Oct. 31, 1933. C. W. HOPKINS ET AL 1,932,969

GRINDING MACHINE

Filed Oct. 10, 1930 5 Sheets-Sheet 1

Fig. 1

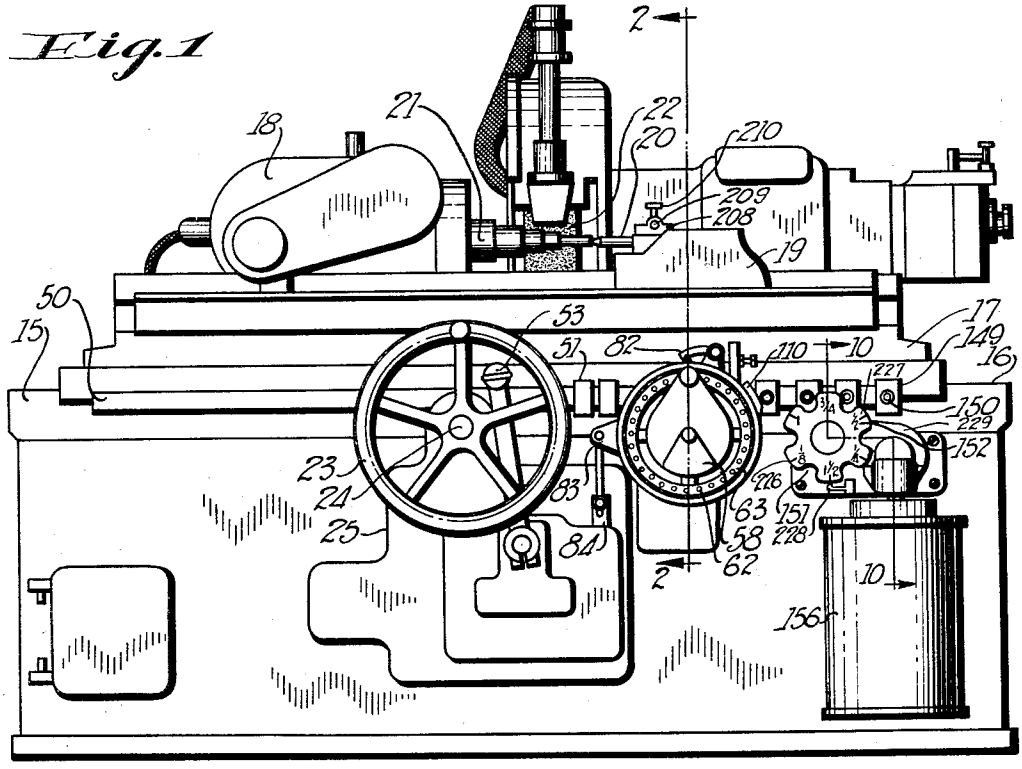
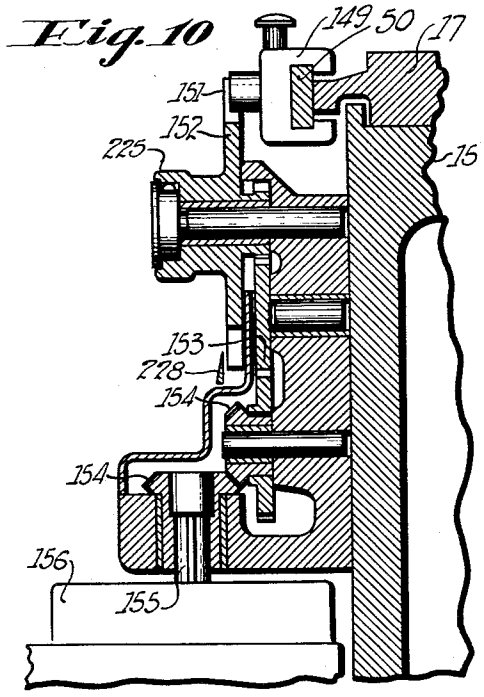


Fig. 10



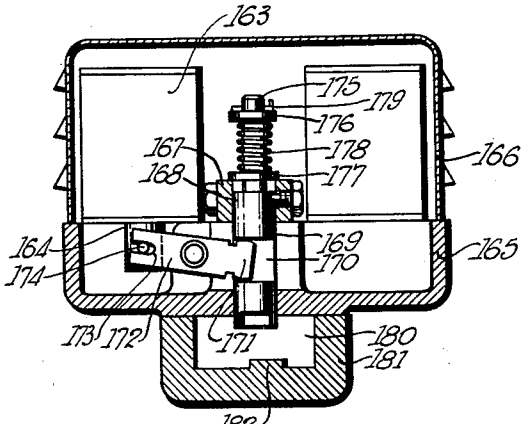


Fig. 8

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GRINDING MACHINE

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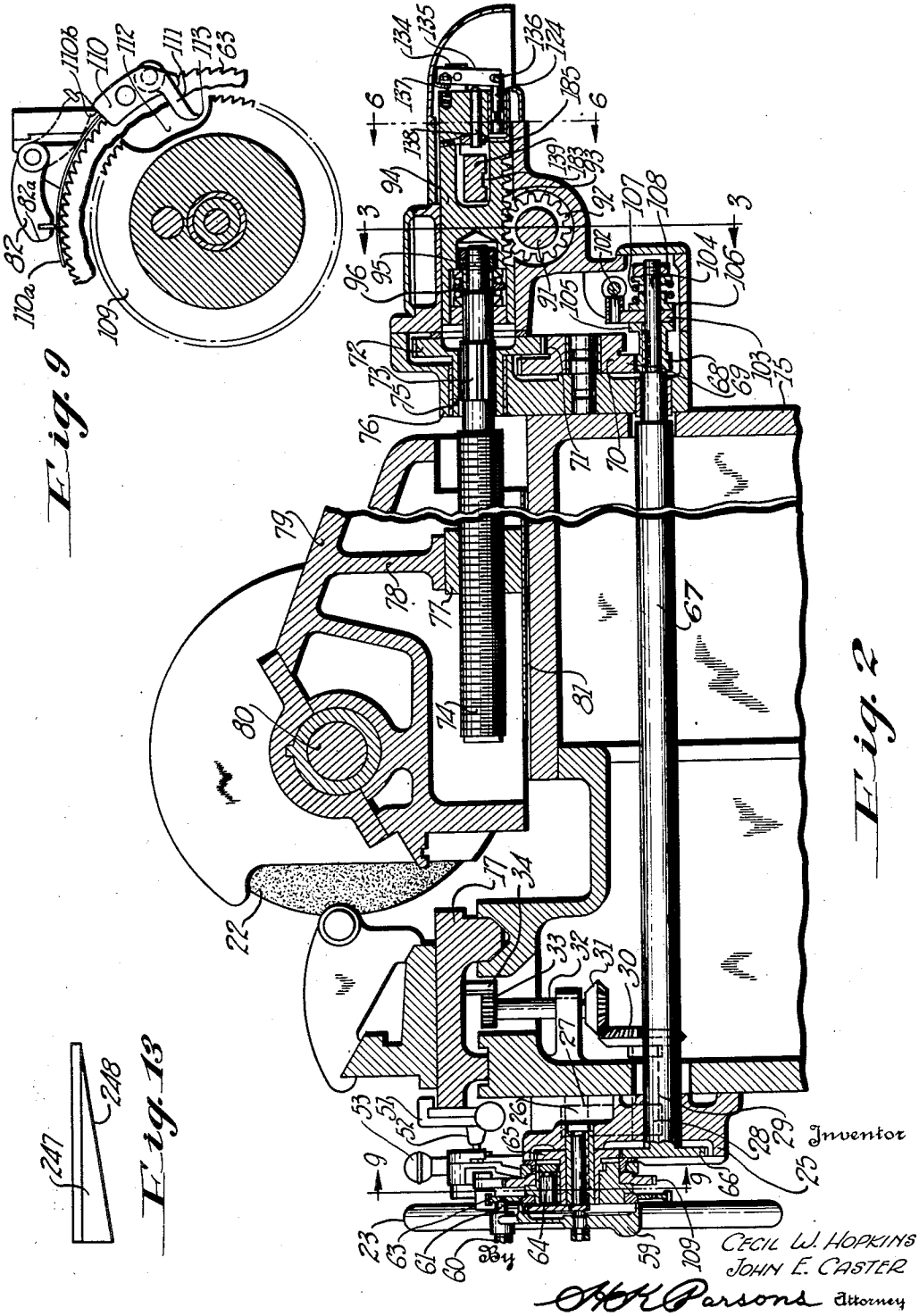


Fig. 9

Fig. 2

Fig. 13

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GRINDING MACHINE

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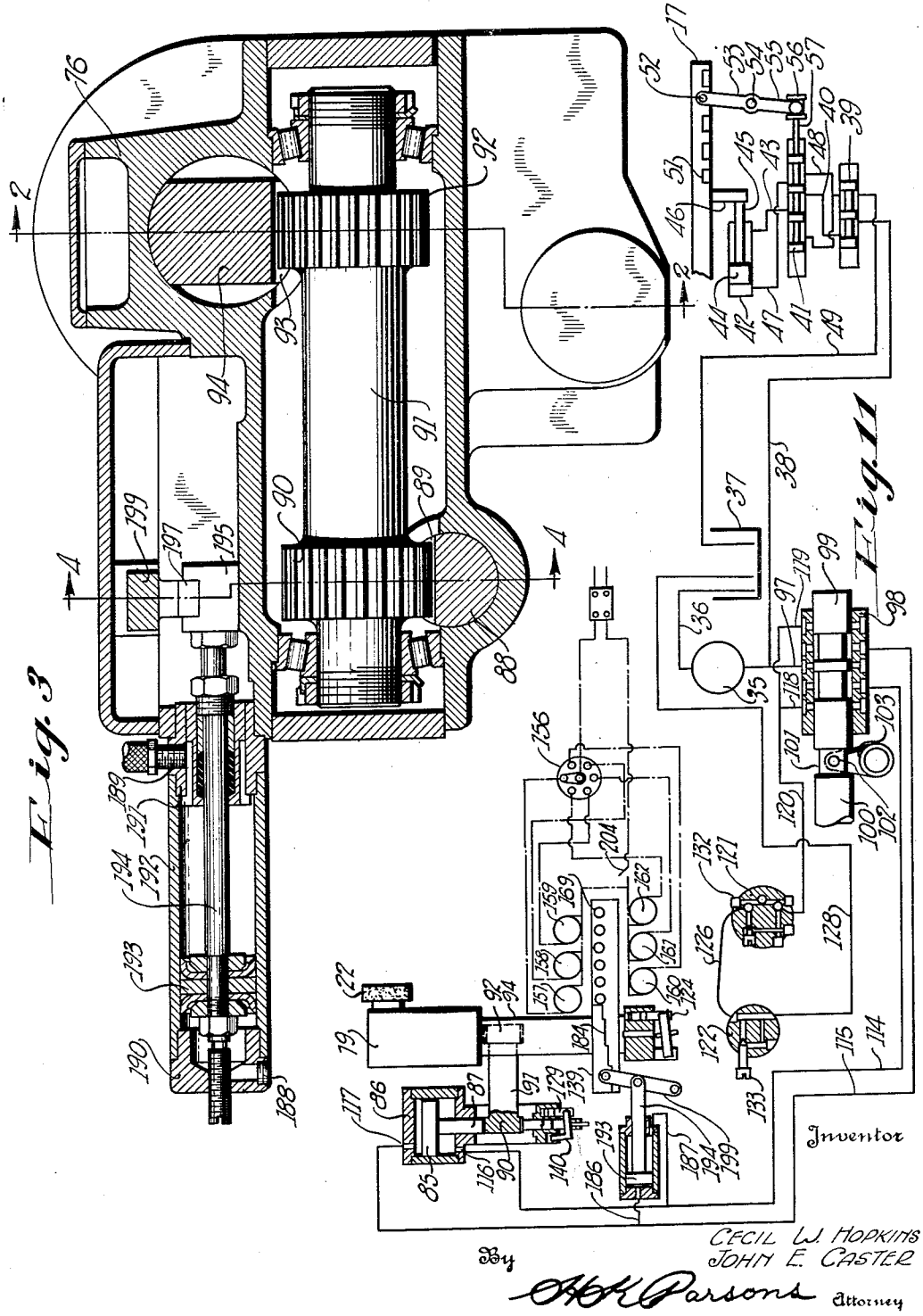


Fig. 3

Fig. 4

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GRINDING MACHINE

Filed Oct. 10, 1930 5 Sheets-Sheet 4

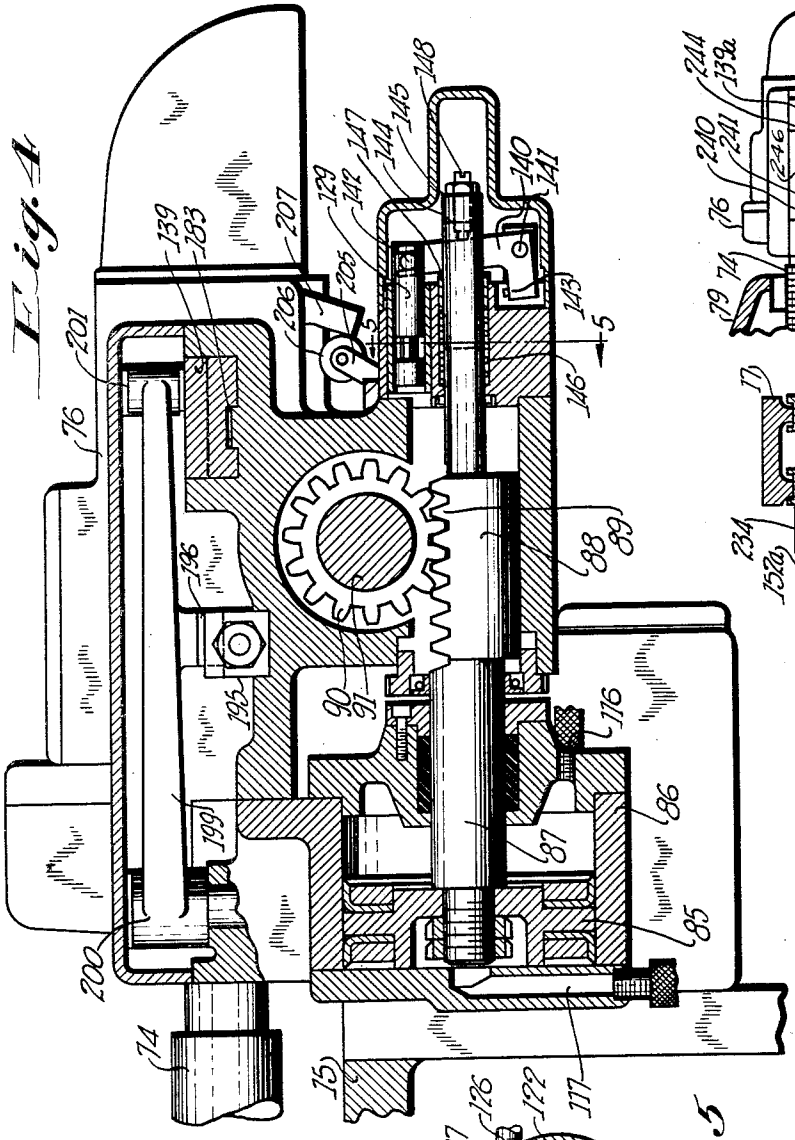


Fig. 4

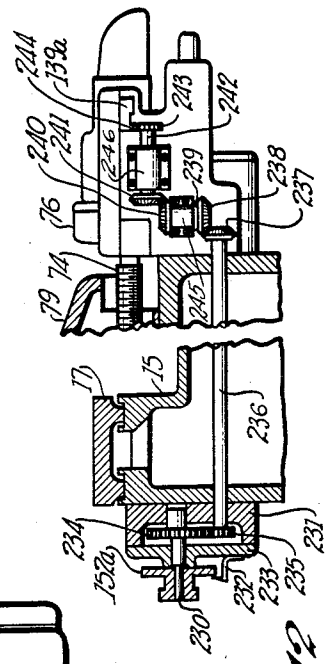


Fig. 12

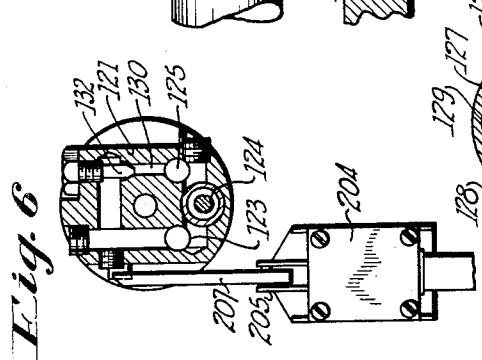


Fig. 6

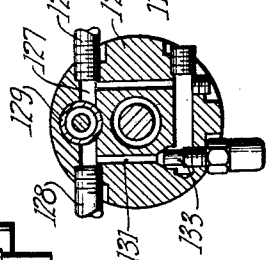


Fig. 5

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GRINDING MACHINE

Filed Oct. 10, 1930 5 Sheets-Sheet 5

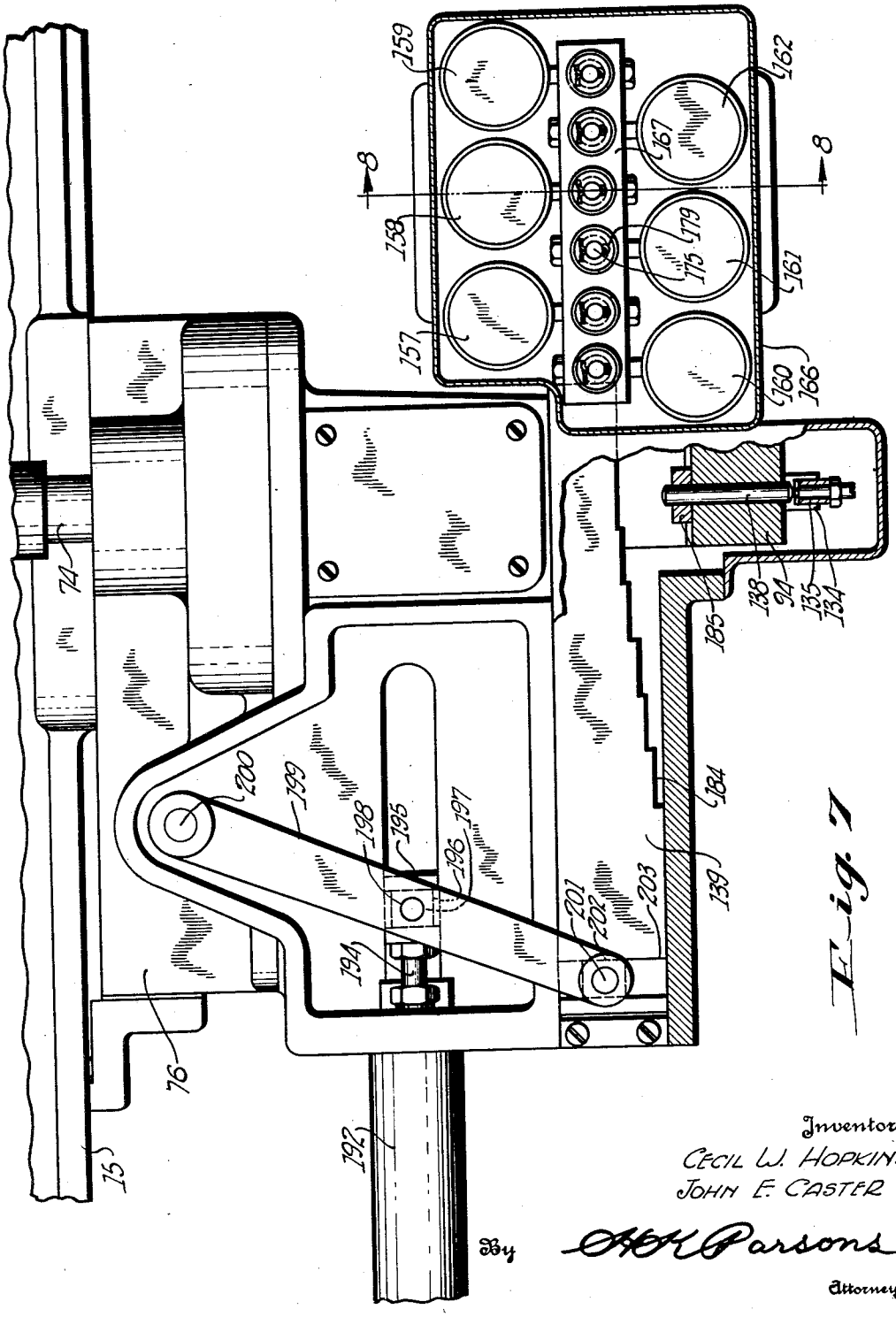


Fig. 7

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Patented Oct. 31, 1933 1,932,969

UNITED STATES PATENT OFFICE

1,932,969

GRINDING MACHINE

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Application October 10, 1930. Serial No. 487,817

31 Claims. (Cl. 51—72)

This invention relates to improvements in machine tool organizations and especially to improvements in center type grinding machines.

One of the principal objects of the present invention is the provision of improved means for economically and expeditiously finishing cylindrical shafts having a plurality of diameters thereon, such as armature shafts and the like.

Another object of the invention is the provision of improved means for actuating the tool support or slide relative to the supporting bed for positively controlling the position of such support or carriage relative to successive portions or diameters of the work.

Another object of the invention is the provision of improved means for synchronizing the movements of the tool carriage and work carriage to position the tool and a selected portion of the multiple diameter work for successive operations on different diameters thereof.

Another object of the invention is the provision of an improved grinding machine for accomplishing the above noted objects to reduce the production cost of said work pieces and increase the production of the machine to the maximum.

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 elevational view of a grinding machine embodying the improvements of this invention.

Figure 2 is a transverse sectional view of the machine as seen from line 2—2 of Figures 1 and 3.

Figure 3 is a 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 sectional view taken on line 5—5 of Figure 4.

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

Figure 7 is a fragmentary top plan view of certain parts shown in the right hand end of Figure 1, portions thereof being removed to more clearly disclose the structure.

Figure 8 is a sectional view taken on line 8—8 of Figure 7.

Figure 9 is a fragmentary sectional view as seen from line 9—9 of Figure 2.

Figure 10 is a fragmentary development of certain parts of the invention forming a detail thereof as seen from line 10—10 of Figure 1.

Figure 11 is a diagrammatic view illustrating the hydraulic and electrical circuits involved in this invention.

Figure 12 is a modified structure showing the invention.

Figure 13 is a modified cam or stop bar forming a detail of the invention.

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

As was noted above this invention pertains primarily to a structure for controlling the movements of work support and tool support relative to one another to properly position the tool and work for successively operating on the various diameters or portions of a work piece or pieces. In the past it was customary to manually feed the work and table relative to the bed for position whereupon a transverse actuation of the parts operatively associated the work and tool. The manual manipulation of these parts, however, resulted in a considerable loss of time to accurately position the parts and the manual feeding of the tool was exceedingly slow, and since the diameters or portions of the work differed greatly the space between the surface of the work and the cutting edge of the tool was relatively great necessitating considerable time and a fatiguing operation to properly adjust the parts. By this invention all of the preceding objections are eliminated and the work and tool are fed relative to one another at a rapid rate by power means and each successive portion or diameter of the work is adjusted relative to the tool to the same degree requiring a minimum of time for operatively associating the wheel and work. For the purpose of illustrating the invention, there has been chosen and illustrated in the drawings a center type grinding machine for grinding the successive portions of an armature shaft, or the like, which comprises a plurality of different diameters.

Referring to the drawings, the machine comprises a bed 15 having formed at the upper end thereof suitable ways 16 for guiding the work supporting table 17 longitudinally of the bed 15. The table has mounted thereon a headstock 18 and a tailstock 19 from which project work supporting members such as the center 20 between which the work 21 is mounted for presentation to the grinding wheel 22. The table 17 is adapt-

ed to be intermittently advanced relative to the bed 15 as by hand wheel 23 on the end of a shaft 24 which carries, interiorly of the bracket 25, a suitable gear or sprocket 26. A transmission chain 27 transmits the power from the pinion or gear 26 to a similar pinion or gear 28 secured to stub shaft 29 journaled in the bracket 25. The shaft 29 extends through the forward wall of the bed 15 to the interior thereof, and has secured thereto a bevel gear 30 meshing with a similar bevel gear 31 secured to vertical shaft 32. A rack pinion 33 is carried by the vertical shaft 32 at its upper end, and meshes with a rack 34 secured to the under surface of the table 17.

The table 17 may be power actuated by any suitable or desirable means, but as here shown resort is had to a fluid pressure pump 35 for drawing an hydraulic medium, preferably oil, through a suction pipe 36 from a tank or sump 37 usually mounted within the bed 15. The hydraulic medium is discharged from the pump 35 through a conduit 38 through which the flow of the medium is controlled by starting and stopping valve 39. A conduit or port 40 may connect the starting and stopping valve 39 with a reversing valve 41 which directs the hydraulic medium to one of the ends of a cylinder 42. As shown in Figure 11, the medium is being directed by the reversing valve 41 through conduit 43 to the right hand side of the cylinder 42 for actuating a piston 44 contained therein toward the left. The piston 44 has extending from it a piston rod 45 connected by a bracket 46 to the table 17, whereby the movement of the piston 44 is transmitted to the table for movement thereof. The hydraulic medium within the cylinder 42 ahead of the piston 44 is exhausted through a conduit 47 to the reversing valve 41 by which it is directed through port or conduit 48 to the stop valve 39 and main return conduit 49 to the sump or tank 37.

From the foregoing description it will be noted that the table 17 may be advanced either manually or hydraulically. To control the movement of the table and position same at the desired point relative to the grinding wheel 22 it is provided with a dog rail 50 having secured thereto a plurality of adjustable dogs 51 adapted to engage an abutment 52 protruding from the upper end of reverse lever 53. This lever 53 is secured to one end of a stub shaft 54 which has depending from its other end valve shifter finger 55 received in an annular groove formed by collars 56, secured to reversing valve stem 57. To hydraulically advance the table 17, the abutment 52 is withdrawn from the dog rail 50 and the lever actuated in a clockwise direction, as seen in Figure 1, whereupon the abutment is released and positioned in the path of movement of the next dog 51 for engagement therewith and actuation thereby. The movement of the reversing lever 53 in a clockwise direction shifts the valve 41 to a position for admitting hyraulic pressure to the right hand end of the cylinder 42, while a shifting of the said lever by one of the dogs 51 returns it to its neutral position thereby cutting off the flow of the hydraulic medium and stopping further movement of the table.

After the table 17 has been positioned, the grinding wheel 22 is actuated toward the work to effect a stock removal therefrom. This movement of the grinding wheel is accomplished by the cross feed mechanism indicated generally in Figure 1 by the numeral 58. This mechanism is shown most clearly in Figure 2 and comprises the hand lever or crank 59 having the manually actuable handle 60 from which extends a pin 61 engageable in suitable apertures 62 formed in a ratchet wheel 63. The ratchet wheel through the usual reduction gearing 64 rotates a pinion 65 meshing with a gear 66 fast on the outer end of transverse shaft 67. A pinion 68 is secured to the shaft 67 at its rear end and meshes with a gear 69 of compound gear 70. A pinion 71 of the compound gear 70 meshes with a gear 72 splined on one end 73 of an adjusting screw 74. The gear 72 has a sleeve 75 extending therefrom whereby the said gear is journaled in a bracket 76 secured to the rear wall of the bed 15. The threaded portion of the adjusting screw 74 has a threaded engagement with a nut 77 secured to a web 78 depending interiorly of grinding wheel carriage 79. A spindle 80 is rotatably mounted in the carriage 79 and has secured to its one end the grinding wheel 22. The lower portion of the carriage 79 is provided with suitable ways received on correspondingly formed guides 81 formed on the bed 15 and extending transversely thereof.

From the foregoing it will be noted that rotation of the handle or crank 59 will advance the carriage 79 by rotating the screw 74 which is axially movable through the bracket or housing 76 and the drive gear carried thereby. In order to feed the carriage 79 by power means the ratchet 63 is adapted to be engaged by the usual pick pawl 82 on one end of oscillating arm 83 operable by the adjustable link 84 in the usual way.

The grinding wheel carriage 79 is adapted to be actuated at a rapid rate by hydraulic pressure which acts on opposite sides of a piston 85 reciprocable through a cylinder 86 formed in the housing or bracket 76. As shown in Figure 4, the piston 85 has secured thereto and extending therefrom a piston rod 87 having an enlarged portion 88 intermediate its ends. Rack teeth 89 are formed on one side of the enlarged portion 88 and mesh with a pinion 90 secured to or integral with a shaft 91. As seen in Figure 3 the shaft 91 has formed integral with or secured to its other end a second pinion 92 meshing with the rack teeth 93 of slide block 94. The slide block 94 has journaled at its inner end the reduced portion 95 of adjusting screw 74 and has surrounding said reduced portion an anti-friction thrust bearing 96 whereby the screw 74 and carriage 79 are actuated hydraulically.

As shown in Figure 11, the pump 35 discharges the hydraulic medium through branch pressure line 97 to a valve sleeve 98 having slidable therein piston valve 99. The piston valve 99 has extending from it a stem 100 being formed with a circumferential groove 101 for roller 102 secured to arm 103 surrounding the reduced portion 104 of transverse shaft 67. The arm 103 is frictionally clamped between a flange 105 formed integral with drive pinion 68 and a second flange 106 slidable relative to the reduced portion 104 by a spring 107. A tension nut 108 is threaded to the end of the reduced portion 104 for adjusting the tension of the spring 107 and holding the arm in the desired position. From this it will be seen that rotation of the crank or handle 59 in either direction will correspondingly shift the valve 99. It will further be noted that as soon as the crank 59 is actuated the valve 99 is simultaneously moved thereby connecting the pressure source from pump 35 with the piston 85 so that the carriage is first moved at a rapid rate either forward or from the work, whereupon the normal feeding movement may be resorted to.

In order to prevent inadvertent engagement

between the wheel and work and to at all times have a definite clearance therebetween, the cross feed mechanism 58 has secured to it a second ratchet wheel 109 behind the normal feeding ratchet wheel 63. The usual stop block 110 is carried by the ratchet 63 and as shown in Figure 9 it has pivotally secured thereto a pawl 111 which cooperates with the teeth of ratchet 109. The stop block 110 has extending from it a guard plate 110*a* which rides under the pawl 82 when the work has been reduced to desired size which is slightly less than the ultimate size of the work. As shown in Figure 9 the fixed ratchet wheel 109 has a recess portion therein in which the pawl 111 drops when the automatic feed of the ratchet wheel 61 stops. The feed pawl 82 is provided with a vertical face 82*a* at the end thereof which face lies in the path of movement of the nose 110*b* of the stop block 110 when the feed pawl is actuated to its other position about its pivotal mounting as shown in dotted lines in Figure 9. The grinding wheel and its carriage is now fed manually by the handle or crank 59 until the face 82*a* of feed pawl 82 and the nose 110*b* of the stop block 110 are in engagement at which time the work has been reduced to the exact size. As noted above, at this time the pawl 111 is in the recess 112 of the fixed ratchet 109. In order to retract the grinding wheel and its carriage from the work it is necessary to actuate the handle or crank 59 in clockwise direction thereby causing the pawl 111 to ride on the teeth of the ratchet 109 with its nose 113 downward. A relatively small portion of a revolution of the handle or crank 59 in a clockwise direction is all that is necessary to shift the valve and effect a retraction of the grinding wheel hydraulically but before the handle or crank 59 can again be actuated in a counter clockwise direction to effect a feed of the wheel a complete clockwise revolution must be made because the nose 113 of the pawl 111 will immediately fall by gravity behind the ratchet teeth of ratchet 109 preventing movement of the hand wheel or crank 59 in a counter clockwise direction. In order to free the pawl 111 from the wheel 109 a complete revolution of the crank 59 is necessary to bring the pawl into alignment with the recess 112 whereupon a reverse actuation of the handle will cause the said pawl 111 to ride on top of the ratchet 109 with the nose 113 thereof extending upward.

Referring again to Figure 11, it will be noted that a pair of conduits 114 and 115 extend from the valve sleeve 98 to opposite ends of the cylinder 86 and the said conduits terminate respectively at ports 116 and 117 formed in the heads of the cylinder 86. The conduits 114 and 115 are alternately employed for intake and exhaust lines, which when used as exhaust lines return the spent hydraulic medium to the valve sleeve 98 where it is directed into either of two branch conduits 118 and 119 connecting with a discharge conduit 120 which passes through cut-off valves 121 and 122 shown diagrammatically in Figure 11 and structurally in Figures 6 and 5.

The cut-off valves 121 and 122 are employed for retarding the movement of the piston 85 at opposite ends of its stroke to prevent a sudden impact of the piston against the cylinder end caps. The hydraulic medium passes first through the cut-off valve 121 from the conduit 120 by way of port 123 then through the valve 124 to the port 125, conduit 126 to the cut-off valve 122. The flow of the medium through the valve 122 is similar to that through valve 121 wherefore the valve 122 is provided with a port 127 communicating on one end with the conduit 126 and on the other end with discharge conduit 128 which returns the medium to the tank or sump 37. The port 127 is provided with a slide valve 129. Each of the cut-off valves 121 and 122 is provided with a by-pass 130 and 131 having a choke valve 132 and 133 therein. The cut-off valve 121 is employed to retard the movement of the carriage toward the work support and as shown in Figure 2 the slide block 94 in which it is mounted has protruding from its rear end a bracket 134 having pivoted thereto intermediate its ends an arm 135. A sliding connection 136 is provided between one end of the arm 135 and the valve 124 and the other end of the arm 135 is provided with a spring seat for spring 137, whereby the arm is actuated in one direction which normally holds the valve 124 in an operative position permitting the flow of the medium from port 132 through port 125. Slidably carried by the block 94 is a pusher 138 normally held in the position shown in Figure 2 with its one end engaging the lever 135 and its other end adapted to engage a stop bar 139 to be described later.

The mechanism for actuating the cut-off valve 122 when the piston 85 is actuated away from the work, comprises a bell crank 140 pivoted at 141 to a fixed portion of the bracket and having a sliding connection at 142 between one arm of the bell crank 140 and the valve 129. An abutment 143 is provided on the other arm of the bell crank and engages the housing of the cut-off valve 122 to limit the movement of the bell crank in one direction. The bell crank 140 extends through a slot 144 formed in an extension 145 of the piston rod 87. A spring 146 surrounds the said arm and abuts on opposite ends with the housing of the cut-off valve 122 and a collar 147 loosely mounted on said rod and engaging the bell crank 140. An adjustable abutment 148 is carried by the end of the extension 145 for engagement with the bell crank 140 to actuate same against the yielding resistance of the spring 146.

From the foregoing description it will be noted that the cut-off valves 121 and 122 are coupled in series with one another for respectively closing the ports and choking off the flow of hydraulic medium therethrough for correspondingly retarding the movement of the piston 85 and parts actuated thereby at opposite ends of the piston travel.

To position the grinding wheel and its carriage relative to the various diameters or steps of the work the dog rail 50 is provided with a plurality of adjustable dogs 149 each having a roller 150 carried thereby. The rollers 150 are adapted to engage in recesses 151 formed around the periphery of dial switch plate 152. The dial switch plate 152 is connected through transmission gear train 153 and bevel gears 154 with the vertical shaft 155 of drum switch 156 secured to the forward face of the bed 15. As shown diagrammatically in Figure 11, the drum switch is connected with the plurality of solenoids 157, 158, 159, 160, 161 and 162. There are as many adjustable dogs 149 and solenoids 157 to 162 inclusive employed as there are different diameters or portions on the work plus one additional dog and solenoid for limiting the approach of the grinding wheel to the trueing position. The solenoids are of similar construction and it is deemed sufficient if but one of them be described in detail, accordingly, each consists of the usual coil 163 having the

movable core 164 extending therethrough. As shown in Figure 8, the solenoids are mounted on opposite sides of a support 165 being enclosed by a suitable cover 166. The support 165 has a bar 167 extending longitudinally thereof between the solenoids and the bar 167 is provided with an opening 168 adjacent each solenoid. Slidable through the opening is a stop pin 169 having a notch 170 formed in the side thereof receiving the enlarged head 171 of a pivotally mounted lever 172. The lever 172 is formed on its opposite end with a slot 173 receiving a pin 174 projecting from the movable core 164. Stop pin 169 has a reduced portion 175 extending upwardly above the bar 167 which is surrounded by a pair of collars 176 and 177, the former lying on the bar 167 and forming one abutment for expansion spring 178. The spring 178 abuts the other collar 177 on its upper end which is confined by a cotter pin or the like 179 extending through the end of the stop pin extension 175. The lower end of the said stop pin 169 projects below the housing 165 into a passage 180 formed by guide bracket 181 secured to the housing 165. A guide tongue 182 extends upwardly from the base of the guide member 181 and is received in a similarly formed guideway 183 provided in the lower face of cam bar 139.

This stop bar, see Figure 7, is provided with a series of cam faces 184 bearing the same relation to one another as the various portions or diameters of the work bear to each other. It is these faces that engage the pin 138 for actuating the valve 124 of cut-off valve 121. A hardened steel bar 185 is carried by the slide block 94 and surrounds the pin 138 which abuts against the cam faces 184 for limiting the movement of the carriage 79 and grinding wheel 22 toward the work. This stop bar is actuated through its guide 181 by hydraulic pressure taken from conduits 114 and 115, as seen in Figure 11, through branch conduits 186 and 187 terminating at ports 188 and 189 formed in cylinder heads 190 and 191 of cylinder 192. Shiftable through the cylinder 192 is a piston 193 having a piston rod 194 extending therefrom. The inner end of the piston rod 194 has a head 195 secured thereto in which a slot 196 is formed receiving block 197 pivoted at 198 to an arm 199. One end of the arm 199 is pivoted at 200 to the bracket 76 while the other end carries a pin 201 for a block 202 received in a guide slot 203 formed in the cam bar 139.

From the foregoing it will be noted that as the piston 193 is reciprocated it oscillates the arm 199 about the pivot 200 thereby reciprocating the cam bar 139 which reciprocation is made possible through the sliding connections between the arm and cam and the arm and piston head.

In the electrical circuit which includes the solenoids 157 to 162 inclusive and the drum switch 156 there is provided a circuit breaker which insures the proper positioning of the parts before the said solenoids are actuated. This circuit breaker is shown diagrammatically at 204 in Figure 11 and is shown structurally in Figure 4. As there shown the circuit breaker comprises a pivotally mounted arm 205 bearing at its upper end a roller 206 for engagement with a projecting lug 207 depending from the fixed housing 76. This circuit breaker is normally open being closed only when the grinding wheel carriage has been retracted to its rearmost position at which time the table 17 is advanced for actuating the drum switch and closing the next circuit thereby energizing the proper solenoid for positioning the grinding wheel relative to the next step of the work piece.

To true or redress the active face of the grinding wheel the tailstock 19 has secured thereto a bracket 208 for the trueing tool or diamond 209 adjustably secured therein by a set screw or the like 210.

The complete operation of the improved grinding machine is as follows: A multiple diameter work piece is mounted on the work supporting table between the headstock 18 and tailstock 19, the starting valve 39 opened to permit a flow of the hydraulic pressure by the pump 35. The lever 53 is now actuated toward the right as seen in Figure 1 having the abutment 52 in position to be engaged by one of the adjustable dogs 51. The movement of the table 17 carries with it the dogs 149 for actuating the dial switch plate 152. As soon as the lever 53 has been actuated by the dog 51 the movement of the table 17 stops. At this time the drum switch has been set for completing the electrical circuit including one of the solenoids 157 to 162 inclusive corresponding to the particular diameter now to be operated upon. The handle or crank 59 is now actuated in a counter clockwise direction, it having been previously positioned, as shown in Figure 9, with the locking pawl 111 within the recess 112, so that by actuating the said handle or crank 59 in a counter clockwise direction the said pawl 111 will ride on the face of the ratchet 109. As soon as the handle or crank 59 is actuated the valve 99 is shifted through the transverse shaft 67 for connecting the hydraulic pressure of the pump 35 with the proper side of the cylinder 86 for actuating the piston 85 therein and feeding the grinding wheel carriage 79 and grinding wheel toward the work at a rapid rate. This movement continues until the sliding pin 138 engages with one of the cam faces 184 on stop bar 139 whereupon the valve 124 is shifted for cutting-off the unrestricted flow of the medium through the cut-off valve 121 causing said flow to by-pass through port 130 and choke valve 132. This movement of the grinding wheel carriage and grinding wheel continues at a slow rate until the hardened steel member 185 carried by the sliding head 94 engages the desired cam face 184 whereupon further movement of the grinding wheel is restricted.

At this time the desired clearance exists between the active face of the grinding wheel and the particular diameter of the work to be ground which space corresponds to one or more complete revolutions of the crank or handle 59 and which space is now taken up by said handle or crank 59 until the wheel and work contact with one another. Upon engagement between the wheel and work the automatic feeding mechanism through the adjustable link 84 is thrown in for reducing the work to the proper size which is controlled by the lock-out member 110 and the guard 110*a* extending therefrom riding under the pick feed pawl 82. The parts are so arranged that the pick feed pawl may be actuated in a counter clockwise direction about its pivotal connection with the arm 83 to position its flat nose 82*a* in the path of movement of throw-out member 110. The handle or crank 59 then is again manually actuated to force the flat face 110*b* of the throw-out member against the flat nose 82*a* of pick feed pawl 82 which is the final size of the work.

As soon as the work has been reduced to its final size the handle or crank 59 is actuated in a clockwise direction thereby shifting the valve

99 to its other position connecting the hydraulic pressure source with the other side of the cylinder 86 to reversely actuate the piston therethrough. At this time the hydraulic pressure source is connected to the proper end of cylinder 192 for actuating the piston 193 therethrough for retracting the cam bar 139 to the position shown in Figure 7. Continued retracting movement of the grinding wheel and its carriage closes the circuit breaker 204 so that the particular switch contact made by the advancing table 17 will energize the proper solenoid for drawing the core 164 upwardly, as seen in Figure 8, actuating the lever 172 about its pivot and depressing the pin 169 into the guideway 180. As soon as the table 17 has been brought to rest the crank 59 is again actuated in a counter clockwise direction for again initiating a movement of the grinding wheel and its carriage toward the work. Immediately on movement of the grinding wheel and its carriage and before the circuit breaker is again opened the piston 193 will be actuated through its cylinder for forcing the end of the stop bar 139 against the particular stop pin 169 positioned in its path. The hydraulic pressure is constantly maintained against the piston 193 which prevents the spring 178 from raising the pin out of its path. However, as soon as the grinding wheel carriage is retracted the piston 193 is likewise actuated thereby relieving the pressure between the pin and the cam bar so that the said spring may draw the said pin out of the path of movement thereof. It is to be noted that should the current at any time be shut off so that the particular stop pin 169 desired to be placed in the path of movement of the stop bar fail to materialize, the hydraulic pressure would actuate the said bar to the limit of its movement thereby placing the largest cam face or the trueing stop in position for stopping the movement of the grinding wheel and its carriage. This would stop the grinding wheel and its carriage a sufficient distance from either of the work diameters and would prevent the wheel from gouging into the work as might happen if no restriction were placed on the movement of the wheel under the influence of the hydraulic medium.

While the stop bar 139 and the dial switch plate 152 are each shown as having six operative portions it is to be understood that any number of such operative portions may be provided.

As shown in Figures 1 and 10 the dial switch plate may be manually operated instead of power operated for which purpose the said dial switch plate 152 is provided with a knob portion 225 having a knurled operating surface. The invention thus far has been described as an automatic or semi-automatic machine for operation on a particular type of work piece, namely: a multiple diameter shaft or the like, it is to be understood, however, that the invention is not restricted solely to this use but may be employed for quickly setting up the machine for operation on any known diameter or size of work piece within the range of the machine whether the work be straight, stepped, contoured, etc. For this purpose, as shown in Figure 1, the dial switch plate 152 carries suitable indicia 226 indicating the particular size of work that may be machined at that particular point. The indicia each have a marker or point 227 cooperating with a pointer 228 secured to gear train housing 229 in turn secured to the front face of the bed 15.

It is to be understood that when setting the dial manually the adjustable dogs 149 are removed from the dog rail so that the table 17 may be reciprocated back and forth, as is usual practice, without changing the drum switch and disturbing the setting of the machine. From the foregoing it will be appreciated that by manually adjusting the dial switch plate 152 to position the particular portion 226 thereof, corresponding to the size of the work piece to be operated upon, relative to the pointer 228 the proper switch contact in the drum switch 156 will be made to energize the proper solenoid 157 to 162 inclusive, so that when the grinding wheel and its carriage are actuated toward the work table it will be positioned properly relative thereto.

The modification shown in Figure 12 illustrates a simple manually operated mechanism for adjusting the stop bar without the use of power means or the like. This modification comprising the dial 152*a* secured to a stub shaft 230 journaled in a bracket or housing 231 secured to the forward face of the bed 15. A pointer 232 is secured to the cover 233 of the bracket 231 for cooperation with the dial 152*a* which carries suitable indicia for setting it for operation on different sizes or kinds of work pieces. A relatively large gear 234 is secured to the stub shaft 230 for movement therewith and the said gear meshes with a relatively small pinion 235 secured to the end of a shaft 236. The gear and pinion 234 and 235 are enclosed within the housing or bracket 231 which housing also provides the bearing for the forward end of shaft 236. This shaft 236 extends through the bed 15 to and beyond the rear wall thereof and the shaft has secured to it bevel gear 237 meshing with a similar bevel gear 238 fast on the lower end of a vertical shaft 239. Another bevel gear 240 is secured to the upper end of the vertical shaft 239 and meshes with a similar bevel gear 241 on one end of pinion shaft 242. A rack pinion 243 is secured to or formed integral with the other end of the pinion shaft 242 and meshes with the rack teeth 244 formed on the under surface of cam or stop bar 139*a*. Suitable bearings 245 and 246 may be provided for supporting the vertical shaft and pinion shaft 239 and 242 respectively. By properly proportioning the gears 234 and 235, 237 and 238, and 240 and 241 to one another a relatively small movement of dial 152*a* may result in a relatively large movement of the cam or stop bar 139*a* whereby any number of different stop portions may be formed on the bar to take care of the different sizes of work pieces throughout the entire range of the machine. Instead of providing a cam or stop bar having a series of cam faces the said bar may be formed, as shown at 247 in Figure 13. This cam bar is provided with a tapered or angled surface or edge 248 against which the stop or abutment member of the grinding wheel or tool carriage may abut. By using such a cam or stop bar an infinite number of stopping points are provided.

What is claimed is:

1. In a machine tool organization, the combination of a bed, a work support thereon, a tool carriage mounted on the bed movable toward and from the work support, a shiftable stop bar movable transversely of the path of movement of the tool carriage for engagement by the said tool carriage to limit its movement in the direction of the work support, and means on the front of the bed for controlling the shifting of the stop bar

2. In a machine tool organization, the combination of a bed, a work support thereon, a tool carriage mounted on the bed movable toward and from the work support, a shiftable stop bar for engagement by the carriage to limit its movement in the direction of the work support, power means for shifting the stop, means abutting the stop bar to variably limit its travel, and means on the front of the machine for indicating the position of the stop bar in accordance with the work on the work support.

3. In a machine tool organization, the combination of a bed, a work supporting member carried by the bed and movable relative thereto, a tool support carried by the bed and movable toward and from the work supporting member, means for actuating the work supporting member at a step by step rate to align individual portions of the work with the tool carriage, and means for limiting the movement of the tool carriage toward the work supporting member determined by the portion of the work in alignment with the tool carriage comprising a plurality of electric circuits closable by the movement of the table, a stop bar, and means operable by the circuits for positioning the stop bar in the path of movement of the tool carriage.

4. In a device of the class described, the combination of a bed, a tool carriage carried thereby and movable relative thereto at rapid traverse and feeding rates, hydraulic means for actuating the carriage at a rapid traverse rate, mechanical means for actuating the carriage at feeding rates, an operative connection between the hydraulic and mechanical means whereby one supplements the other, and means for variably limiting the movement of the carriage by the hydraulic pressure including a stop bar for engagement with the carriage.

5. In a device of the class described, the combination of a bed, a tool carriage carried thereby and movable relative thereto at rapid traverse and feeding rates, hydraulic means for actuating the carriage at a rapid traverse rate, mechanical means for actuating the carriage at feeding rates, an operative connection between the hydraulic and mechanical means whereby one supplements the other, and means for variably limiting the movement of the carriage by the hydraulic pressure including a stop bar for engagement with the carriage, said hydraulic means including a pressure source, an hydraulic circuit, and a retarding valve in the circuit for engaging the stop bar for actuation thereby.

6. In a device of the class described, the combination of a bed, a tool carriage carried thereby and movable relative thereto at rapid traverse and feeding rates, hydraulic means for actuating the carriage at a rapid traverse rate, mechanical means for actuating the carriage at feeding rates, an operative connection between the hydraulic and mechanical means whereby one supplements the other, and means for variably limiting the movement of the carriage by the hydraulic pressure including a stop bar for engagement with the carriage, said hydraulic means comprising an hydraulic pressure source, a piston operable thereby, a rack associated with the piston, a slide block operatively coupled with the tool carriage, and means operable by the piston rack for actuating the slide block and carriage.

7. In a device of the class described, the combination of a bed, a grinding wheel carried thereby and movable relative thereto, a work supporting table on the bed translatable relative thereto for traversing the work relative to the grinding wheel carriage, stop dogs carried by the table for positioning same, and hydro-electric means operable by the table for variably limiting the approach of the tool carriage and work supporting table, said means comprising an hydraulically actuated stop bar, and a drum switch carried by the bed for positioning the stop bar.

8. In a grinding machine of the class described, the combination of a bed, a tool carriage carried thereby and movable relative thereto, hydro-electric means for variably limiting the movement of the tool carriage comprising a stop bar shiftable transversely of the tool carriage to position various portions thereof for engagement with the carriage, an hydraulically actuated piston for shifting the stop bar, and electrically operated means for limiting the movement thereof.

9. In a grinding machine of the class described, the combination of a bed, a tool carriage carried thereby and movable relative thereto, hydro-electric means for variably limiting the movement of the tool carriage comprising a stop bar shiftable transversely of the tool carriage to position various portions thereof for engagement with the carriage, an hydraulically actuated piston for shifting the stop bar, and electrically operated means for limiting the movement thereof, said means comprising a plurality of electrical circuits, a solenoid in each circuit, and a switch plate selectively energizing individual solenoids for selectively positioning the stop bar.

10. In a grinding machine of the class described, the combination of a bed, a tool carriage carried thereby for movement relative thereto, and hydraulic and mechanical means for effecting said movement comprising an adjusting screw rotatably and axially mounted for effecting a slow and fast movement of the tool carriage, a rotatable shaft for rotating the screw and advancing the tool carriage at a slow rate, hydraulic means operable by the shaft for axially shifting the screw to actuate the carriage at a fast rate, a friction connection between the hydraulic actuating means and the rotatable shaft, and means preventing reverse actuation of the hydraulic actuating means until the shaft has made one or more complete revolutions.

11. In a grinding machine, the combination of a bed, a slide carried thereby and movable relative thereto, an adjusting screw operatively connected with the slide, means for rotating the screw in opposite directions to correspondingly actuate the slide, and positive means preventing an instantaneous reversal in the rotation of the screw while same is being rotated in one direction.

12. In a grinding machine, the combination of a bed, a slide carried thereby and movable relative thereto, an adjusting screw operatively connected with the slide, means for rotating the screw in opposite directions to correspondingly actuate the slide, means preventing rotation of the screw in one direction until it has been rotated a definite amount in the opposite direction, said means comprising a rotatable handle, a fixed ratchet having a recess formed in its periphery, and a pivotally mounted pawl carried by the handle cooperating with the ratchet.

13. In a grinding machine, the combination of a bed, a slide carried thereby and movable relative thereto, a piston carried by the slide for moving same, an hydraulic pressure source for actuating the piston, retarding valves operable at each end of the piston stroke for retarding

the movement of the piston prior to its engagement with definite limit stops, and means connecting the retarding valves in series with one another.

14. In a grinding machine for grinding individual portions or diameters of a multiple diameter work piece, the combination of a bed, a work supporting table carried thereby and translatable longitudinally thereof, a tool supporting slide carried by the bed for movement relative thereto toward and from the work supporting table, and means controlling the operative association of the tool carriage and work support comprising a cam bar conforming substantially to the contour of the work piece and shiftable relative to the slide, hydraulic means for shifting the cam bar, and electro-magnetic means for limiting the movement of and for positioning the cam bar relative to the slide to position the portion of the cam bar corresponding to the portion of the work to be operated upon for engagement with the slide.

15. In a grinding machine for grinding individual portions or diameters of a multiple diameter work piece, the combination of a bed, a work supporting table carried thereby and translatable longitudinally thereof, a tool supporting slide carried by the bed for movement relative thereto toward and from the work supporting table, means controlling the operative association of the tool carriage and work support comprising a cam bar conforming substantially to the contour of the work piece and shiftable relative to the slide, hydraulic means for shifting the cam bar, electro-magnetic means for limiting the movement of and for positioning the cam bar relative to the slide to position the portion of the cam bar corresponding to the portion of the work to be operated upon for engagement with the slide, and means operable by the table for energizing the electro-magnetic means.

16. In a grinding machine for grinding successive portions or diameters of a multiple diameter work piece, the combination of a bed, a slide carried thereby and movable relative thereto, hydraulic means for effecting the movement of the slide, means for variably limiting the said movement of the slide in one direction comprising a cam bar conforming substantially to the contour of the work piece and adapted to be engaged by the slide, and means for limiting the shifting movement of the said cam bar comprising a solenoid, a movable core therefor, a stop pin, and a pivotally mounted lever connecting the core and stop pin whereby movement of the core by the solenoid will position the stop pin in the path of movement of the cam bar.

17. In a grinding machine for grinding successive portions or diameters of a multiple diameter work piece, the combination of a bed, a slide carried thereby and movable relative thereto, hydraulic means for effecting the movement of the slide, means for variably limiting the said movement of the slide in one direction comprising a cam bar conforming substantially to the contour of the work piece and adapted to be engaged by the slide, means for limiting the shifting movement of the said cam bar comprising a solenoid, a movable core therefor, a stop pin, a pivotally mounted lever connecting the core and stop pin whereby movement of the core by the solenoid will position the stop pin in the path of movement of the cam bar and yielding means for raising the stop pin out of the path of movement of the cam bar.

18. In a grinding machine for grinding successive portions or diameters of a multiple diameter work piece, the combination of a bed, a slide carried thereby and movable relative thereto, hydraulic means for effecting the movement of the slide, means for variably limiting the said movement of the slide in one direction comprising a cam bar conforming substantially to the contour of the work piece and adapted to be engaged by the slide, means for limiting the shifting movement of the said cam bar comprising a solenoid, a movable core therefor, a stop pin, a pivotally mounted lever connecting the core and stop pin whereby movement of the core by the solenoid will position the stop pin in the path of movement of the cam bar, yielding means for raising the stop pin out of the path of movement of the cam bar, and hydraulic means for shifting the cam bar into engagement with and maintaining contact between the cam bar and the stop pin to prevent withdrawal of the stop pin prior to actuation of the slide in the reverse direction.

19. In a machine tool organization, the combination of a bed, a work support associated therewith, a tool slide on the bed for movement relative thereto toward and from the work support, means shiftable into the path of movement of the tool slide for engagement with the tool slide for variably limiting the movement of the slide in the direction of the work support, actuating means for effecting the movement of the tool slide movement limiting means, and dial means associated with the actuating means readable in terms of work diameter for determining the position of the tool slide movement limiting means in accordance with the work on the work support.

20. In a grinding machine of the class described, the combination of a bed, a work support mounted thereon a tool carriage mounted on the bed for movement toward and from the work support, means for actuating the tool carriage at rapid and slow speeds toward the tool carriage and selective means operable to stop the rapid movement of the tool carriage at a point depending on the size of the work to be operated upon.

21. In a grinding machine of the class described, the combination of a bed, a work support mounted thereon, a tool carriage mounted on the bed for movement toward and from the work support, means for actuating the tool carriage at rapid and slow speeds toward the tool carriage, selective means operable to stop the rapid movement of the tool carriage at a point depending on the size of the work to be operated upon, and means for setting said stopping means reading in terms of work diameter.

22. In a grinding machine of the class described, the combination with a bed, a work support mounted thereon, a grinding wheel carriage carried by the bed for movement toward and from the work support, of means for stopping said movement of the carriage before it engages the work comprising a slide bar, means for shifting the slide bar transversely of the path of movement of the tool carriage, and means for positioning the slide bar at a point representative of the diameter of work to be operated upon.

23. In a grinding machine of the class described, the combination of a bed, a grinding wheel rotatably supported thereby for movement relative thereto, a work support mounted on the bed, a pair of hydraulically actuable pistons for movement at right angles to one another, means for

stopping the movement of the grinding wheel toward the work support, and means connecting one of the pistons with the grinding wheel for effecting the movement thereof and the other of the pistons with the stopping means for effecting its actuation.

24. In a grinding machine of the class described, the combination of a bed, a grinding wheel rotatably supported thereby for movement relative thereto, a work support mounted on the bed, a pair of hydraulically actuable pistons for movement at right angles to one another, means for stopping the movement of the grinding wheel toward the work support, means connecting one of the pistons with the grinding wheel for effecting the movement thereof and the other of the pistons with the stopping means for effecting its actuation, and a common hydraulic mechanism for actuating the pistons including a pressure source and conduits from the pressure source to the pistons.

25. In a grinding machine of the class described, the combination of a bed, a grinding wheel rotatably supported thereby for movement relative thereto, a work support mounted on the bed, a pair of hydraulically actuable pistons for movement at right angles to one another, means for stopping the movement of the grinding wheel toward the work support, means connecting one of the pistons with the grinding wheel for effecting the movement thereof and the other of the pistons with the stopping means for effecting its actuation, a common hydraulic mechanism for actuating the pistons including a pressure source and conduits from the pressure source to the pistons, and throttle means in the conduits for cushioning the stopping of the grinding wheel.

26. In a grinding machine of the class described for grinding successive portions of a multiple diameter work piece the combination of a bed, a work supporting table mounted thereon and shiftable relative thereto, a grinding wheel slide mounted on the bed for movement toward and from the work on the work supporting table, a stop bar including a plurality of stops shiftable transversely of the direction of movement of the grinding wheel slide for stopping the grinding wheel at a point depending upon the particular portion or diameter of the work to be operated upon, and means operable upon movement of the work supporting table to determine the position of the stop bar and consequently the particular stop thereof to be operative.

27. In a grinding machine of the class described for grinding individual portions or diameters of a unitary work piece the combination of a bed, a work support on the bed for movement relative thereto, a grinding wheel on the bed for movement toward and from the work, means for shifting the work support to align different portions with the grinding wheel, a plurality of stops shiftable transversely of the grinding wheel for stopping the grinding wheel at a point depending upon the portion of the work in alignment therewith, and an interlock between the work support shifting means and the stops whereby the desired stop is positioned with respect to the grinding wheel in accordance with the position of the work.

28. In a grinding machine of the class described the combination of a bed, a grinding wheel mounted thereon and movable relative thereto, a work supporting table mounted on the bed in the line of movement of the grinding wheel, a stop bar movable transversely of the line of movement of the grinding wheel for variably limiting the approach of the grinding wheel to the work supporting table, and means controlled and actuated by the work supporting table for controlling the position of the stop bar.

29. In a grinding machine of the class described the combination of a bed, a grinding wheel mounted thereon and movable relative thereto, a work supporting table mounted on the bed in the line of movement of the grinding wheel, a stop bar movable transversely of the line of movement of the grinding wheel for variably limiting the approach of the grinding wheel to the work supporting table, and power actuated means for controlling the position of the stop bar.

30. In a grinding machine of the class described the combination of a bed, a grinding wheel mounted thereon and movable relative thereto, a work supporting table mounted on the bed in the line of movement of the grinding wheel, a stop bar movable transversely of the line of movement of the grinding wheel for variably limiting the approach of the grinding wheel to the work supporting table, power actuated means for controlling the position of the stop bar, and means carried by the table for energizing the power actuated stop bar stopping means.

31. In a grinding machine of the class described the combination of a bed, a grinding wheel thereon and movable relative thereto, a work supporting table mounted on the bed in the line of movement of the grinding wheel, a stop bar movable transversely of the line of movement of the grinding wheel for variably limiting the approach of the grinding wheel to the work supporting table, power actuated means for controlling the position of the stop bar, and means carried by the table for energizing the power actuated stop bar stopping means, said power actuated stop bar positioning means comprising a plurality of pins individually projectable into the path of movement of the stop bar.

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DISCLAIMER

1,932,969.—*Cecil W. Hopkins*, Cincinnati, Ohio, and *John E. Caster*, Covington, Ky. GRINDING MACHINE. Patent dated October 31, 1933. Disclaimer filed February 8, 1935, by the assignee, *Cincinnati Grinders Incorporated.*

Hereby enters this disclaimer of claim 20 of the said specification which is in the following words, to wit:

In a grinding machine of the class described, the combination of a bed, a work support mounted thereon, a tool carriage mounted on the bed for movement toward and from the work support, means for actuating the tool carriage at rapid and slow speeds toward the tool carriage and selective means operable to stop the rapid movement of the tool carriage at a point depending on the size of the work to be operated upon.

This Disclaimer is presented for the reason that the Examiner has held this claim to be readable on the disclosure of the application of John E. Caster, No. 483,891, in which the claim has been, therefore, presented, and the disclaimer is as to Patent 1,932,969 only, and not a disclaimer of the right of petitioner to said subject matter as it may appear in the sole application of Caster aforesaid.

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