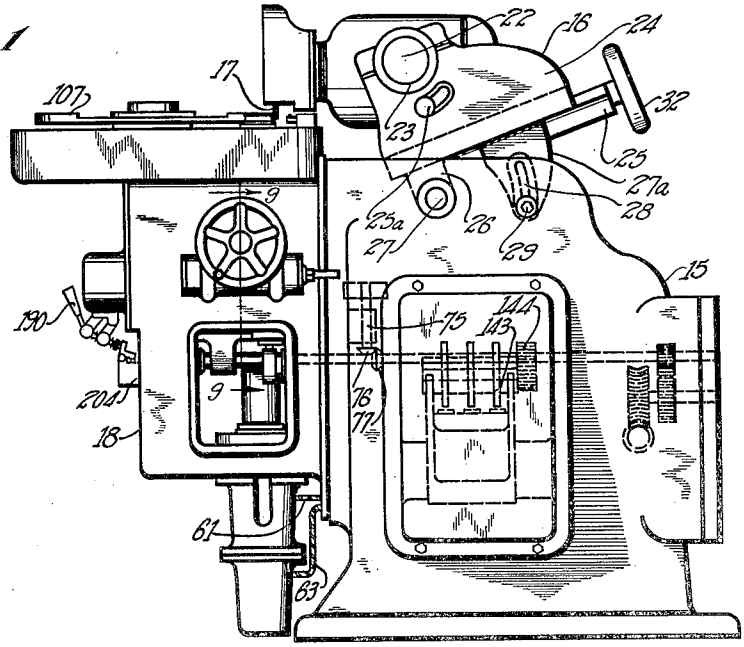
July 4, 1933. C. BOOTH 1,916,916

GRINDING MACHINE

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Fig. 1



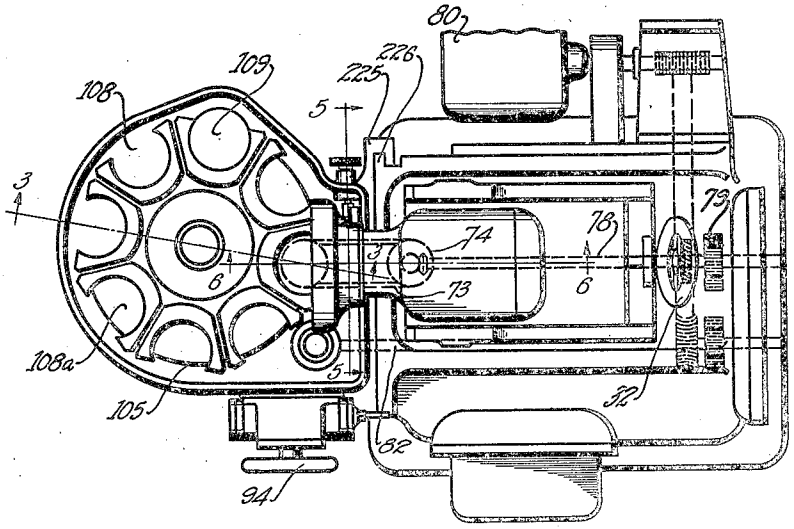




Fig. 2

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Fig. 3

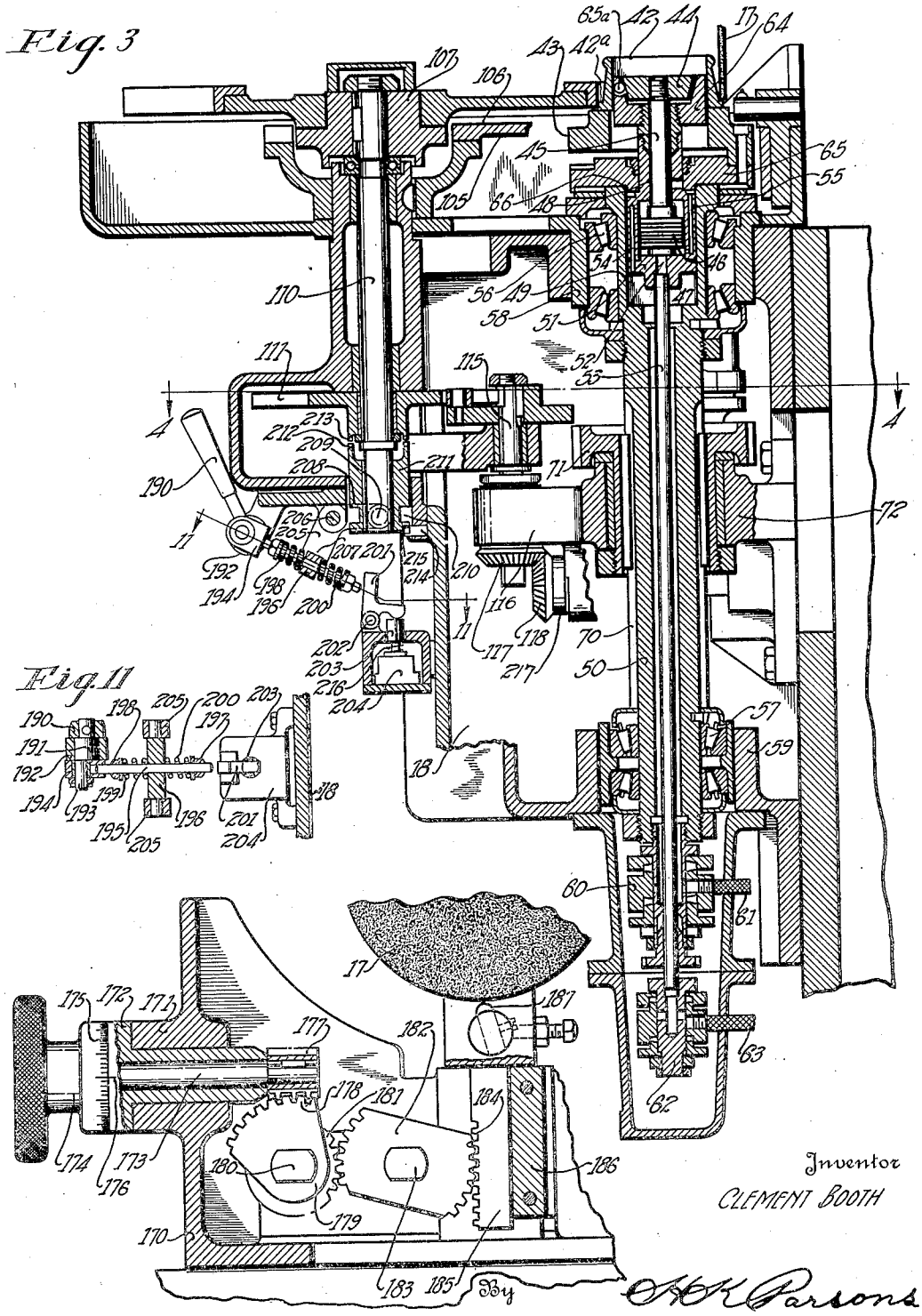



Fig. 11




Fig. 5

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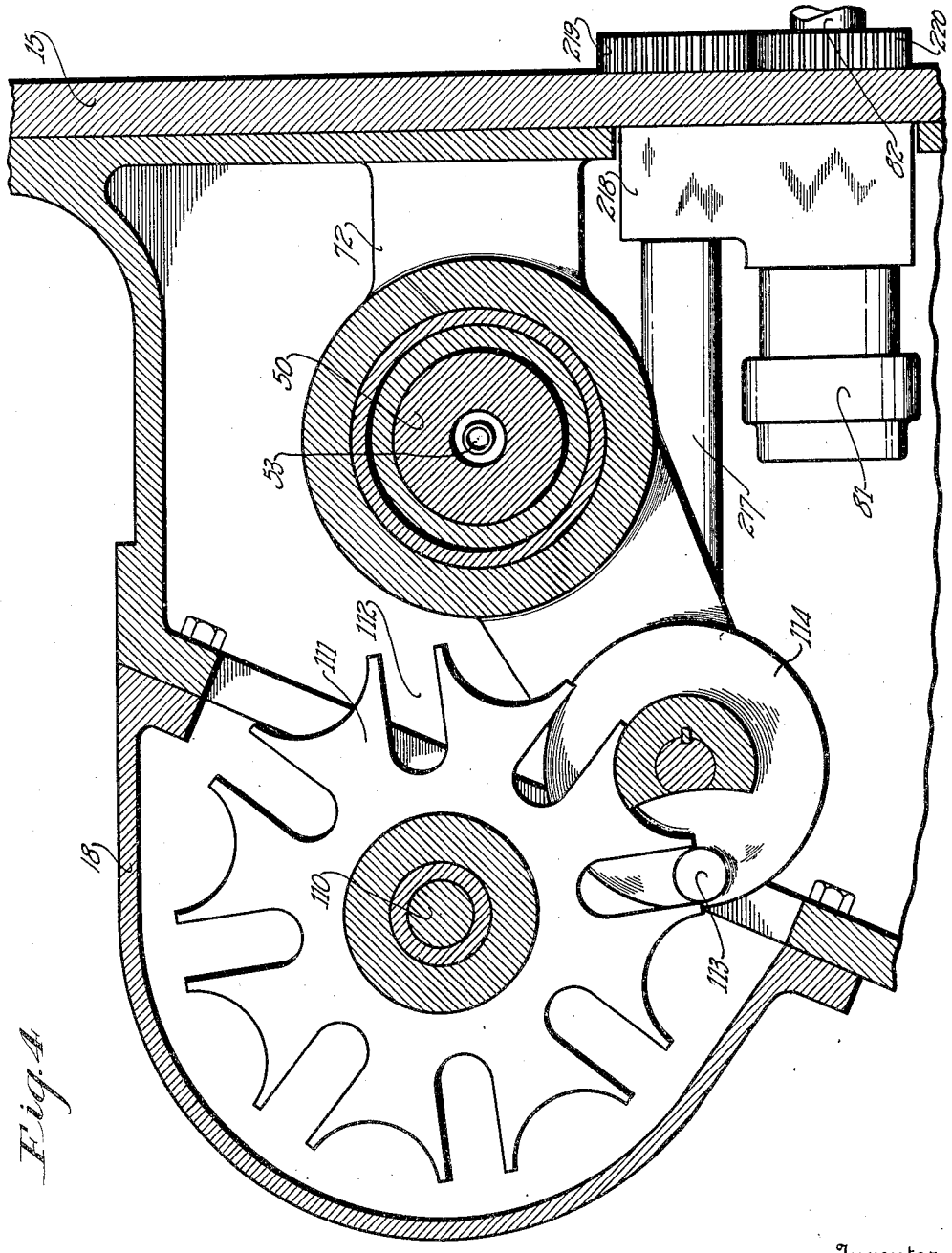



Fig. 4

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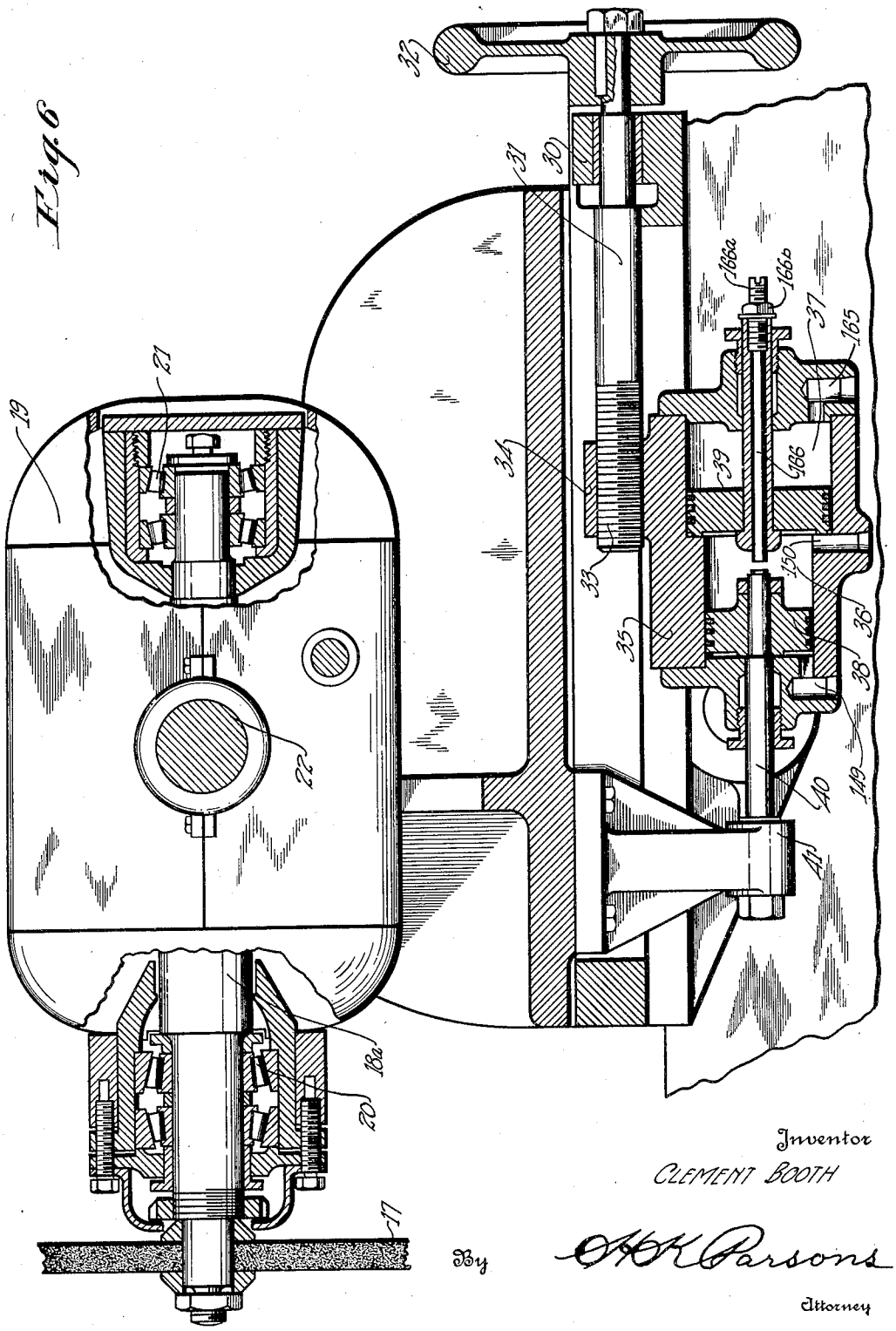
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GRINDING MACHINE

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Fig. 6




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GRINDING MACHINE

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Fig. 7

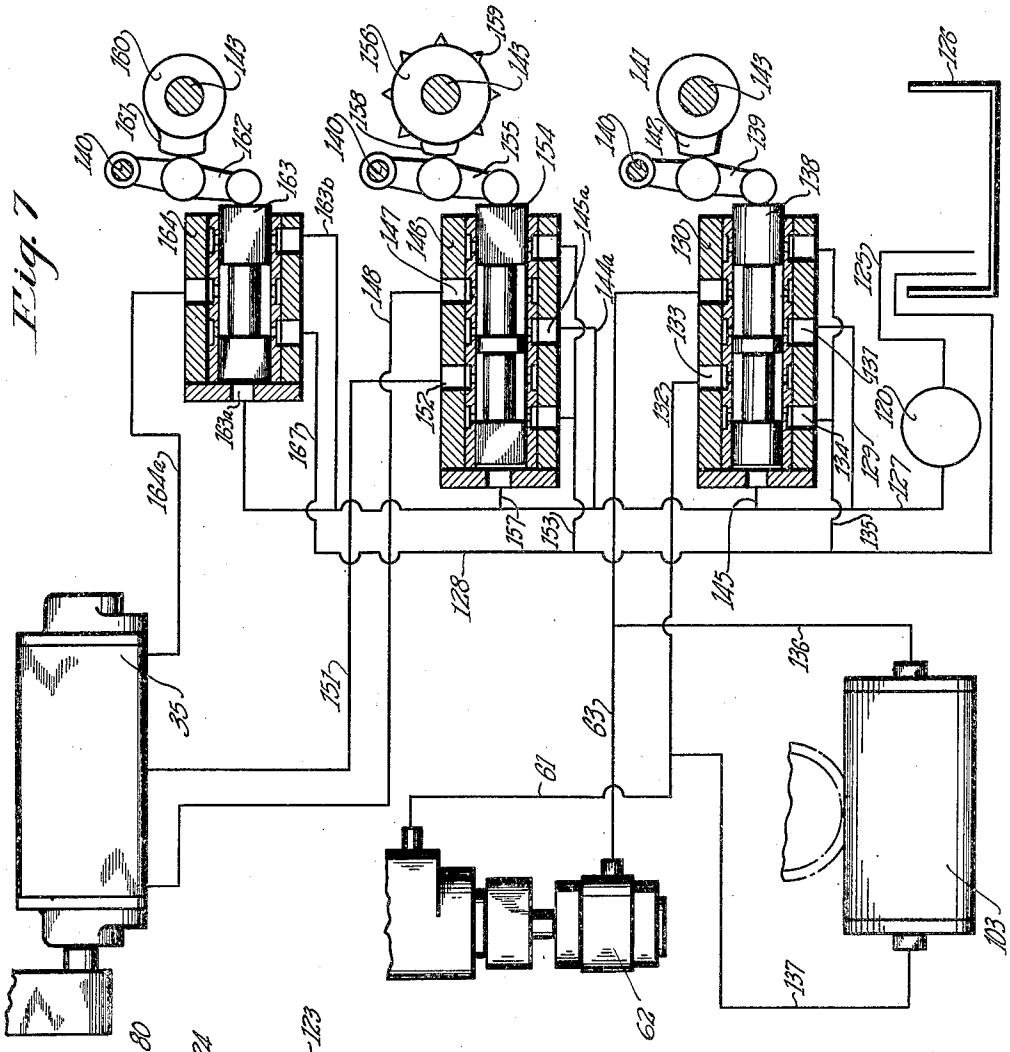
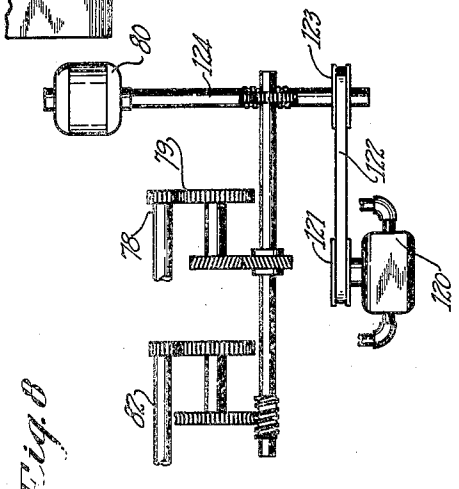


Fig. 8



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GRINDING MACHINE

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Fig. 9

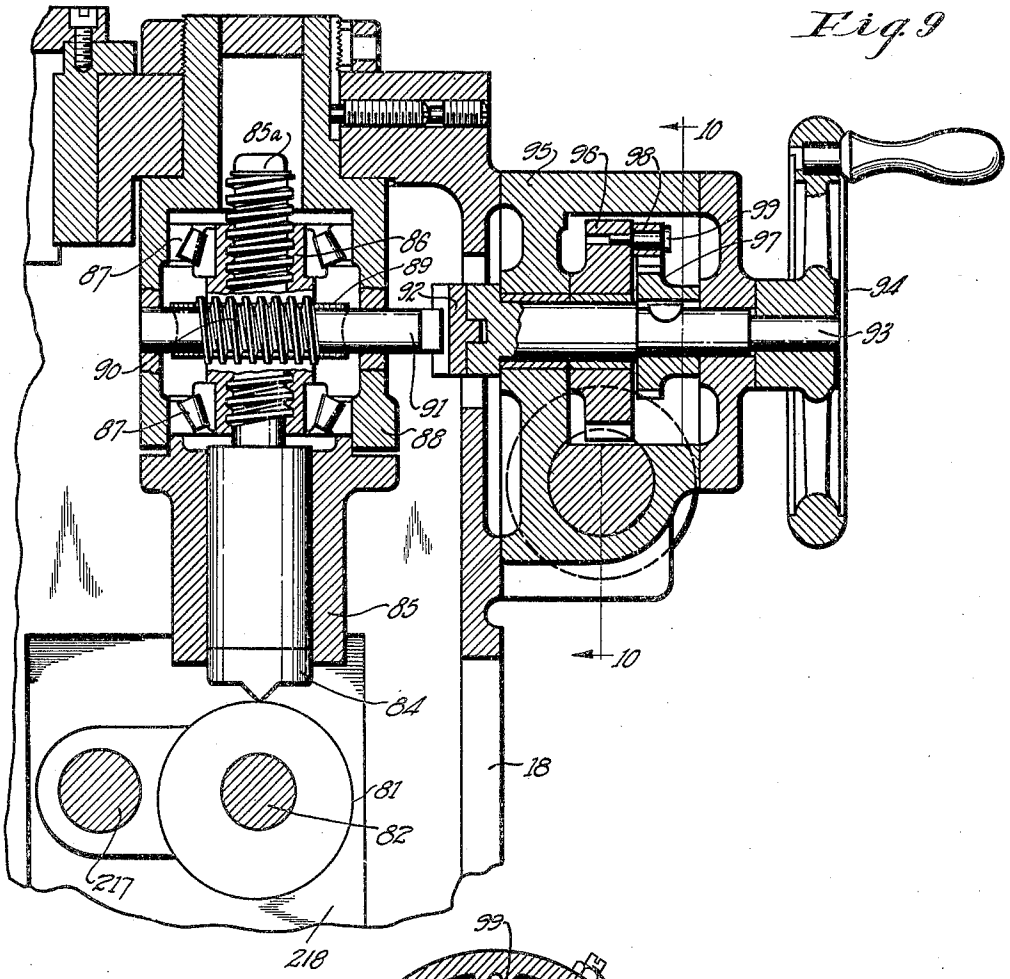
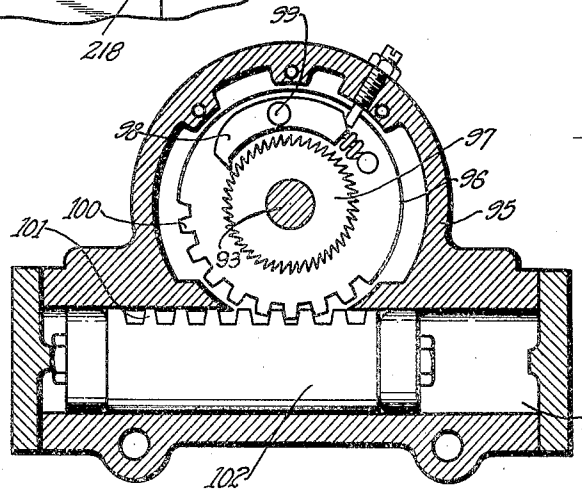



Fig. 10




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# UNITED STATES PATENT OFFICE

CLEMENT BOOTH, OF CINCINNATI, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE HEALD MACHINE COMPANY, OF WORCESTER, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS

## GRINDING MACHINE

Application filed March 31, 1930. Serial No. 440,369.

This invention relates to improvements in grinding machines and has particular reference to a machine adapted for use in grinding an angularly related portion on a work piece, the invention residing in grinding machines for the automatic reduction of corresponding surfaces on successive workpieces all to the same size.

One of the principal objects of the present invention is the provision of a machine which will make possible the accurate grinding of the seat on taper roller bearing cones so that when assembled the taper rolls will rotate or roll about an axis normal to said seat.

A further object of the invention is the provision of a machine which will automatically position and accurately support the article to be operated upon in such manner that the surface produced by the grinding operation will be located in accurate and definite relation to the body portion of the article.

A further object of the invention is the provision of a machine particularly adapted for use in the formation of the flange or seat supporting portion of an anti-friction tapered roller bearing cone which will produce a series of such cones each having the seat portion thereof in definite spaced relation to the tapered body rolling portion whereby the several rolls to be mounted on the flange or seat will bear throughout their length on the said rolling bearing portion of the cone and the said roller bearings will rotate about an axis normal to said seat.

An additional object of the invention is the provision of an improved machine in which the articles to be operated upon will be automatically, successively, shifted from a loading position to a grinding position, automatically clamped in place without use of a mandrel, arbor or chuck externally engaging same, and rotated while the grinding operation is being performed, then automatically released and shifted from the said grinding position to a position for automatic discharge from the machine.

A further object of this invention is the provision of a machine that may be readily adjusted to perform the grinding operation at any desired or necessary angle with respect to a given plane and in which the surface of the grinding wheel is reconditioned after the completion of each work piece while the latter is being replaced with an unfinished work piece thereby cutting down the idle or non-productive time of the machine to a minimum.

Other objects and advantages of the present invention will 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 specific structural details therein 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 side elevational view of a machine tool embodying the improvements of this invention.

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

Figure 3 is a fragmentary sectional view taken on line 3—3 of Figure 2.

Figure 4 is a sectional view taken on line 4—4 of Figure 3.

Figure 5 is a fragmentary sectional view taken on line 5—5 of Figure 2.

Figure 6 is a sectional view on line 6—6 of Figure 2.

Figure 7 is a semi-diagrammatical view of the hydraulic circuit embodied in this invention showing the valves in cross section.

Figure 8 is a diagrammatic view of the mechanical drive forming a detail of the invention.

Figure 9 is a sectional view taken on line 9—9 of Figure 1.

Figure 10 is a sectional view taken on line 10—10 of Figure 9, and

Figure 11 is a sectional view taken along the line 11—11 of Figure 3.

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

Broadly, this invention comprises a bed or support having mounted thereon a grinding wheel unit adapted to be shifted substantially axially relative thereto. The unit is mounted for angular adjustment relative to the bed and includes means for shifting the unit axially of the spindle carrying the grinding wheel in a plane angularly related to the bed determined by the angular adjustment thereof. In alignment with the stroke of the grinding wheel spindle is a suitable means for supporting a work piece. Improved novel means are provided for centralizing and clamping the work for rotation about an axis

determined by the finished interior bore of the work piece. This centralizing and clamping mechanism is automatically operated and work pieces are adapted to be vertically shifted for feeding the work piece into the grinding wheel to effect a stock removal from the work piece. The active face of the grinding wheel is trued or reconditioned at the completion of each work piece and automatically actuated means are provided to take up the wear on the wheel due to the grinding of the work piece and the trueing of the active face thereof so that each successive work piece is finished to the same size. The various hydraulic circuits controlling the hydraulic movements of the several parts each include a valve which is operated in synchronized sequence for successively performing the various functions of the machine during the completion of the work piece. In addition there is provided automatic means for carrying the work piece from a loading station to the operating position and then removing same to the discharging position.

In the drawings the numeral 15 represents the bed or column of the machine having mounted thereon the grinding wheel unit 16 rotatably supporting a grinding wheel 17 for operation on a work piece carried by a suitable work supporting table mounted on shiftable housing 18 secured to the forward face of the bed 15. The grinding wheel 17 is secured to one end of a spindle 18*a*, Fig. 6, forming a part of the grinding wheel motor 19 and having anti-friction bearings 20 and 21 at the opposite ends thereof. The motor 19 is provided with trunnions 22 received in bearings 23 of a tiltable housing or carriage 24 slidably carried by a second tiltable slide 25. A locking bolt or the like 25*a* is provided for locking the motor 19 in adjusted position relative to the carriage 24. The slide 25 has lugs 26 depending therefrom, and pivots 27 extend through the lugs 26 into the bed or support 15; the slide 25 in addition has depending from it a quadrant 27*a* having slots 28 through which locking bolts 29 extend. The slide 25 is provided at its rear end with a boss 30, Fig. 6, in which is journaled the reduced portion of an adjusting screw 31. A hand wheel 32 is secured to one end of the screw 31 and the threaded end 33 of the screw is threadedly received in a nut 34 formed integral with cylinder 35. The cylinder 35 is formed interiorly thereof with a small chamber 36 and a larger chamber 37 in which are mounted respectively pistons 38 and 39. Piston 38 in the smaller chamber 36 has extending therefrom a piston rod 40 secured at one end to a bracket 41 bolted or otherwise secured to the carriage 24. An hydraulic medium under pressure is introduced into the chambers 36 and 37 for actuating pistons 38 and 39 by means to be described hereinafter, thereby procuring substantially axial shifting movement of the grinding wheel.

Mounted within the housing 18 is the work rotating and controlling means shown most clearly in Figures 3 and 9 to which reference is now to be had. The work piece 42 which in the construction shown, comprises the inner race of a roller bearing and has the surface 42*a* on which the grinding operation is to be performed is positioned on plate 43 beneath the grinding wheel 17 and clamped in position by plunger 44. Plunger 44 is carried by a piston rod 45 carrying on its opposite end piston 46 operable in a cylinder 47. The cylinder 47 is provided with a stud 48 forming a bearing for the piston rod 45. This cylinder 47 is likewise reciprocable in a cylinder 49 formed on the end of a relatively long hollow shaft 50. A head 51 is secured to the end of cylinder 47, thereby completely enclosing the piston 46, and the said head 51 is provided with a port 52 communicating with a conduit or pipe 53 extending centrally through the shaft 50. The piston cylinder 47 is also provided with conduits or ports 54 and 55 communicating with the interior thereof on opposite sides of the piston 46. The shaft 50 and cylinder 49 are supported for rotation in anti-friction bearings 56 and 57 mounted about the cylinder 49 and about the lower end of the shaft 50, respectively. The anti-friction bearings 56 and 57 are received in bearing cups, keyed or otherwise secured in bearings 58 and 59 formed integral with the housing 18. The lower end of the shaft 50 is threaded, and has secured thereto an hydraulic coupling 60 to which is secured one end of a conduit 61 to convey an hydraulic medium under pressure to the interior of shaft 50 in the space surrounding the conduit or pipe 53. A similar coupling 62 is secured to the lower end of conduit or pipe 53, and has connected thereto one end of a conduit 63 for conveying an hydraulic medium to said pipe or conduit 53.

The medium flowing through the shaft 50 outside of pipe 53 is adapted to actuate the piston cylinder 47 to elevate said cylinder together with the stud 48 to which a chuck member 64 is secured. The piston cylinder 47 is actuated until it abuts a plate 65 which forms the upper head of the cylinder 49. The contact between the piston cylinder 47 and head 65 is made by a boss formed on the said cylinder thereby providing a space 66 between the cylinder proper and the head. The hydraulic medium, while maintaining a constant pressure against the lower end of the movable cylinder 47, then passes through the port 54 into the interior of said cylinder to the upper side of the piston 46 urging said piston 46 downwardly together with its piston rod and plunger head 44 secured thereto. The movement of the plunger head 44 forces clamping dogs 65*a* outwardly through radial

slots in the member 64 in which said dogs are mounted, into engagement with the inner wall of the work piece, thereby clamping said work piece to the chuck member 64. As shown in the drawings, the clamping dogs 65*a* are in the nature of steel balls and there may be three or more such balls carried by the chuck for engaging the work piece at an equal number of points circumferentially spaced about the periphery of said chuck. During the movement of the piston cylinder 47 and piston 46 the hydraulic medium is discharged from above the cylinder 47 and from beneath piston 46 through port 55 into and through the conduit or pipe 53 to the conduit 63. Upon completion of the grinding operation a valve, to be later described in detail, is actuated to reverse the flow of the fluid so that same passes under pressure through the conduit 63 and into and through the pipe 53 for first elevating the piston 46 to relieve the clamping pressure on the dogs 65*a*, the medium in the piston cylinder 47 above the piston 46 being exhausted through port 54. After the piston 46 has been actuated to the upper limit of its movement the medium under pressure passes from beneath said piston through conduit 55 into the space 66 between the movable cylinder 47 and the head 65 for lowering said cylinder 47 together with the chuck member 64, said cylinder 47 carrying therewith the piston 46, piston rod 45 and plunger head 44. This movement continues until the said chuck member 64 and plunger head 44 are beneath the upper surface of plate 43 at which time the work piece is automatically removed from the said plate 43.

To effect a rotation of the hollow shaft 50 and the work piece secured thereto, said shaft is provided with splines 70 for slidably receiving keys carried by sprocket 71. This sprocket is journaled for rotation only in a bracket 72 secured to the face of bed or column 15, said sprocket being held against axial movement in said bracket. The sprocket 71 is driven by a sprocket chain 73, Fig. 2, which extends about a sprocket 74 secured to a vertical stub shaft 75, Fig. 1. This shaft 75 has secured to its lower end a beveled gear 76 which meshes with a similar beveled gear 77 on transmission shaft 78, and the latter shaft 78 receives its rotation from worm and worm wheel connections indicated generally by the reference numeral 79, the rotation being derived from a prime mover 80 secured to the base of the machine exteriorly of the bed or column.

The housing unit 18 and parts supported thereby including the shaft 50, chuck 64, plunger 44 and pistons 46 and 47 are adapted to be automatically elevated as a unit for feeding the work piece secured thereto against the grinding wheel 17 to effect a cutting action on the work piece. The housing 18 has guide ways 225, Fig. 2, formed on opposite sides thereof, for engagement with tongues 226 formed on the bed or column 15 for guiding the said housing during its vertical movement. A bracket 218, Figs. 4 and 9, on the face of the bed 15, forms a bearing for a shaft 82 driven from prime mover 80 and the shaft 82 has secured to its inner end, interiorly of the housing 18, an eccentric disc cam 81. The cam 81 has riding on its periphery a follower 84, Fig. 9, longitudinally slidable through a guide bracket 85 carried by the housing unit 18. Integral with the follower 84 is a threaded shaft 85*a* having threaded connection with a nut 86 journaled in antifriction bearing 87 carried by a housing or the like 88 secured to the housing 18 and providing a support for the bracket 85. The nut 86 has formed exteriorly thereon a worm gear 89 for engagement with and rotation by a worm 90, the latter procuring rotation of the nut 86 for adjusting the position of the follower 84 relative to the bracket 85 and housing 88 to change the relative position of housing 18 and the bed 15. To effect rotation of the nut 86 the stem 91 of the worm 90 is connected by an Oldham coupling or the like 92 to a rotatable stub shaft 93. A hand wheel 94 is pinned or otherwise secured to the end of shaft 93 whereby the said shaft may be manually rotated for manual vertical movement of the housing 18 relative to the bed 15 The shaft 93 is journaled in a housing 95 which encloses means for automatically rotating the said shaft 93, said means comprising a segmental gear 96 loosely journaled about the shaft 93. A ratchet wheel 97 is keyed or otherwise secured to shaft 93 and cooperates with a pawl 98 pivotally secured as at 99 to the flange of the segmental gear 96. The teeth 100 formed on the gear 96 mesh with a rack 101 formed intermediately the ends of a piston 102 shiftable in a cylinder 103 by hydraulic pressure.

It will be apparent from the above description that rotation of the cam 81 procures a vertical movement of the housing 18 to elevate the chuck member 64, thereby carrying the workpiece 42 into operative engagement with the grinding wheel 17, and subsequent lowering of the chuck to withdraw the workpiece from operative position to provide for removal of the finished workpiece and the substitution of an unground workpiece. Rotation of the hand wheel 94 will adjust the vertical position of the workpiece relative to the housing and rotation of the worm 90 by movement of the piston 102 in response to fluid under pressure operates to compensate for the wear on the grinding wheel by raising the chuck 64 so that, in response to rotation of the cam 81, the workpiece is carried nearer to the center of the grinding wheel.

From the foregoing it will be noted that the work pieces are clamped in position relative to the grinding surface of the grinding

wheel and are rotated in said position. At the same time the grinding wheel is axially shifted across the portion of the work being ground by hydraulic pressure. To reduce the work piece to the proper and desired shape and form, the work piece is bodily raised and fed into the grinding wheel during the grinding operation.

The work pieces are adapted to be automatically positioned on the plate 43 and automatically discharged therefrom by the mechanism shown in Figs. 2, 3 and 4. A table or plate 105, Fig. 3, has its upper surface 106 in the same plane as the surface of plate 43, and a work carrier and positioning member 107 is mounted to rotate above said surface 106. The carrier 107 comprises a plurality of seats or pockets 108, Fig. 2, in which the work pieces are adapted to be individually positioned at the front or operator's side 108*a* of the machine with the base of the work piece resting upon the surface 106 to be slid therealong into position relative to the clamping mechanism and grinding wheel. Opposite to the position of the operator the table 105 has formed therein an opening 109 for alignment with a suitable discharge chute through which the work pieces are discharged after the completion of the grinding operation. The carrier or spider 107 is secured for rotation to a vertical shaft 110 journaled in the housing 18 and provided on its lower end with an intermittent rotating mechanism such as the Geneva wheel 111. The Geneva wheel 111 is provided with a plurality of radially extending slots 112, Fig. 4, in which the driving pin 113 is received for rotating same intermittently. This pin 113 is secured eccentrically to a continuously rotating disc 114 secured to a shaft 115 journaled for rotation in the extension 116, Fig. 3, of bracket member 72. A bevel gear 117, which is journaled in the extension 116, has a sliding connection with the shaft 115 for rotating same and the gear 117 meshes with a similar beveled gear 118 secured to the end of transmission shaft 217, (see Fig. 4) journaled in bracket 218, and is rotated by means of a gear 219, keyed or otherwise secured to the said shaft 217 and in mesh with a gear 220 which is keyed to drive shaft 82. It will be noted that when the housing unit 18 is raised, as described above, the shaft 115 is moved therewith without disturbing its driving connection with the gear 117. The intermittent rotation of the carrier 107 which occurs while the chuck is in its lowermost position operates to remove the completed workpiece from a position in which it is engaged by the chuck and to substitute an unground workpiece therefor, said intermittent rotation occurring between successive grinding operations while the grinding wheel is out of engagement with the workpiece for a dressing action on said wheel.

Referring now to Figs. 7 and 8, the hydraulic circuit for effecting the various movements of the members comprises a pump 120 having a pulley 121 for transmission belt 122 which surrounds a second pulley 123 on the end of transverse shaft 124 driven by prime mover 80. The pump 120 has extending therefrom a suction pipe or conduit 125 for drawing a suitable hydraulic medium, preferably oil, from a tank or the like 126. The medium is discharged from the pump 120 through conduit or pipe 127 under pressure for actuating the various pistons certain of which have already been enumerated while others will be described hereinafter. A common discharge line 128 is also provided for returning the spent medium to the sump or tank 126.

As shown in Fig. 7, the valve 138 is arranged to operate the mechanism for releasing the finished work piece from the chuck and replacing said work piece by an unfinished work piece, said valve also providing for compensation for the wear on the grinding wheel. The medium passes from the pressure line 127 through a conduit 129 to the valve casing 130, which controls the flow therethrough, to the work clamping and releasing mechanism. The medium enters the valve casing 130 through inlet port 131 passing therethrough into the conduit 63 to the coupling 62 from which it flows through pipe 53 into piston cylinder 47 for raising piston 46 to relieve the pressure of the plunger head 44 on the clamping dogs or balls 65*a*. This pressure then builds up in said chamber and flows through port 55 into the space 66 between the piston cylinder 47 and head 65 whereupon the said piston cylinder 47 together with the piston 46 is lowered to position the chuck 64 and plunger head 44 beneath the upper surface of the plate 43, the workpiece being stripped from said chuck by the plate 43 as said chuck is moved downwardly in response to fluid under pressure. The medium formerly contained in the piston cylinder 47 above the piston 46, and the pressure medium beneath hydraulic piston cylinder 47 in cylinder 49 discharges, during the above movement, through the hollow interior of the shaft 50 outside of the pipe 53 out through the conduit 61 to the conduit 132 through port 133 and into the interior of the valve casing 130. The medium then passes through exhaust port 134 into and through conduit 135 to the common discharge conduit 128 for delivery to the tank or sump 126. With the valve 138 in the position shown, a part of the medium under pressure which is flowing through conduit 63 passes through conduit 136 to one end of cylinder 103 for actuating piston 101 therein to oscillate segmental gear 96, thereby rotating the worm 90

to raise the housing unit 18 and thus to compensate for wheel wear and the material that was removed during the preceding trueing operation on the grinding wheel 17. When the valve 138 is shifted to reverse the direction of movement of piston 46 and piston cylinder 47, the medium flows through the valve casing 130 into conduit 132 and also enters conduit 137 to shift piston 101 to the other end of cylinder 103. From this it will be seen that the fluid pressure circuit from the pressure line 63 through conduit 136 into the cylinder 103 and the return circuit from the other side of said cylinder through circuit 137 to conduit 132 may be termed a closed circuit and the medium is merely shifted first to one side and then to the other for reciprocating piston 102 between its end stops.

The valve 138 within the cylinder 130 is actuated in one direction through a pivotally mounted arm 139 secured to pivot shaft 140 and actuated about its pivot by a cam 141 having a single projection 142 thereon. This cam is keyed or otherwise secured to a rotating shaft 143 driven from the rotating drive shaft line 82 through a pair of intermeshing gears 144, Fig. 1. The valve 138 is held against the arm 139 for shifting movement in the other direction by hydraulic pressure which enters the end of the casing 130 through a conduit 145 leading from the main pressure line 127 to exert pressure on the end of the valve 138. The shifting of the valve spool 138 is in timed relation to the hydraulic movements of the grinding wheel unit axially of itself toward and from the work piece.

The hydraulic medium also passes from main pressure line 127 through conduit 144*a* and port 145*a* into and through the valve casing 146 for controlling the movements of the grinding wheel. As shown in the drawings the medium passes out through port 147 in the casing 146 into conduit 148 to the inlet port 149, Fig. 6, in the left hand end of the smaller chamber 36 of cylinder 35. The medium on the right of piston 38 in the chamber 36 is discharged through port 150 and through conduit 151 to port 152 where it enters the casing 146, said medium passing through said casing into conduit 153 to the common discharge line 128 for delivery to the sump or tank 126.

The valve casing 146 has interiorly thereof for shifting movement therethrough, to effect a reverse flow of the fluid, a valve 154 which similar to valve 138 is actuated in one direction by a pivotally mounted arm 155 pivotally carried by the pivot rod 140, said arm being oscillated about its pivot by a cam 156. The cam 156, similar to cam 141, is keyed or otherwise secured to the shaft 143 for rotation therewith. Hydraulic pressure from pressure line 127 through conduit 157 enters the left hand end of the casing 146 for shifting the valve 154 in the other direction by pressure on the end of said valve, thereby maintaining contact between the arm 155 and the periphery of the cam 156. As shown in Figure 7, the cam 156 is provided with a single elongated portion 158 and with plurality of points or small cam portions 159. The points 159 cause a rapid shifting of the valve from one extreme to the other thereby causing a continuous reciprocation of the grinding wheel unit in operative relation to the surface of the workpiece as effected by the piston 38 for breaking the grinding lines and the like on the work piece while the latter is being ground. The surface of the grinding wheel is adapted to be dressed or trued after the completion of each work piece which is effected at the time the elongated cam portion 158 is holding the valve 154 in the position shown in Figure 7.

The dressing operation is procured by an extended movement of the wheel to withdraw said wheel from contact with the work piece and to carry said wheel past the dressing tool. With the valve 154 in the position of Fig. 7, the cam 160, which is keyed or otherwise secured to shaft 143, has a single projection 161 in position to actuate arm 162 about its pivot for shifting a valve 163 relative to the valve casing 164 to establish fluid connection between the port 165 of larger chamber 37 of cylinder 35 and the exhaust 128. By this construction the pressure flowing through conduit 148 into chamber 36 forces the piston 38 against the stop pin 166, carried by the piston 39, so that continuous pressure entering through the port 149 moves pistons 38 and 39 as a unit to the right relative to the cylinder 35 for retracting the grinding wheel 17 a sufficient distance to permit the finished work piece to be replaced by an unfinished one and to cause the active face of the grinding wheel to pass the truing tool or diamond, to be later described. The medium in chamber 37 is exhausted therefrom through conduit 164*a* to the valve casing 164 from which it flows through conduit 167 to the main or common discharge conduit 128 for delivery to the sump or tank 126.

Rotation of cam shaft 143 removes the projection 161 of cam 160 from the arm 162 to permit the hydraulic medium flowing from the main pressure line 127 through a conduit 163*a* into the end of the casing 164, to exert a pressure on the end of the valve 163 to shift said valve 163 to the right thereby connecting the branch pressure line 163*b* through the valve casing 164 with the conduit 164*a*, thereby shifting the piston 39 in the larger chamber 37 to the left, to the position shown in Fig. 6. This piston is then held in this position by hydraulic pressure and the stop pin 166 carried thereby acts as an abutment for limiting the reciprocatory movement of piston 38 in one direction under the influence of the hydraulic medium, as

was described above. To change the length of the normal reciprocatory stroke of the piston 38 the stop pin 166 is adjustable through its guide sleeve and is provided on its end with threads 166*a* for this purpose, a locking nut 166*b* locking the said pin in its adjusted position..

From the foregoing description it will be noted that each of the valve spools 138, 154 and 163 is actuated in timed sequential order so that the movements of the various members under control of the hydraulic medium are properly actuated in timed sequential order. Consequently the mechanism for raising the work piece from its normal receiving and discharging position into contact with the grinding wheel, thereby effecting a stock removal becomes operative only after the wheel wear compensator has effected the necessary adjustment, and after the grinding wheel has been retracted to the limit of its stroke, the latter retraction being effected while the compensating mechanism is actuated as well as during the time that the work feeding mechanism is in its lowermost position in which position the finished work piece is discharged and replaced by an unfinished one. It will also be noted that the trueing or reconditioning of the active face of the grinding wheel takes place during the replacing of the work piece and as soon as the trueing operation has been completed the grinding wheel is automatically returned to its operative position and oscillated or reciprocated axially of itself to produce the proper finish on the work piece.

The trueing mechanism utilized for reconditioning the active face of the wheel comprises a bracket 170, Fig. 5, secured to the frame of the housing unit 18 and has a bearing 171 formed therein in which is secured a bushing 172 in turn forming a bearing for stub shaft 173. Secured to the outer end of the stub shaft is a knob 174 provided with suitable graduations 175 cooperating with an index mark 176 carried by an enlarged collar portion of the bushing 172. On the inner end of the shaft 173 is a worm 177 meshing with worm teeth 178 formed on segmental worm gear 179 keyed or otherwise secured to a shaft 180. A gear 181 is also secured to the shaft 180 for rotation therewith and meshes with the teeth on an intermediate gear 182 loosely journaled on idler stud 183, said gear 182 meshing with rack teeth 184 formed on a vertically shiftable rod 185. This rod 185 is guided through a bearing 186 formed in bracket 170 and carries at the upper end thereof a diamond or other trueing tool 187 for engagement with the active face of the wheel 17. The diamond is positioned in the line of travel of the grinding wheel outside of the normal reciprocation of the said wheel and adapted to engage said wheel when the latter is moved by fluid pressure under the control of the valve 163 beyond its said normal reciprocating stroke.

To control the rotation of the prime mover 80 and to start and stop the various movements of the machine at the completion of a given cycle thereof so as not to cause a jam, use is made of manually actuable lever 190 pivotally mounted at the forward end of the machine on the housing 18. Said lever 190 is pinned or otherwise secured to a stud 191, Figs. 3 and 11, journaled in bracket 192 secured to the housing 18 and the stud 191 is provided with an eccentric 193 about which collar 194 extends. Carried by a collar for movement therewith is a pin 195 slidably guided through guide block 196 and having on its other end a nut 197. A similar nut 198 is secured to the pin intermediate the block 196 and collar 194. A pair of coil springs 199 and 200 are mounted about the pin 195 on opposite sides of the block 196 and the springs respectively abut on their adjacent inner ends against the block 196 and on their outer ends against the nuts 198 and 197. As the lever 190 is actuated in a counter clock-wise direction, in Figure 3, through a part of its stroke the eccentric 193 actuates the collar 194 for shifting the pin 195 toward the right, carrying the end of said pin into engagement with the switch arm 201 for actuating said switch arm 201 about its pivot 202, thereby depressing switch plunger 203 to close the switch 204 and complete a circuit through the prime mover 80 to effect a rotation thereof.

At this time the spring 199 is slightly compressed so that continued movement of handle or lever 190 will transmit a force through the collar 194, spring 199 and guide member 196 to rotate bell crank lever 205 about its pivot 206, said lever 205 having the guide block 196 pivotally mounted on the end of one of the arms 207 thereof. The other arm 208 of the bell crank 205 supports roller 209 received in circumferential groove 210 formed on one end of clutch spool 211 slidably keyed to the vertical shaft 110. This clutch spool 211 has formed on its inner end clutch teeth 212 adapted to engage similar clutch teeth 213 formed on the adjacent end of the hub of Geneva wheel 111. Should the clutch teeth 212 and 213 not be in position to interlock with one another at the time the clutch spool is actuated the spring 199 will be compressed to hold the said clutch spool 211 in engagement with the face of the Geneva wheel hub so that the instant the said Geneva wheel is rotated a distance equal to the width of the face of one clutch tooth the spring 199 will cause an engagement of the said clutch teeth.

To stop the machine the handle or lever 190 is reversely actuated (clockwise), and to insure the stopping of the machine only at

the completion of a given cycle a mechanical interlock is provided comprising a pin 214 carried by the housing 18, said pin cooperating with a notch 215 formed in the clutch spool 211. There are as many notches 215 formed in the said spool 211 as there are radial slots 112 in the Geneva wheel 111 and should the handle 190 be actuated before the completion of the cycle the spring 200 would be compressed with the end of the clutch spool engaging the pin so that as soon as the cycle is complete the said spring 200 will expand and actuate the bell crank 205 about its pivot to disengage the clutch teeth 212 and 213. A spring 216 surrounding the switch button 203 will then open the switch 204 to break the electrical circuit and stop rotation of motor 80.

What is claimed is:

1. In a device of the class described the combination of a bed, a slide pivotally carried by the bed and having guideways thereon, a carriage on the slide movable relative thereto in an angular direction as determined by the adjustment of the slide, a grinding wheel unit including a grinding wheel and a prime mover pivotally carried by the carriage and adjustable relative thereto whereby the grinding wheel unit may be moved in the angular plane of the carriage with its axis disposed parallel with the bed, and means for adjusting and locking the slide in angular positions relative to the bed including a pivotal connection between the slide and bed, a quadrant depending from the slide and having an elongated opening therein, and means carried by the bed and engaging within the opening for clamping the quadrant in adjusted positions.

2. In a device of the class described the combination of a bed, a slide pivotally carried by the bed and having guideways thereon, a carriage on the slide movable relative thereto in an angular direction as determined by the adjustment of the slide, a grinding wheel unit including a grinding wheel and a prime mover pivotally carried by the carriage and adjustable relative thereto whereby the grinding wheel unit may be moved in the angular plane of the carriage with its axis disposed parallel with the bed, means for adjusting and locking the slide in angular positions relative to the bed including a pivotal connection between the slide and bed, a quadrant depending from the slide and having an elongated opening therein, means carried by the bed and engaging within the opening for clamping the quadrant in adjusted positions, and means carried by the slide and movable therewith for actuating the carriage relative to the slide ways.

3. In a device of the class described the combination of a bed, a slide pivotally carried by the bed and having guideways thereon, a carriage on the slide movable relative thereto in an angular direction as determined by the adjustment of the slide, a grinding wheel unit including a grinding wheel and a prime mover pivotally carried by the carriage and adjustable relative thereto whereby the grinding wheel unit may be moved in the angular plane of the carriage with its axis disposed parallel with the bed, means for adjusting and locking the slide in angular positions relative to the bed including a pivotal connection between the slide and bed, a quadrant depending from the slide and having an elongated opening therein, means carried by the bed and engaging within the opening for clamping the quadrant in adjusted positions, means carried by the slide and movable therewith for actuating the carriage relative to the slide ways, and means carried by the bed for supporting a work piece in the line of reciprocation of the grinding wheel.

4. In a device of the class described the combination of a bed, a slide pivotally carried by the bed and having guideways thereon, a carriage on the slide movable relative thereto in an angular direction as determined by the adjustment of the slide, a grinding wheel unit including a grinding wheel and a prime mover pivotally carried by the carriage and adjustable relative thereto whereby the grinding wheel unit may be moved in the angular plane of the carriage with its axis disposed parallel with the bed, means for adjusting and locking the slide in angular positions relative to the bed including a pivotal connection between the slide and bed, a quadrant depending from the slide and having an elongated opening therein, means carried by the bed and engaging within the opening for clamping the quadrant in adjusted positions, means carried by the slide and movable therewith for actuating the carriage relative to the slide ways, means carried by the bed for supporting a work piece in the line of reciprocation of the grinding wheel, and means for extending the stroke of the grinding wheel unit beyond its normal reciprocating zone whereby to redress the active face of the grinding wheel and permit replacement of the work piece.

5. In a grinding machine the combination of a bed, a grinding wheel unit carried thereby including a grinding wheel, a shaft for the grinding wheel, a prime mover for rotating the shaft, slide means pivotally carried by the bed for supporting the prime mover for angular adjustment and reciprocation relative thereto, and means carried by the slide means for reciprocating the grinding wheel unit relative to the slide comprising an hydraulic circuit, a piston actuated thereby, and means for changing the zone through which the reciprocation of the grinding wheel takes place under influence of the hydraulic means.

6. In a grinding machine the combination of a bed, a vertically positioned rotating drive shaft carried thereby, the shaft having a hollow interior, an hydraulically actuated chuck and centering mechanism carried by the shaft, means supporting a work piece substantially centrally of the shaft, a piston reciprocable within the hollow interior of the shaft, a second piston reciprocable within the first piston, and hydraulic means for actuating the pistons in sequential order to first centralize the work piece relative to the shaft and then clamp the work piece in its centralized position.

7. In a grinding machine the combination of a bed, a vertically positioned rotating drive shaft carried thereby, the shaft having a hollow interior, an hydraulically actuated chuck and centering mechanism carried by the shaft, means supporting a work piece substantially centrally of the shaft, a piston reciprocable within the hollow interior of the shaft, a second piston reciprocable within the first piston, hydraulic means for actuating the pistons in sequential order to first centralize the work piece relative to the shaft and then clamp the work piece in its centralized position, means for rotating the shaft and work carried thereby, a tool above the work for operation thereon, and means for feeding the work and tool relative to one another.

8. In a grinding machine the combination of a bed, a vertically positioned rotating drive shaft carried thereby, the shaft having a hollow interior, an hydraulically actuated chuck and centering mechanism carried by the shaft, means supporting a work piece substantially centrally of the shaft, a piston reciprocable within the hollow interior of the shaft, a second piston reciprocable within the first piston, hydraulic means for actuating the pistons in sequential order to first centralize the work piece relative to the shaft and then clamp the work piece in its centralized position, means for rotating the shaft and work carried thereby, and a grinding wheel supported by the bed and reciprocable relative thereto for operation on the work piece while same is being rotated.

9. In a grinding machine the combination of a bed, a vertically positioned rotating drive shaft carried thereby, the shaft having a hollow interior, an hydraulically actuated chuck and centering mechanism carried by the shaft, means supporting a work piece substantially centrally of the shaft, a piston reciprocable within the hollow interior of the shaft, a second piston reciprocable within the first piston, hydraulic means for actuating the pistons in sequential order to first centralize the work piece relative to the shaft and then clamp the work piece in its centralized position, means for rotating the shaft and work carried thereby, a grinding wheel supported by the bed and reciprocable relative thereto for operation on the work piece while same is being rotated, means for extending the normal reciprocable stroke of the grinding wheel, and means for replacing the work piece at the time the grinding wheel unit is in its retracted position.

10. In a grinding machine the combination of a bed, a grinding wheel unit carried by the bed and reciprocable relative thereto, hydraulic means for reciprocating said unit including a cylinder, a piston within said cylinder, an hydraulic medium for actuating the piston through the cylinder, a second piston within the cylinder acting as a stop for limiting the stroke of reciprocation of the grinding wheel unit, and a valve controlling the flow of the medium to the cylinder having two operable positions, in one position effecting the normal reciprocation of the grinding wheel unit by actuating one of the pistons and in the other position effecting the actuation of both pistons to extend the stroke of grinding wheel unit.

11. In a device of the class described the combination of a bed, a work piece support, hydraulic means for centralizing and clamping the work piece for rotation relative to its support including a valve, a rotating tool carried by the bed, means for angularly adjusting the tool relative to the bed, hydraulic means for reciprocating the tool relative to the bed across the work piece in a plane parallel with the angular adjustment thereof inincluding a valve, hydraulic means for extending the stroke of the tool to retract same from the work piece to permit replacement thereof on the work piece support including a valve, and automatic means for actuating the valves in sequential order to effect a synchronized operation of the parts.

12. In a device of the class described the combination of a bed, a work piece support, hydraulic means for centralizing and clamping the work piece for rotation relative to its support including a valve, a rotating tool carried by the bed, means for angularly adjusting the tool relative to the bed, hydraulic means for reciprocating the tool relative to the bed across the work piece in a plane parallel with the angular adjustment thereof including a valve, hydraulic means for extending the stroke of the tool to retract same from the work piece to permit replacement thereof on the work piece support including a valve, automatic means for actuating the valves in sequential order to effect a synchronized operation of the parts comprising a cam for each valve, and common means for actuating the cams.

13. In a grinding machine the combination of a bed, a grinding wheel carried thereby and reciprocable relative thereto, hydraulic means for effecting said reciprocation including a pair of pistons, means for connecting one of said pistons with the grinding wheel, a hy-

draulic circuit for actuating the pistons, a pair of valves, one for controlling the movement of one of the pistons to effect reciprocation of the grinding wheel through a given zone and the other for controlling the movement of the second piston and for extending the zone of reciprocation of the grinding wheel, and individual means for actuating the valves.

14. In a grinding machine the combination of a bed, a grinding wheel carried thereby and reciprocable relative thereto, hydraulic means for effecting said reciprocation including a pair of pistons, means for connecting one of said pistons with the grinding wheel, a hydraulic circuit for actuating the pistons, a pair of valves, one for controlling the movement of one of the pistons to effect reciprocation of the grinding wheel through a given zone and the other for controlling the movement of the second piston and for extending the zone of reciprocation of the grinding wheel, individual means for actuating the valves, and means synchronizing the valve actuators.

15. In a grinding machine of the class described the combination of a bed, a grinding wheel support on the bed for movement relative thereto, a grinding wheel rotatably carried by the support, a work supporting, rotating and feeding mechanism including a housing reciprocably carried by the bed, a cam carried by the bed within the housing, a cam follower on the housing and contacting with the cam, and means for actuating the cam for feeding the housing relative to the bed for feeding the grinding wheel and work relative to one another.

16. In a grinding machine of the class described the combination of a bed, a grinding wheel support on the bed for movement relative thereto, a grinding wheel rotatably carried by the support, a work supporting, rotating and feeding mechanism including a housing reciprocably carried by the bed, a cam carried by the bed within the housing, a cam follower on the housing and contacting with the cam, means for actuating the cam for feeding the housing relative to the bed for feeding the grinding wheel and work relative to one another, said follower having a screw thread, a nut for engagement with the thread, and hydraulic means for actuating the nut to vary the relationship of the follower with respect to the housing to thereby compensate for wear on the grinding wheel.

17. In a grinding machine of the class described the combination of a bed, a grinding wheel support on the bed for movement relative thereto, a grinding wheel rotatably carried by the support, a work supporting, rotating and feeding mechanism including a housing reciprocably carried by the bed, a cam carried by the bed within the housing, a cam follower on the housing and contacting with the cam, means for actuating the cam for feeding the housing relative to the bed for feeding the grinding wheel and work relative to one another, said follower having a screw thread, a nut for engagement with the thread, hydraulic means for actuating the nut to vary the relationship of the follower with respect to the housing to thereby compensate for wear on the grinding wheel, and additional manual means for actuating the nut independently of the hydraulic means to further adjust the housing relative to the bed.

18. In a grinding machine for grinding a seat angularly to the axis of rotation of a work piece the combination of a bed, a grinding wheel carried thereby for reciprocating movement in a direction angularly related to the bed, a work support adjacent the bed and in the path of movement of the grinding wheel, a centralizing and clamping mechanism cooperating with the work support and comprising a centralizing member and a pressure head member, hydraulic means for independently actuating the centralizing and pressure head member, and means for periodically automatically placing on and removing a work piece from the support and operated in timed sequence with the centralizing and clamping mechanism.

19. In a grinding machine for grinding a seat angularly to the axis of rotation of a work piece the combination of a bed, a grinding wheel carried thereby for reciprocating movement in a direction angularly related to the bed, a work support adjacent the bed and in the path of movement of the grinding wheel, a centralizing and clamping mechanism cooperating with the work support and comprising a centralizing member and a pressure head member, hydraulic means for independently actuating the centralizing and pressure head member, means for periodically automatically placing on and removing a work piece from the support and operated in timed sequence with the centralizing and clamping mechanism, and means for effecting a vertical feed of the work and grinding wheel.

20. In a machine tool organization the combination of a bed, a rotating tool carried thereby and shiftable relative thereto, a hydraulic motor for shifting the tool, a work support on the line of reciprocation of the tool, a chuck cooperating with the support for holding a work piece on the support, a hydraulic motor for actuating the chuck, means for effecting a relative feed between the tool and work, a hydraulic motor for actuating the feeding means, a hydraulic system for the motors including a plurality of valves, a casing for the valves, and means for positively operating the valves in timed sequence for correspondingly effecting sequential operation of the motors.

21. In a machine tool organization the combination of a bed, a rotating tool carried thereby and shiftable relative thereto, a hydraulic motor for shifting the tool, a work support on the line of reciprocation of the tool, a chuck cooperating with the support for holding a work piece on the support, a hydraulic motor for actuating the chuck, means for effecting a relative feed between the tool and work, a hydraulic motor for actuating the feeding means, a hydraulic system for the motors including a plurality of valves, a casing for the valves, means for positively operating the valves in timed sequence for correspondingly effecting sequential operation of the motors, said means including an actuator for each valve, a cam operatively associated with and driving the actuators, and hydraulic means maintaining operative engagement between the cam and valve actuators.

22. In a machine tool organization the combination of a bed, a tool and work support cooperating with the bed, a hydraulic motor for reciprocating the tool relative to the bed, a second hydraulic motor for extending the stroke of the tool relative to the bed, a chuck supporting and rotating the work, means for effecting a relative feed between the tool and work including a hydraulic motor, a valve for each motor, a hydraulic system including the valves for operating the several motors and individual actuators for each valve for adjusting said valves in one direction, and hydraulic pressure means for shifting the valves in the other direction.

23. In a machine tool organization the combination of a bed, a tool and work support cooperating with the bed, a hydraulic motor for reciprocating the tool relative to the bed, a second hydraulic motor for extending the stroke of the tool relative to the bed, a chuck supporting and rotating the work, means for effecting a relative feed between the tool and work including a hydraulic motor, a valve for each motor, a hydraulic system including the valves for operating the several motors and individual actuators for each valve for adjusting said valves in one direction, hydraulic pressure means for shifting the valves in the other direction, a rotating shaft, a plurality of cams on said shaft, the said cams cooperating with the valve actuators for shifting same, and means for rotating the shaft whereby the valves are actuated in timed sequential order.

24. In a grinding machine the combination of a bed, a grinding wheel, a support for the wheel carried by the bed and shiftable relative thereto, a hydraulic motor connected with the support for shifting same through a predetermined zone, a second hydraulic motor determining one limit of said zone of reciprocation, a hydraulic pressure source for operating said motors, a valve for each motor shiftable in one direction by the hydraulic pressure source, an actuator for each valve for shifting same against the hydraulic pressure source, and a cam member for each actuator.

25. In a grinding machine the combination of a bed, a grinding wheel, a support for the wheel carried by the bed and shiftable relative thereto, a hydraulic motor connected with the support for shifting same through a predetermined zone, a second hydraulic motor determining one limit of said zone of reciprocation, a hydraulic pressure source for operating said motors, a valve for each motor shiftable in one direction by the hydraulic pressure source, an actuator for each valve for shifting same against the hydraulic pressure source, a cam member for each actuator, and means associated with the second hydraulic motor for varying the limit of the normal reciprocation zone.

26. In a device of the class described, a table, reciprocation of which causes a traversing movement between a cutting tool and a work piece, fluid pressure mechanism to procure reciprocation of said table, valve means to control the admission of fluid pressure to said mechanism, other fluid pressure mechanism to limit the movement of said table in one direction, and valve means to control the admission and exhaust of fluid pressure to said other fluid pressure mechanism to render said mechanism inoperative to procure an extended movement of said table beyond the normal reciprocatory position.

27. In a device of the class described, a table, reciprocation of which causes a traversing movement between a cutting tool and a work piece, fluid pressure mechanism for effecting said reciprocation including a pair of pistons, one of which is connected to said table, a hydraulic circuit for actuating the pistons, and a pair of valves, one of which controls the movement of one of the pistons to effect reciprocation of the table through a given zone and the other of which controls the movement of the second piston for extending the zone of reciprocation of the table.

28. In a device of the class described, a chuck, work loading means for placing an unfinished work piece in position for engagement by said chuck, means for advancing said chuck axially into engagement with the work piece for centering said work piece and means thereafter operative for clamping said work piece on said chuck while said chuck is in advanced position.

29. In a device of the class described, a chuck, work loading means for placing an unfinished work piece in position for engagement by said chuck, means for advancing said chuck axially into engagement with the work piece for centering said work piece and for withdrawing said chuck from the work piece at the completion of a cutting operation on

said work piece, and means operative while said chuck is in advanced position for clamping said work piece on said chuck.

30. In a device of the class described, a chuck, work loading means for placing an unfinished work piece in position for engagement by said chuck, fluid pressure means for advancing said chuck axially into engagement with the work piece for centering said work piece and for withdrawing said chuck from the work piece, and fluid pressure means operative while said chuck is in advanced position for clamping said work piece on said chuck and for subsequently releasing said work piece.

31. In a device of the class described, a chuck, an intermittently actuated work loading member for positioning a work piece in axial alinement with said chuck, fluid pressure means for advancing or retracting said chuck axially into and out of engagement with the work piece for centering said work piece, fluid pressure means operative for clamping or releasing said work piece on said chuck, and valve means to control the supply of fluid pressure to said fluid pressure means to first advance the chuck and clamp the work piece and subsequently to release the work piece and then retract the chuck.

32. In a device of the class described, a chuck, an intermittently actuated work loading member for positioning a work piece in axial alinement with said chuck, fluid pressure means for advancing or retracting said chuck axially into and out of engagement with the work piece for centering said work piece, fluid pressure means operative for clamping or releasing said work piece on said chuck, and valve means to control the supply of fluid pressure to said fluid pressure means to first advance the chuck and clamp the work piece and subsequently to release the work piece and then retract the chuck, said intermittently actuated work loading member being actuated while said chuck is in retracted position.

33. In a device of the class described, a grinding wheel and a work piece, a chuck on which said work piece is mounted, work loading means for positioning an unfinished work piece in position for engagement by said chuck, fluid pressure means for advancing said chuck axially into engagement with the work piece for centering the work piece, and means operative while said chuck is in advanced position for clamping said work piece on said chuck, and additional means for reciprocating said chuck toward and away from said grinding wheel to procure a feeding movement of the work piece.

34. In a grinding machine, a grinding member and a work holding member, a base, a carriage, a slide member on said base on which said carriage is mounted for reciprocation, said slide member being mounted for angular adjustment on said base, a bearing member angularly adjustable on said carriage in the plane of adjustment of the slide member, and a rotary spindle journaled in said bearing member and supporting one of said members.

35. In a grinding machine, a grinding member and a work holding member, a base, a carriage, a slide member on said base on which said carriage is mounted for reciprocation, said slide member being mounted for angular adjustment on said base, a bearing member angularly adjustable on said carriage in the plane of adjustment of the slide member, a rotary spindle journaled in said bearing member and supporting one of said members, and means on said slide member and movable therewith for actuating the carriage relative to said slide.

36. In a grinding machine, a grinding member and a work holding member, a carriage on which one of said members is mounted, fluid pressure means to procure a reciprocatory movement of said carriage to move the member carried thereby into operative engagement with said other member and to retract said member to inoperative position, a second carriage for the other of said members, means to procure a reciprocatory movement of said second carriage to procure a feeding movement of a work piece on the work holding member relative to the grinding wheel, means to dress the grinding member during the reciprocation of said first carriage, fluid pressure means to vary the location of the reciprocatory movement of said second carriage to compensate for the reduction in size of the grinding member, and means to actuate said carriages and said fluid pressure compensatory means in timed relation so that said second carriage is advanced in one direction while said first carriage remains in advanced position, and said compensatory means is actuated during the movement of said second carriage in the opposite direction.

37. In a grinding machine, a grinding member and a work holding member, a carriage on which one of said members is mounted, means to reciprocate said carriage to procure a feeding movement of a work piece in the work holding member relative to the grinding member and a subsequent withdrawal of the work piece relative to the grinding member, and fluid pressure means operable between successive grinding operations to advance the position of reciprocation of said carriage during the succeeding grinding operation to compensate for the reduction in size of the grinding member.

In testimony whereof I affix my signature.

CLEMENT BOOTH.