven shaft, a work feeding mechanism connected with the driven shaft, a power source, a clutch yieldingly actuated for connecting the power source with the driven shaft, a cam associated with the clutch, a plunger adapt- 75

ed to cooperate with the cam for retracting same against the yielding urge thereof, means for holding the plunger out of engagement with the cam during the operating cycle, said means comprising a spring urging the plunger in one direction, a rod, a coupling between the rod and plunger whereby movement of the plunger in one direction shifts the rod in the reverse direction, and removable means contacting with the rod for limiting its movement and thereby holding the clutch plunger out of engagement with the clutch cam.

6. In a work rotation and feeding mechanism of the class described, the combination of a driven shaft, a work driving head connected with the work and driven shaft, a work feeding mechanism connected with the driven shaft, a power source, a clutch yieldingly actuated for connecting the power source with the driven shaft, a cam associated with the clutch, a plunger adapted to cooperate with the cam for retracting same against the yielding urge thereof, means for holding the plunger out of engagement with the cam during the operating cycle, said means comprising a spring urging the plunger in one direction, a rod, a coupling between the rod and plunger whereby movement of the plunger in one direction shifts the rod in the reverse direction, removable means contacting with the rod for limiting its movement and thereby holding the clutch plunger out of engagement with the clutch cam, and a manually actuable lever for actuating the removable means from the path of the shift rod.

7. In a grinding machine of the class described, the combination of a bed, a grinding wheel rotatably mounted on the bed, a work supporting member adjacent the grinding wheel for peripherally supporting the work, flexible driving means for rotating the work on the supporting member, yieldably actuated means including a work contacting roll for urging the work into engagement with the supporting member and grinding wheel, means limiting the movement of the work in the direction of the grinding wheel, means for periodically shifting the work from the grinding wheel to effect spot grinding on the periphery of the work, means for retracting the work from the grinding wheel at the conclusion of the grinding operation including a cam for retracting the yieldable contacting roll, and a coupling between the contacting roll and flexible drive whereby the work is retracted from the grinding wheel and relative to the work supporting member.

8. In a grinding machine of the class described, the combination of a bed, a grinding wheel rotatably mounted on the bed, a work supporting member adjacent the grinding wheel for peripherally supporting the work, flexible driving means for rotating the work on the supporting member, yieldably actuated means including a work contacting roll for urging the work into engagement with the supporting member and grinding wheel, means limiting the movement of the work in the direction of the grinding wheel, means for periodically shifting the work from the grinding wheel to effect spot grinding on the periphery of the work, means for retracting the work from the grinding wheel at the conclusion of the grinding operation including a cam for retracting the yieldable contacting roll, a coupling between the contacting roll and flexible drive whereby the work is retracted from the grinding wheel and relative to the work supporting member, and a manually actuable lever for actuating the retracting means.

9. In a grinding machine of the class described, the combination of a bed, a grinding wheel rotatably mounted thereon, a work support adjacent the grinding wheel, means for positively rotating a work piece while on the support, means for yieldingly urging the work toward the grinding wheel, means for limiting the urge of the work toward the grinding wheel, means for periodically actuating the work from the grinding wheel, and power means for actuating the work limiting and retracting means comprising an hydraulic cylinder, a piston therein and actuable relative thereto, an oscillatable cam, and a rack and pinion connection between the piston and cam.

10. In a grinding machine of the class described, the combination of a bed, a grinding wheel rotatably mounted thereon, a work support adjacent the grinding wheel, means for positively rotating a work piece while on the support, means for yieldingly urging the work toward the grinding wheel, means for limiting the urge of the work toward the grinding wheel, means for periodically actuating the work from the grinding wheel, power means for actuating the work limiting and retracting means comprising an hydraulic cylinder, a piston therein and actuable relative thereto, an oscillatable cam, a rack and pinion connection between the piston and cam, a valve controlling the flow of hydraulic medium to the cylinder, a manually actuable lever for actuating the valve in one direction, means yieldingly holding the valve in its manually actuated position, and power means for releasing the valve and shifting it to its reverse position after a definite cycle of grinding.

11. In a machine for grinding a portion of a work piece to non-circular contour in predetermined relation to a preformed portion of the work piece, the combination with a grinding wheel, of a work supporting device adjacent the grinding wheel in position to engage a preformed peripheral portion of the work piece, means to effect rotation of the work piece, means for urging the work piece against said supporting device as a guide, and means for effecting an oscillation of the work piece and its supporting device in a direction toward and from the grinding wheel in timed relation with the rotation of the work.

12. In a grinding machine of the character described, the combination with the grinding wheel, of work supporting members spanning the grinding wheel adjacent the operative portion of the periphery thereof whereby said members will engage pre-formed peripheral portions of a work piece, means for supporting a work piece with its periphery engaging said members and its intermediate portion in opposition to the grinding wheel, means for rotating the work piece at a prescribed rate while so supported, and means for effecting a back and forth movement of the work supporting members during each rotation of the work piece whereby a central portion of non-circular contour will be formed on the work piece in predetermined relation to the pre-formed support engaging peripheral portions thereof.

13. A grinding machine of the character described, including a grinding wheel, a work support and a work limiting mechanism disposed adjacent the grinding wheel for engagement with the work piece for positioning a work piece in operative relation to the grinding wheel, means interengaged with the work for effecting a positive rotation thereof when so supported, means for resiliently urging the work in the direction

of the grinding wheel and the limiting devices, means for retracting said resilient urging device, and means for subsequently jointly retracting the work and its driving means with respect to the work limiting means whereby discharge of a completed work piece is facilitated.

14. A grinding machine of the character described including a grinding wheel, a work support and a work limiting mechanism disposed adjacent the grinding wheel for engagement with the work piece for positioning a work piece in operative relation to the grinding wheel, means inter-engaged with the work for effecting a positive rotation thereof when so supported, means for resiliently urging the work in the direction of the grinding wheel and the limiting devices, means for retracting said resilient urging device, means for subsequently jointly retracting the work and its driving means with respect to the work limiting means whereby discharge of a completed work piece is facilitated, and means for effecting an oscillation of the work limiting means with respect to the grinding wheel during the grinding operation whereby a varying contour is produced on the work piece during rotation thereof.

15. A grinding machine of the character described including a grinding wheel, means adjacent the grinding wheel adapted to peripherally engage and support a work piece in operative relation to the grinding wheel, means for effecting rotation of the work piece, means for resiliently urging the rotated work piece into operative engagement with the grinding wheel, means engageable with the work piece for variably determining its position with respect to the grinding wheel whereby a non-circular contour is produced on the work piece during rotation thereof, and a single control device for determining the operative effect of said several means as respects the work piece.

16. A grinding machine of the character described including a rotatable grinding wheel and a work support adjacent the grinding wheel for peripheral engagement with the work piece, means independent of the support for effecting a positive rotation of the work piece, work piece engaging means for limiting the movement of the work piece in the direction of the grinding wheel, means for shifting said limiting means and thus the work in a direction substantially radial with respect to the grinding wheel at its point of contact with the work whereby to vary

the work piece diameter as produced by the grinding wheel, a driving member, connections between the driving member and the work rotating mechanism for effecting power rotation thereof, connections between the driving member and the limiting devices for effecting their movement, and a single clutch effective to determine the operative connection between the driving member and said work rotating and position determining elements.

17. A grinding machine of the character described including a rotatable grinding wheel and a work support adjacent the grinding wheel for peripheral engagement with the work piece, means independent of the support for effecting a positive rotation of the work piece, work piece engaging means for limiting the movement of the work piece in the direction of the grinding wheel, means for shifting said limiting means and thus the work in a direction substantially radial with respect to the grinding wheel at its point of contact with the work whereby to vary the work piece diameter as produced by the grinding wheel, a driving member, connections between the driving member and the work rotating mechanism for effecting power rotation thereof, connections between the driving member and the limiting devices for effecting their movement, a single clutch effective to determine the operative connection between the driving member and said work rotating and position determining elements, means for resiliently urging the work piece in the direction of the grinding wheel, and a single control device coupled with said resilient means and said clutch for determining the operative positionings thereof.

18. A grinding machine of the centerless type including a grinding wheel and an opposed carriage, a bracket pivoted to the carriage in proximate relation to the grinding wheel, a plurality of work supporting members carried by the bracket for determining the position of a work piece on the bracket, means for rotating the work piece and urging the same in the direction of the grinding wheel, and power driven means for effecting a limited oscillatory movement of the bracket and parts carried thereby during rotation of the work piece whereby the periphery of the work piece will be variably presented to the operative face of the grinding wheel substantially as and for the purpose described.

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