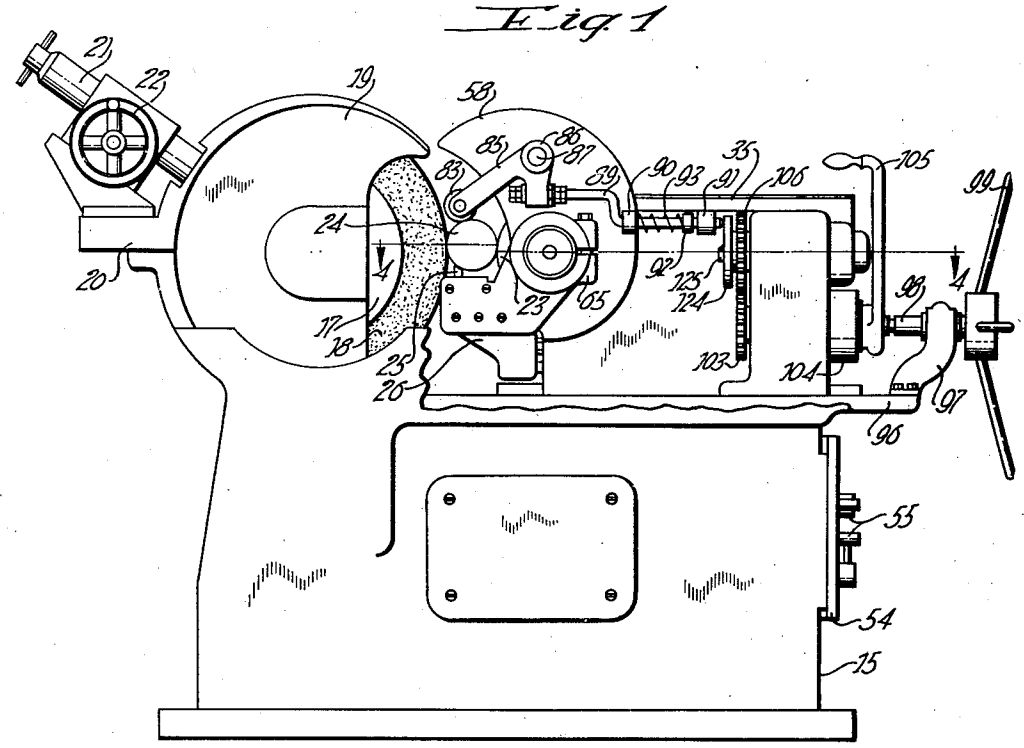
May 7, 1935. A. W. FOERSTER ET AL 2,000,586

GRINDING MACHINE

Filed Sept. 15, 1932 5 Sheets-Sheet 1

Fig. 1



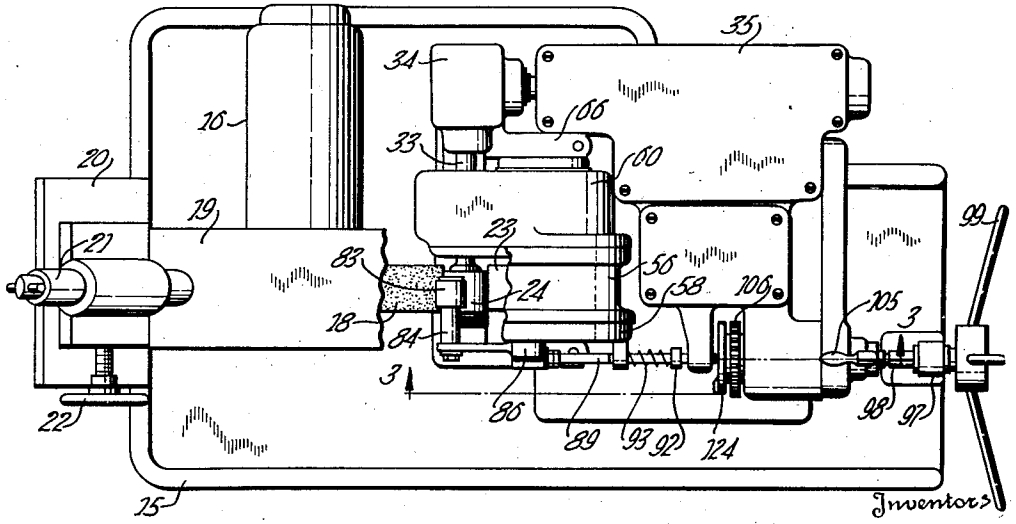


Fig. 2

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GRINDING MACHINE

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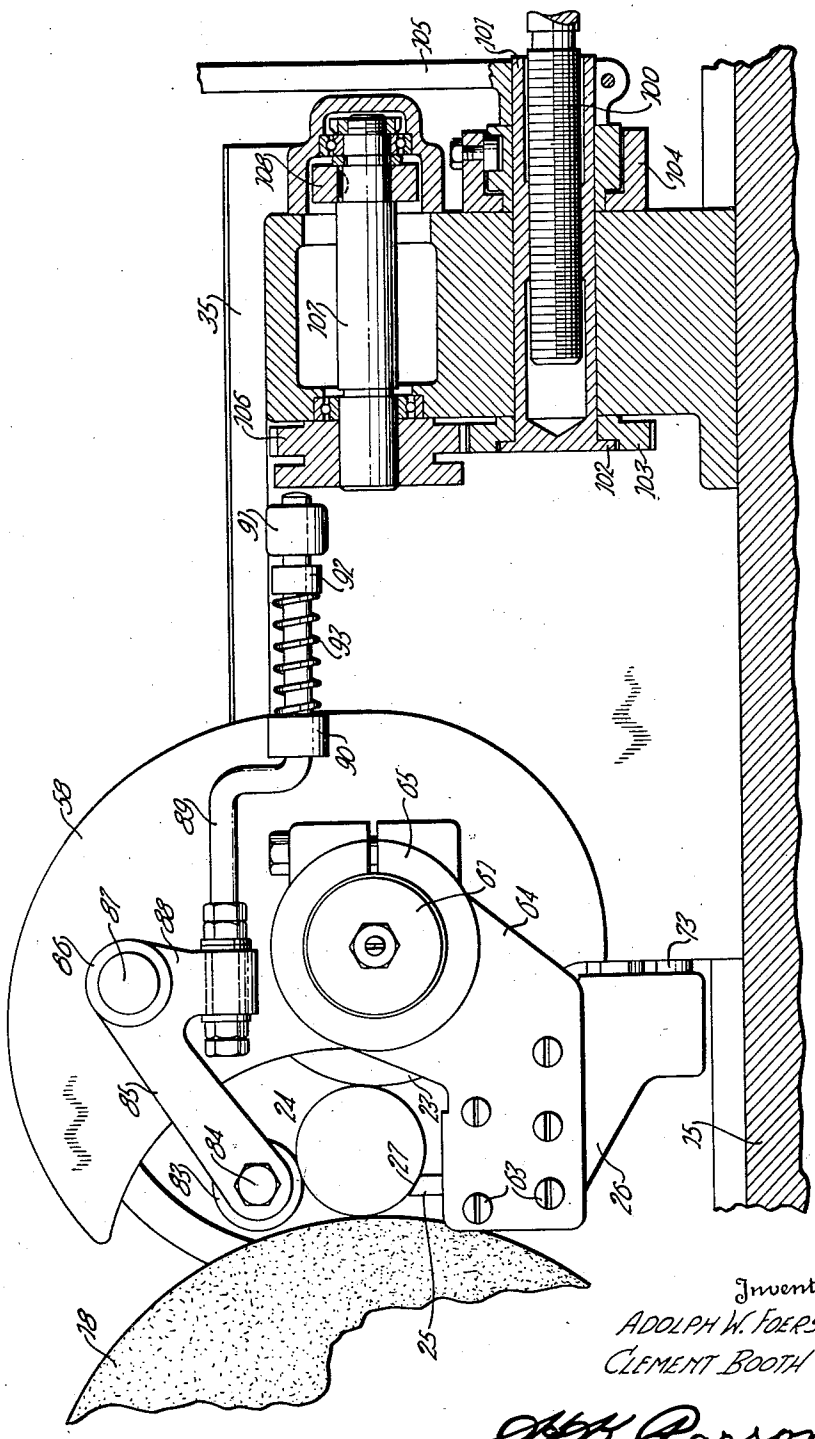
Fig. 3



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GRINDING MACHINE

Filed Sept. 15, 1932 5 Sheets-Sheet 3

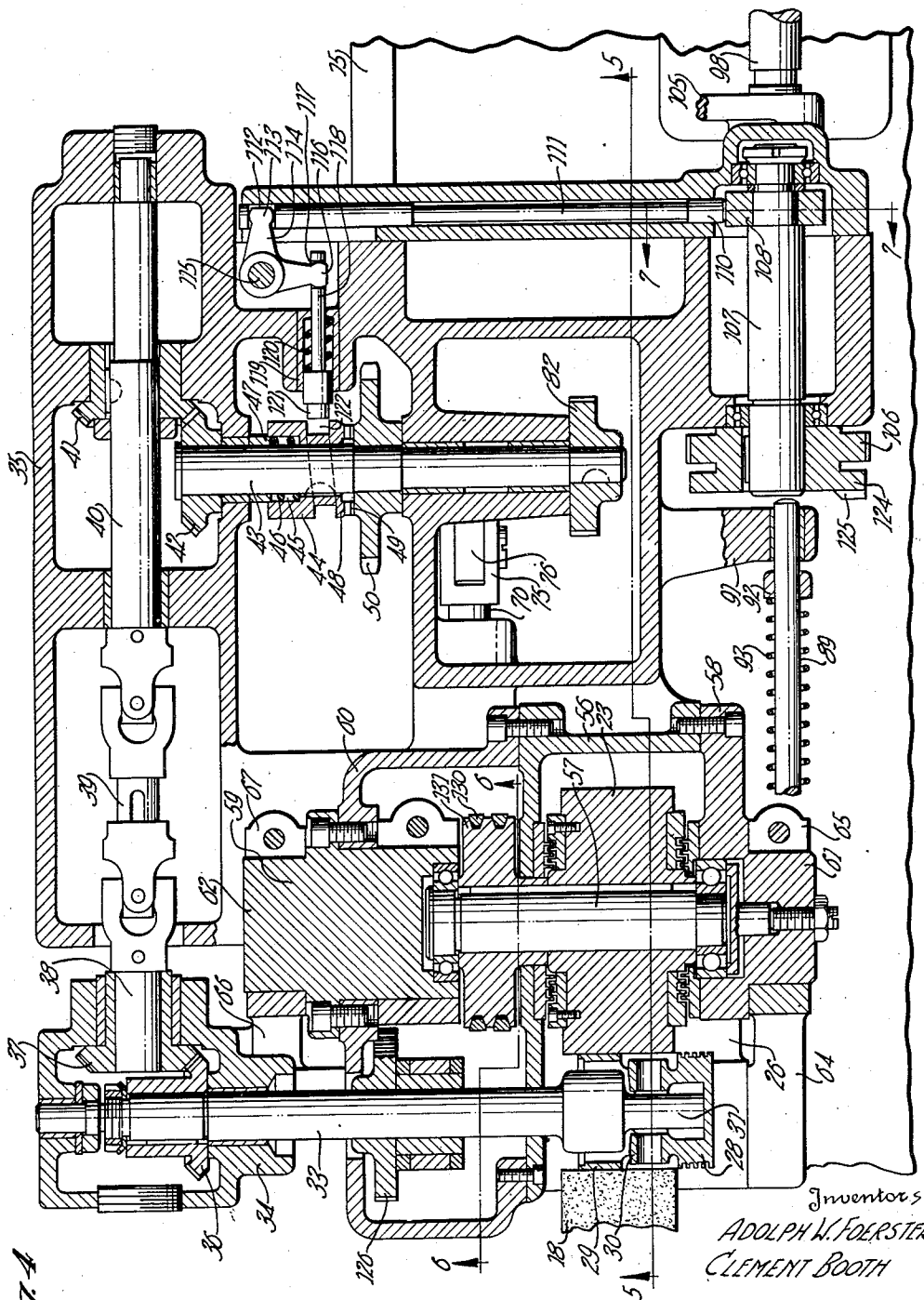

Fig. 4

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GRINDING MACHINE

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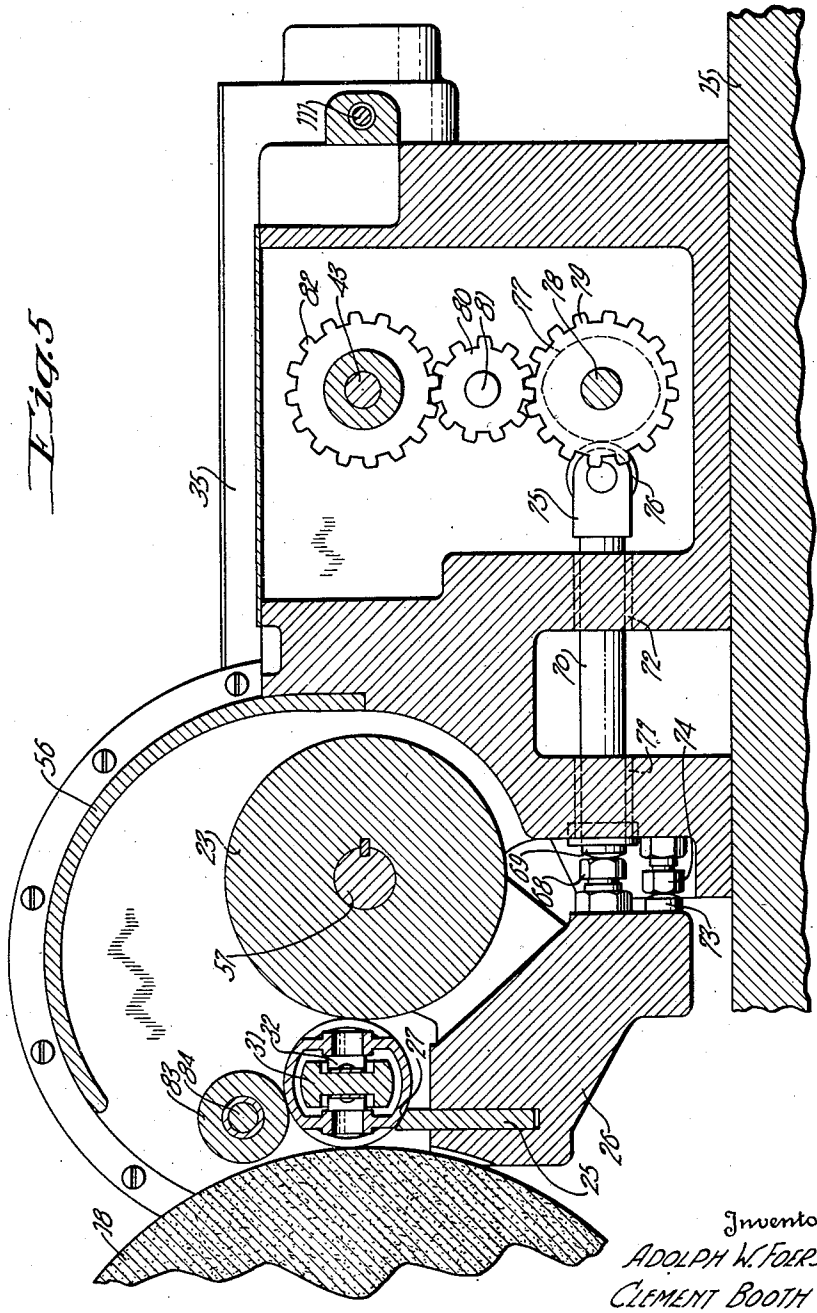
Fig. 5



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GRINDING MACHINE

Filed Sept. 15, 1932 5 Sheets-Sheet 5

Fig. 6

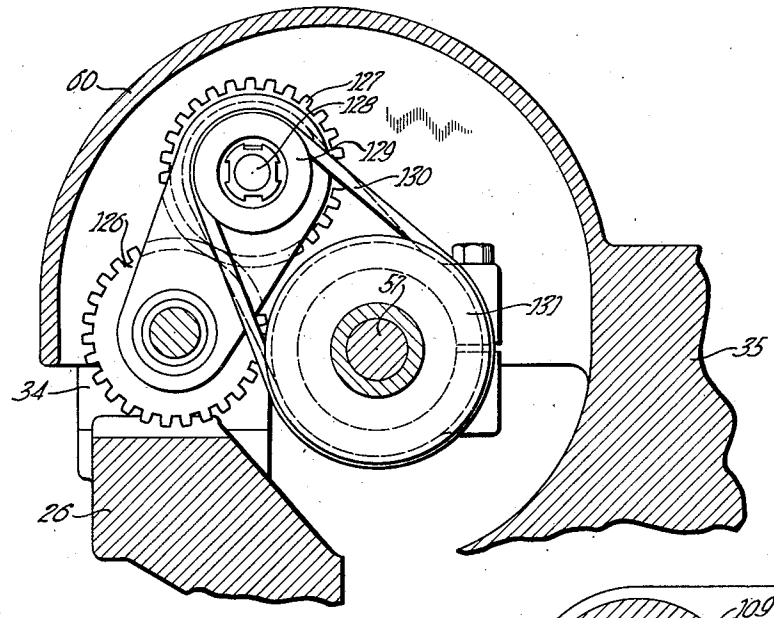


Fig. 7

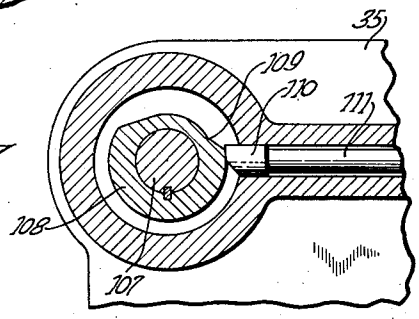
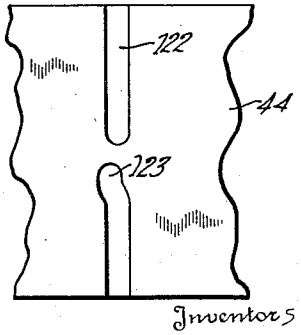


Fig. 8



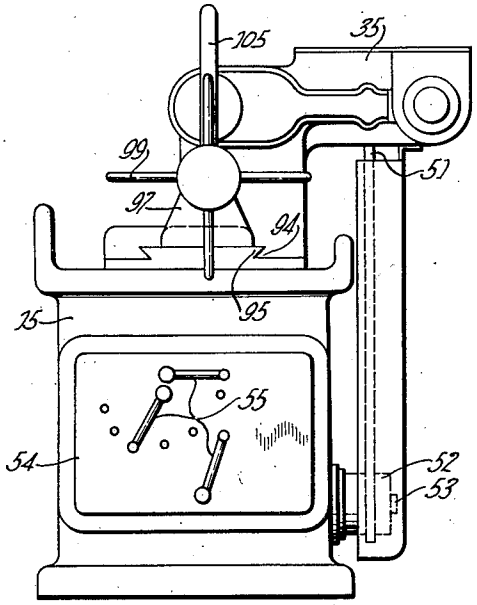


Fig. 9

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Patented May 7, 1935 2,000,586

UNITED STATES PATENT OFFICE

2,000,586

GRINDING MACHINE

Adolph W. Foerster, Detroit, Mich., and Clement Booth, Cincinnati, Ohio, assignors to Cincinnati Grinders Incorporated, Cincinnati, Ohio, a corporation of Ohio

Application September 15, 1932, Serial No. 633,326

18 Claims. (Cl. 51—103)

This invention relates to improvements in machine tools and more especially to improvements in centerless grinders.

An object of the invention is the provision of an improved centerless grinder for producing irregular cylindrical work pieces such as ellipses, cams and the like.

Another object of the invention is the provision of improved means for actuating the work piece while being ground relative to the grinding wheel for generating the desired contour thereon.

A further object of the invention is the provision of an improved work control and feeding mechanism particularly adapted for use with centerless grinding machines.

Further objects and advantages of the present invention consist in improved and simplified details of construction and drive; improved mounting and drive for the regulating wheel; and an improved and simplified control for the parts.

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

In the drawings:

Figure 1 is a front elevation of a centerless grinder embodying the improvements of this invention.

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

Figure 3 is an enlarged view partly in section and partly in elevation as seen from line 3—3 on Figure 2.

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

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

Figure 6 is a fragmentary sectional view taken on line 6—6 of Figure 4 and illustrating the regulating wheel drive.

Figure 7 is a fragmentary sectional view on line 7—7 of Figure 4 illustrating the clutch throw out and engaging mechanism forming a detail of the invention.

Figure 8 is a developed view of the clutch actuating cam slot.

Figure 9 is an end elevation of the machine as seen, for example, from the right hand end of Figures 1 and 2.

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

The machine illustrated in the drawings is adapted to produce various cams or contours of a substantially elliptical shape. There is illustrated in the drawings a machine for producing a piston for an internal combustion engine, which is adapted to have its skirt relieved at points diametrically opposed to one another so that the said skirt forms a substantially elliptical contour when finished. It is to be understood that the machine is not to be limited to a mechanism for producing the specific article illustrated in the drawings, but rather to a machine for generating and finishing cams of elliptical and other shapes.

The machine of this invention comprises a bed 15 having a rectangular or box-like construction from which rises at one end a pedestal bearing 16. Rotatably journaled in the bearing 16 is a spindle 17 for the grinding wheel 18 enclosed within a suitable housing or guard 19 secured in any desirable manner to the bearing 16. The spindle 17 and wheel 18 are adapted to be rotated at a high rate of speed in a clockwise direction by any suitable source, such as a line or countershaft or an independent motor. The hood or housing 19 has secured to it or formed integral therewith a shelf 20 to which is secured the truing mechanism 21 adapted to be traversed relative to the operative face of the grinding wheel 18 by means of the hand wheel or the like 22.

Opposed to the grinding wheel is a regulating wheel or backing up member 23 which co-operates with the grinding wheel to form a grinding throat therebetween in which is disposed the work 24. The work 24 is peripherally supported by a work rest blade 25 secured in a pivotally mounted block 26. The blade 25 is provided with an operative inclined supporting surface 27 which inclines in the direction of the active face of the regulating wheel 23. By means to be later described the regulating wheel 23 is rotated in a clockwise direction at a rate slightly in excess of the speed of rotation of the work. The regulating wheel 23 frictionally engages the work 24 and controls its rotation so as to eliminate chatter and slippage while the work is driven by means to be later described and while the work is supported by the blade 25 and in contact with the grinding wheel 18.

As was noted above, the work piece illustrated

in the drawings is a piston as employed with internal combustion engines and comprises a land portion 28 for the piston rings and a skirt portion 29 interiorly of which is formed the bosses 30 for the wrist pin holes. The bosses on the interior of the piston are provided with substantially parallel surfaces between which is disposed, see Figure 5, the work driving head 31. Secured to the sides of the head 31 are the spring take up members 32 which actually contact with the inner surfaces of the bosses 30 and thereby yieldably centralize the piston or work as respects the work driving head 31.

The work head 31 is formed on the forward end of a shaft or mandrel 33 which is journaled in suitable bearings provided by a supplemental housing or bracket 34. The shaft 33 has keyed to it interiorly of the supplemental housing 34 a bevel gear 36 which meshes with a complementary bevel gear 37 secured to the short shaft 38 and likewise disposed within the housing 34. The shaft 38 is rotatably journaled in the supplemental housing and is connected by a telescoping universal joint connection 39 with the driven shaft 40 suitably rotatably journaled in a work supporting and controlling unit 35.

The driven shaft 40 has keyed or otherwise secured thereto a bevel gear 41 which meshes with a complementary bevel gear 42 keyed or otherwise secured to the main driven shaft 43 rotatably journaled in suitable bearings provided by the work controlling unit 35. Slidably keyed to the driven shaft 43 is a clutch member 44 having formed in one end thereof a counterbore 45 housing a suitable spring 46. The spring 46 abuts on one end with the base of the counterbore 45 and on the other end with a collar 47 pinned or otherwise secured to the driven shaft 43. At its other end the clutch 44 is formed with clutch teeth 48 adapted to mesh with or engage complementary clutch teeth 49 formed on the adjacent side of a sprocket or gear 50. The sprocket 50 is loosely journaled on the driven shaft 43 and adapted to be connected with the shaft for rotating same by means of the clutch teeth 48 and 49.

Trained about the sprocket 50, see Figure 9, is a sprocket chain 51, which is in turn trained about a sprocket 52 on a shaft 53 projecting from the rear of the bed near the right hand end thereof, as seen in Figure 1. The shaft 53 is in reality the final driven shaft of a change speed gear box which is let into the bed from the right hand side thereof and includes the plate 54 through which the change gear levers 55 project for effecting the operation of the movable members within the speed box.

From the foregoing it will be noted that the work may be driven at variable speeds through a suitable driving mechanism while supported by the work rest blade 25 and while in contact with the grinding and regulating wheels.

The regulating wheel 23 is enclosed within a guard 56 formed integral with the work control and feeding unit 35 and is keyed or otherwise secured to a shaft or spindle 57 journaled at opposite ends in anti-friction bearings carried respectively by a cover plate 58 attached to the guard 56 and a journal block 59 secured in a supplemental housing 60 in turn attached to the guard 56. The regulating wheel is driven from the shaft or mandrel 33 by means of a gear 126 keyed or otherwise secured to said mandrel and meshing with a gear 127 carried by a shaft 128 journaled in the guard or housing 56. Also secured to the shaft 128 is a pulley or sheave 129 having grooves therein for a flexible transmission member such as the V-shaped belts 130. The belts 130 are in turn trained about a sheave or pulley 131 keyed or otherwise secured to the regulating wheel shaft or spindle 57. A slight differential in the speeds of rotation of the work shaft or mandrel 33 and regulating wheel 23 is maintained so that the proper frictional engagement between the work and wheel is had to prevent any lateral or side play in the driving connection of the work and head 31, thereby to eliminate chatter.

The cover plate 58 has projecting from it a trunnion bearing 61 and the journal block 59 has similarly projecting from it a trunnion bearing 62. The work rest block or bracket 26 has sceured to its forward end, as by means of screws 63, see Figure 3, an arm 64 which has its upper end formed into a split bearing 65 receiving the cover plate trunnion 61. The rear surface of the block 26 has similarly secured to it an arm 66 having its upper end formed into a split bearing 67 receiving the trunnion bearing 62. Integral with this arm 66 is the supplemental housing 34.

The block 26 has projecting from it an adjustable abutment 68, see Figure 5, abutting with one end 69 of a plunger 70 adapted to be axially shifted through bearings 71 and 72 provided by the work controlling unit 35. Also projecting from the block 26 is a stop stud 73 adapted to engage with a co-operating adjustable stop 74, here shown as a bolt which projects from the work controlling unit 35. The axially reciprocable plunger 70 has secured to its inner end, and disposed within a suitable cavity in the work controlling unit 35, a clevis 75 between the arms of which is rotatably mounted a roller 76. The roller 76 engages the periphery of a cam member 77 keyed or otherwise secured to the transverse shaft 78. The shaft 78 has further secured to it a gear 79 meshing with an idler gear 80 loosely journaled on a shaft 81. The idler gear 80 in turn meshes with a driving gear 82 keyed or otherwise secured to the end of the driven shaft 43.

The proximate points of the grinding and regulating wheels form a grinding throat of the smallest dimension and above and below this point the grinding throat enlarges due to the recession of the peripheries of the wheels. It is at the smallest part of the grinding throat that the work is introduced. The work while being supported on the work rest blade is adapted to be swung, while being ground, from the narrowest part into the wider part of the throat through the swinging of the arms 64 and 66. The rotation of the work and the rotation of the cam 77 is in the ratio of one to one so that for each rotation of the work the cam makes a complete rotation. Therefore, with a cam as shown in Figure 5, the work will be elevated from its normal position and returned thereto twice for each rotation of the work, thereby having the low points and high points of the ellipse at diametrically opposed points or having the major and minor axes at right angles. It is to be understood that a different form of cam 77 will produce different configurations on the work.

To maintain the work in contact with the blade surface 27 and periphery of the wheel 23 there is disposed above the work a pressure roller 83 rotatably carried by a shaft 84. The

shaft 84 is secured in the end of one arm 85 of a bell crank 86 pivoted as at 87 to the outer surface of the cover plate 58. The other arm 88 of the bell crank 86 has passing through it one end of a shiftable rod 89. This rod 89 is slidably mounted in suitable bearings 90 and 91 respectively projecting from the cover plate 58 and the control unit 35. Secured to the rod 89 intermediate the bearings 90 and 91 is a collar 92 forming one abutment for a spring 93 which surrounds said rod and abuts on its other end with the bearings 90. The spring 93 is of the expansion type and tends to at all times actuate the roller 93 into contact with the work 24.

In order to guide the work control unit 35 during the adjustment thereof relative to the bed 15 and in order to maintain the proper alignment of the parts, the said unit is provided on its under surface with a dove-tailed guideway 94 receiving a correspondingly shaped guide tongue 95 projecting from the bed 15. Secured to an extension 96 of the bed is a bracket 97 in which is journaled one end of a screw 98. For effecting the rotation or adjustment of said screw it projects beyond the bearing 97 and has secured to it the pilot or hand wheel 99. The threaded portion 100 of the screw 98 is received in a suitably threaded bore formed in a sleeve nut 101 rotatably journaled in the rear end of the work control unit 35. The nut 101 is held against relative axial movement by means of a head 102, on one end thereof, received in a recess formed in a gear 103 which abuts an inner wall of the unit 35 and by means of a collar 104 which abuts the outer wall of said unit. Secured to the nut 101 beyond the collar 104 is a manually actuable lever 105, oscillation of which in a counterclockwise direction, as seen in Figure 9, effects a retraction of the unit from the grinding wheel while reverse actuation thereof effects the forward movement of said unit.

Meshing with the gear 103 is a complementary spur gear 106 keyed or otherwise secured to the short shaft 107 rotatably journaled in suitable bearings provided by the work control unit 35. Also keyed to the shaft 107 is a cam 108 having the contour as seen in Figure 7 and providing a cut back or relieved portion 109. The periphery of the cam 108 contacts with a head 110 on the end of a sliding plunger or rod 111. The other end of the rod 111 has formed therein a notch 112 receiving the ball end 113 of a bell crank 14. The bell crank 114 is pivoted at 115 to a fixed portion of the work controlling unit 35 and its other end is provided with a ball end 116 received in a suitable notch 117 formed in clutch release plunger 118. The plunger 118 is slidable through a sleeve 119 having a counterbore formed therein through which the plunger passes. Within the counterbore and abutting on the base thereof is a spring 120 which surrounds the plunger 118 and abuts on its other end with a shoulder formed on said plunger. At its free end the plunger is provided with a reduced portion or nose 121 adapted to enter an interrupted cam groove 122 formed in the surface of the clutch member 44. From the foregoing it will be noted that oscillation of the lever 105 will effect rotation of the cam 108 for shifting the rod 111 in one direction for effecting the clutch release through the spring 120 by yieldably shifting the clutch release plunger 118 into operative position, while operation of the lever in the opposite direction retracts the said plunger 118 against the yielding urge of the spring 120.

As shown in Figure 8, the cam slot 122 is provided at its end with an offset portion 123 whereby the clutch is actuated to disengaging position. This insures the stopping of the parts at all times at the same position so that they are at no time out of timed relation with one another.

In order to release the work from the pressure roller 83, to permit a replacement of the work on the mandrel the gear 106 has secured to it or formed integral therewith a flange 124 carrying a cam lug 125. The lug 125 is adapted to engage with the free end of the rod 89 for shifting same against the yielding resistance of the spring 93 for thereby oscillating the bell crank 86 in a counterclockwise direction and raising the roller to its inoperative position. It should be noted that this mechanism operates just prior to the movement of the lever 105 to its final retracting position.

The operation of the entire mechanism is as follows: The handle 105 is actuated in a counterclockwise direction through an arc of ninety degrees from the position shown in Figure 1 which retracts the work controlling unit to its rearmost position, this position of the handle disposes the relieved portion 109 of the cam 108 in line with the head 110 on the rod 111 thereby permitting the spring 120 to shift the clutch release plunger 118 into position for retracting the clutch against the yielding resistance of spring 46, thereby disconnecting the power from the rotating parts of the machine and a work piece may now be mounted on the work driving head. The lever 105 is then actuated comparatively slowly toward the position shown in Figure 1, through an arc of substantially ninety degrees. At the commencement of this movement of the lever and through the gears 103 and 105 the cam lug 125 is removed from the rod 89 permitting the spring 93 to shift the pressure roller 83 into engagement with the work to force same against the work rest blade and regulating wheel surface. The relieved portion 109 of the cam 108 is now actuated out of alignment with the rod 111 so that the shoulder at the end of said relieved portion shifts said rod in a direction for oscillating the bell crank 114 in a direction to retract the clutch release plunger 118 thereby connecting the power with the driven shaft 43 and through the bevel gears and transverse shaft to the work mandrel 33. A rotation of the work and regulating wheel is immediately initiated as is the rotation of the cam 77. Continued movement of the lever 105 feeds the work into the grinding wheel simultaneously with the rotation of the cam 77 which through the rod 70 oscillates the work rest block 26 for elevating the work above the point in the grinding throat at which it was introduced therein. In other words, at the initiation of the grinding operation the work is in the position where the grinding throat is the smallest for thereby grinding the portion of the work on the minor axis of the ellipse and as the work rest block and work are elevated to a wider part of the grinding throat the portion of the work being ground is gradually enlarged to the major diameter or axis of the ellipse. As this oscillation of the work takes place about the axis of the regulating wheel shaft or spindle 57, the work is at all times properly supported by the work rest blade

and backed up by the regulating or friction control wheel. The amount of oscillation imparted to the work and the ultimate size of the work is controlled and determined by the cam 77. To take up for wear on the regulating wheel, the abutment 68, as above described, is made adjustable so as to insure the proper zone of movement of the work. It is to be understood that this abutment 68 may also be employed for modifying the final contour imparted to the work by the cam 77.

When the lever 105 reaches a horizontal position or a position substantially at right angles to that shown in Figure 1, the work is to the proper size and contour and at this time a dwell in the movement of the parts is permitted to produce the desired finish on the work. As soon as the grinding operation has been completed the lever is returned to its vertical position which first disengages the clutch 44 to stop all movement of the parts, next raises the pressure roller from the work so that it can be readily withdrawn from operative position, and finally retracts the parts to the work loading position. The finished work piece is now removed from the mandrel and an unfinished one placed thereon whereupon the above cycle is repeated.

What is claimed is:

1. In a grinding machine of the class described the combination of a bed, a grinding wheel rotatably mounted on the bed, an opposed work controlling wheel forming with the grinding wheel a grinding throat, the proximate points of said wheels representing the narrowest point of the throat and above which point the throat flares, means for supporting a work piece and oscillatable with the work through the flaring throat along an arcuate path substantially concentric with the surface of one of said wheels during the grinding of the work piece, and means for effecting the oscillation of the work support and work in timed relation with the rotation of the work.

2. In a grinding machine of the class described the combination of a bed, a grinding wheel rotatably mounted on the bed, an opposed work controlling wheel forming with the grinding wheel a grinding throat, the proximate points of said wheels representing the narrowest point of the throat and above which point the throat flares, means for supporting a work piece and oscillatable with the work through the flaring throat along an arcuate path substantially concentric with the surface of one of said wheels during the grinding of the work piece, means for effecting the oscillation of the work support and work in timed relation with the rotation of the work, and pressure means for maintaining the work in peripheral contact with the work support and work controlling member.

3. In a grinding machine of the class described the combination of a bed, a grinding wheel rotatably mounted on the bed, an opposed work controlling member forming with the grinding wheel a grinding throat, the proximate points of said wheel and member representing the narrowest point of the throat and above which point the throat flares, means for supporting a work piece and oscillatable with the work through the flaring throat during the grinding of the work piece, means for effecting the oscillation of the work support and work in timed relation with the rotation of the work, pressure means for maintaining the work in peripheral contact with the work support and work controlling member, and a common means for releasing the pressure means and stopping the rotation of the work.

4. In a grinding machine for producing elliptical work pieces the combination of a pair of opposed grinding and backing up members forming a grinding throat between them, the grinding throat having the walls thereof flaring as the peripheries of the grinding member and backing up member recede from one another, a work support oscillatable about the axis of one of said members for actuating a work piece peripherally supported thereby through the flaring grinding throat for producing an irregular contour on the work, means for positively rotating the work during the oscillation thereof, and means for effecting a slight differential in speed between the rotation of the work and of the backing up member for thereby eliminating back lash and chatter between the work and its driving member.

5. In a grinding machine for producing elliptical work pieces the combination of a pair of opposed grinding and backing up members forming a grinding throat between them, the grinding throat having the walls thereof flaring as the peripheries of the grinding member and backing up member recede from one another, a work support oscillatable about the axis of one of said members for actuating a work piece peripherally supported thereby through the flaring grinding throat for producing an irregular contour on the work, means for positively rotating the work during the oscillation thereof, and means for effecting the oscillation of the work support and work including a cam, a reciprocable plunger operatively associated with the cam and work support whereby variations in the cam effect the oscillation of the work support, and adjustable means for varying the effect of the cam.

6. In a grinding machine for producing elliptical work pieces the combination of a pair of opposed grinding and backing up members forming a grinding throat between them, the grinding throat having the walls thereof flaring as the peripheries of the grinding member and backing up member recede from one another, a work support oscillatable about the axis of one of said members for actuating a work piece peripherally supported thereby through the flaring grinding throat for producing an irregular contour on the work, means for positively rotating the work during the oscillation thereof, means for effecting the oscillation of the work support and work including a cam, a reciprocable plunger operatively associated with the cam and work support whereby variations in the cam effect the oscillation of the work support, and adjustable means for varying the effect of the cam, means connecting the work rotation means and the cam rotation means whereby they are rotated in timed relation, and a common source of power for effecting the said rotation of the work and cam.

7. In a grinding machine for producing elliptical work pieces the combination of a pair of opposed grinding and backing up members forming a grinding throat between them, the grinding throat having the walls thereof flaring as the peripheries of the grinding member and backing up member recede from one another, a work support oscillatable about the axis of one of said members for actuating a work piece pe-

ripherally supported thereby through the flaring grinding throat for producing an irregular contour on the work, a work driving shaft operatively connected therewith, and transmission means between the work driving shaft and backing up member whereby a slight differential of speed is had between the rotation of the work and the backing up member to eliminate back lash between the work and its driver.

8. In a grinding machine for producing elliptical work pieces the combination of a pair of opposed grinding and backing up members forming a grinding throat between them, the grinding throat having the walls thereof flaring as the peripheries of the grinding member and backing up member recede from one another, a work support including a work rest blade oscillatable about the axis of one of said members for actuating a work piece peripherally supported thereby through the flaring grinding throat for producing an irregular contour on the work, pressure means for holding the work in peripheral engagement with the work rest blade and backing up member, means for positively driving the work while in contact with the blade and contact member, a source of power, an interruptable transmission mechanism between the power source and work driver, and common means for sequentially interrupting the transmission and releasing the pressure means.

9. In a grinding machine for producing elliptical work pieces the combination of a pair of opposed grinding and backing up members forming a grinding throat between them, the grinding throat having the walls thereof flaring as the peripheries of the grinding member and backing up member recede from one another, a work support including a work rest blade oscillatable about the axis of one of said members for actuating a work piece peripherally supported thereby through the flaring grinding throat for producing an irregular contour on the work, pressure means for holding the work in peripheral engagement with the work rest blade and backing up member, means for positively driving the work while in contact with the blade and contact member, a source of power, an interruptable transmission mechanism between the power source and work driver, a rotatable cam for effecting the oscillation of the work support and work relative to the grinding throat operatively connected with the interruptable transmission, a second cam for effecting the interruption in the transmission, and manually operable means for effecting the operation of the second cam for interrupting the transmission and sequentially releasing the pressure means.

10. In a grinding machine of the class described the combination of a bed, a grinding wheel rotatably mounted thereon, a slide member mounted on the bed, a backing up member rotatably supported by the slide and adapted to form with the grinding wheel a flaring grinding throat, flaring from the proximate point of said grinding wheel and backing up member, a work supporting mechanism including a work rest blade pivotally mounted for oscillation about the axis of the backing up member for shifting the work through the flaring throat and effecting elliptical grinding thereon, means operable on the slide for effecting its movement toward and from the grinding wheel to operatively associate the work and grinding wheel and permit a replacement of the work on the blade, a disruptable work drive mechanism, and means operable to interrupt the work driving mechanism upon retraction of the slide.

11. In a grinding machine of the class described the combination of a bed, a grinding wheel rotatably mounted thereon, a slide member mounted on the bed, a backing up member rotatably supported by the slide and adapted to form with the grinding wheel a flaring grinding throat, flaring from the proximate point of said grinding wheel and backing up member, a work supporting mechanism including a work rest blade pivotally mounted for oscillation about the axis of the backing up member for shifting the work through the flaring throat and effecting elliptical grinding thereon, means operable on the slide for effecting its movement toward and from the grinding wheel to operatively associate the work and grinding wheel and permit a replacement of the work on the blade, a disruptable work drive mechanism, means operable to interrupt the work driving mechanism upon retraction of the slide, and pressure means for maintaining contact of the work with the work rest blade and backing up member.

12. In a grinding machine of the class described the combination of a bed, a grinding wheel rotatably mounted thereon, a slide member mounted on the bed, a backing up member rotatably supported by the slide and adapted to form with the grinding wheel a flaring grinding throat, flaring from the proximate point of said grinding wheel and backing up member, a work supporting mechanism including a work rest blade pivotally mounted for oscillation about the axis of the backing up member for shifting the work through the flaring throat and effecting elliptical grinding thereon, means operable on the slide for effecting its movement toward and from the grinding wheel to operatively associate the work and grinding wheel and permit a replacement of the work on the blade, a disruptable work drive mechanism, means operable to interrupt the work driving mechanism upon retraction of the slide, pressure means for maintaining contact of the work with the work rest blade and backing up member, and a single manually operable member for effecting the shifting of the slide, interrupting the work drive and rendering the pressure means inoperative.

13. In a grinding machine of the class described the combination of a bed, a grinding wheel rotatably mounted thereon, a slide member mounted on the bed, a backing up member rotatably supported by the slide and adapted to form with the grinding wheel a flaring grinding throat, flaring from the proximate point of said grinding wheel and backing up member, a work supporting mechanism including a work rest blade pivotally mounted for oscillation about the axis of the backing up member for shifting the work through the flaring throat and effecting elliptical grinding thereon, means operable on the slide for effecting its movement toward and from the grinding wheel to operatively associate the work and grinding wheel and permit a replacement of the work on the blade, a disruptable work drive mechanism including a power transmission, a cam for effecting the oscillation of the work carrier, and a branch transmission from the work drive transmission for effecting the operation of the cam whereby the rotation of the work and oscillation thereof are in timed relation.

14. In a grinding machine of the class described the combination of a bed, a grinding wheel rotatably mounted thereon, a slide member mounted on the bed, a backing up member rotatably supported by the slide and adapted to form with the grinding wheel a flaring grinding throat, flaring from the proximate point of said grinding wheel and backing up member, a work supporting mechanism including a work rest blade pivotally mounted for oscillation about the axis of the backing up member for shifting the work through the flaring throat and effecting elliptical grinding thereon, means operable on the slide for effecting its movement toward and from the grinding wheel to operatively associate the work and grinding wheel and permit a replacement of the work on the blade, a disruptable work drive mechanism including a power transmission, a cam for effecting the oscillation of the work carrier, a branch transmission from the work drive transmission for effecting the operation of the cam whereby the rotation of the work and oscillation thereof are in timed relation, and manually operable means for effecting the disruption of the work drive and simultaneously interrupting the cam drive whereby the rotation of the work and rotation of the cam are simultaneously stopped.

15. In a grinding machine of the class described the combination of a bed, a grinding wheel rotatably mounted thereon, a slide member mounted on the bed, a backing up member rotatably supported by the slide and adapted to form with the grinding wheel a flaring grinding throat, flaring from the proximate point of said grinding wheel and backing up member, a work supporting mechanism including a work rest blade pivotally mounted for oscillation about the axis of the backing up member for shifting the work through the flaring throat and effecting elliptical grinding thereon, means operable on the slide for effecting its movement toward and from the grinding wheel to operatively associate the work and grinding wheel and permit a replacement of the work on the blade, a disruptable work drive mechanism including a power transmission, a cam for effecting the oscillation of the work carrier, a branch transmission from the work drive transmission for effecting the operation of the cam whereby the rotation of the work and oscillation thereof are in timed relation, a shiftable plunger having contact simultaneously with the cam and work support, and means for varying the zone of oscillation of the work support and work as effected by the cam.

16. In a grinding machine of the class described the combination of a bed, a grinding wheel rotatably mounted thereon, a slide member mounted on the bed, a backing up member rotatably supported by the slide and adapted to form with the grinding wheel a flaring grinding throat, flaring from the proximate point of said grinding wheel and backing up member, a work supporting mechanism including a work rest blade pivotally mounted for oscillation about the axis of the backing up member for shifting the work through the flaring throat and effecting elliptical grinding thereon, means operable on the slide for effecting its movement toward and from the grinding wheel to operatively associate the work and grinding wheel and permit a replacement of the work on the blade, a disruptable work drive mechanism including a power transmission, a cam for effecting the oscillation of the work carrier, a branch transmission from the work drive transmission for effecting the operation of the cam whereby the rotation of the work and oscillation thereof are in timed relation, a shiftable plunger having contact simultaneously with the cam and work support, means for varying the zone of oscillation of the work support and work as effected by the cam, and means for rendering the cam inoperative.

17. A grinding machine for the production of work pieces of substantially elliptical form in cross section including a rotatably mounted grinding wheel and an opposed backing member forming with the grinding wheel a grinding throat for reception of a work piece of flaring form above and below the proximate portion of the surfaces of the grinding wheel and backing member, means for maintaining the grinding wheel and backing member in substantially fixed relation, one to the other, during performance of a grinding operation on an individual work piece, and means for rotatably supporting a work piece with its periphery jointly engaging the grinding wheel and backing member, and means for effecting a definite series of sequential movements of an individual work piece toward and from the narrowing portion of the grinding throat in timed relation with the rotation of the work piece whereby a predetermined elliptical contour will be produced on the periphery of the work piece.

18. A grinding machine for the production of work pieces of substantially elliptical form in cross section including a rotatably mounted grinding wheel and an opposed backing member forming with the grinding wheel a grinding throat for reception of a work piece of flaring form above and below the proximate portion of the surfaces of the grinding wheel and backing member, means for maintaining the grinding wheel and backing member in substantially fixed relation, one to the other, during performance of a grinding operation on an individual work piece, means for rotatably supporting a work piece with its periphery jointly engaging the grinding wheel and backing member, and means for effecting a definite series of sequential movements of an individual work piece toward and from the narrowing portion of the grinding throat in timed relation with the rotation of the work piece whereby a predetermined elliptical contour will be produced on the periphery of the work piece, said means including a driven cam reacting on the work piece and its support to cause the prescribed movement thereof, a driving member engaged with the work piece, and driving connections coupling said member with the cam for effecting the synchronized movement of said parts.

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