May 6, 1924. **1,493,301**

H. L. WALKER

POWER CONTROL FOR BORING MACHINES

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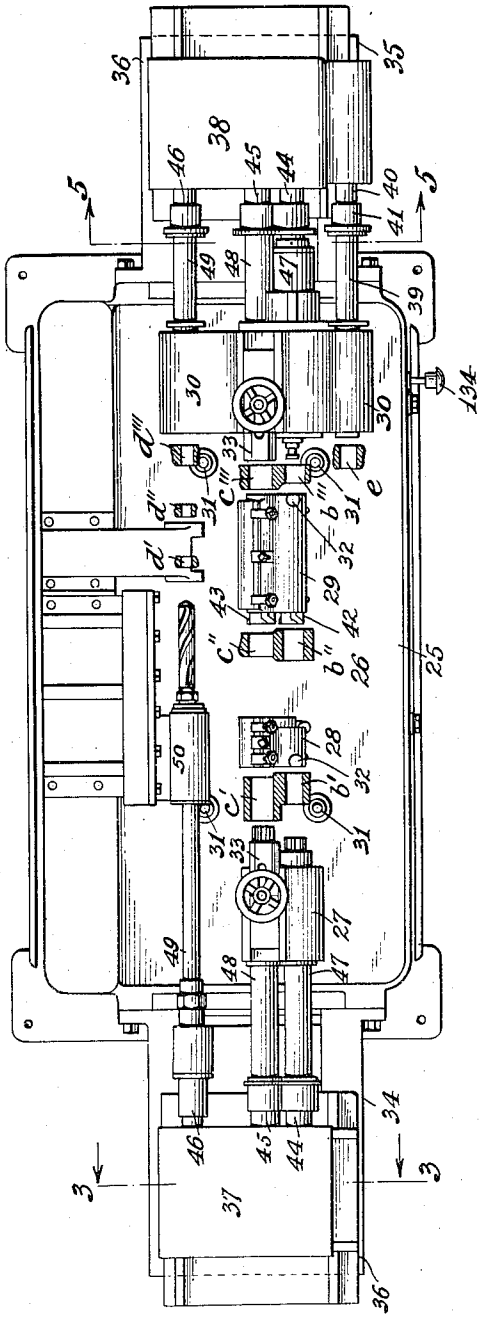

Fig. 1.

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POWER CONTROL FOR BORING MACHINES

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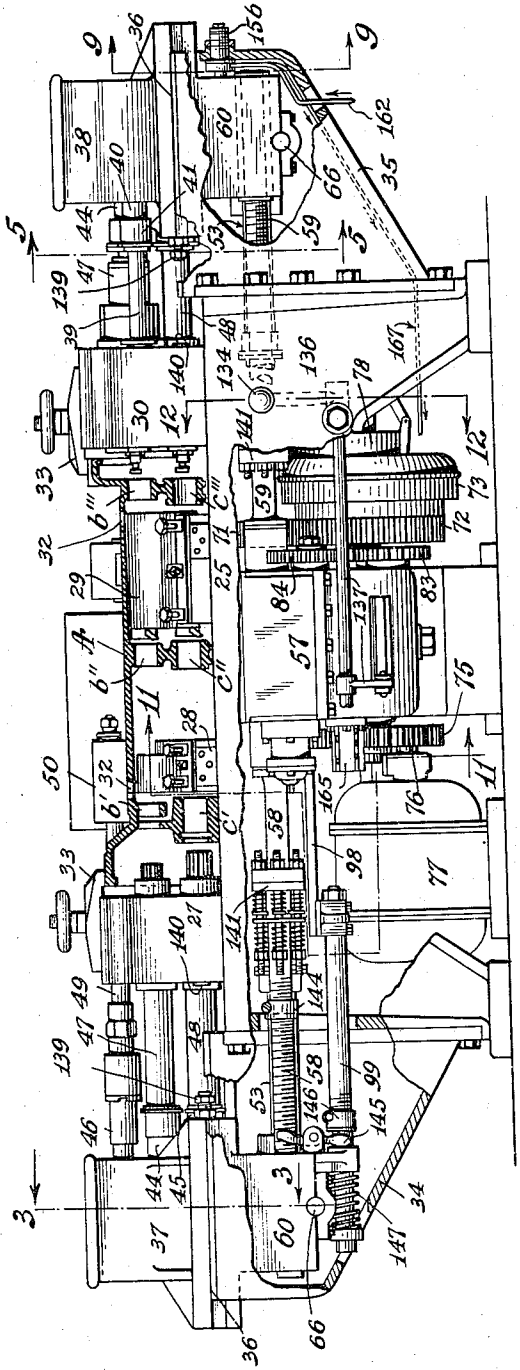

Fig. 2.

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POWER CONTROL FOR BORING MACHINES

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Fig. 3.

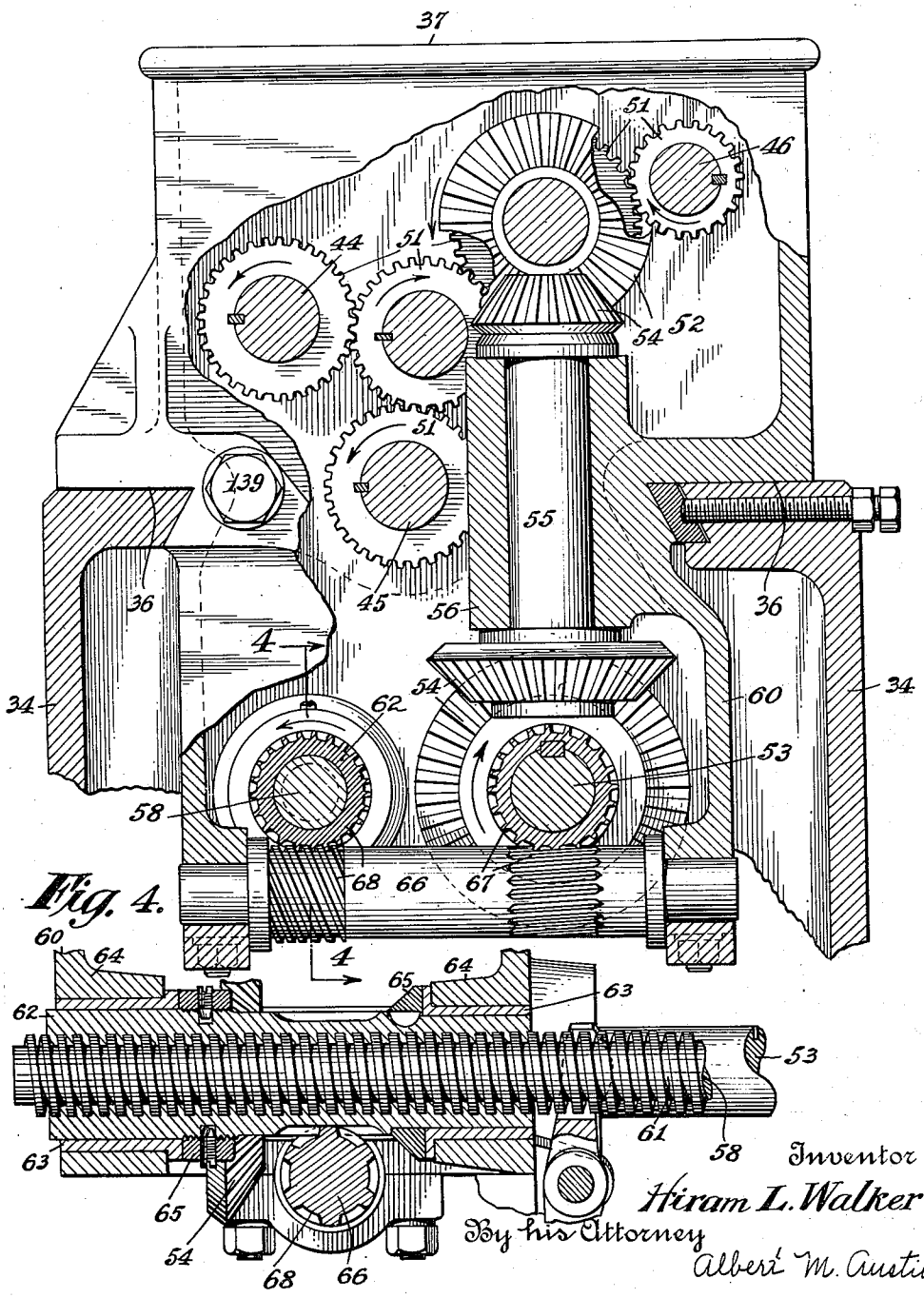

Fig. 4.

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POWER CONTROL FOR BORING MACHINES

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Fig. 5.

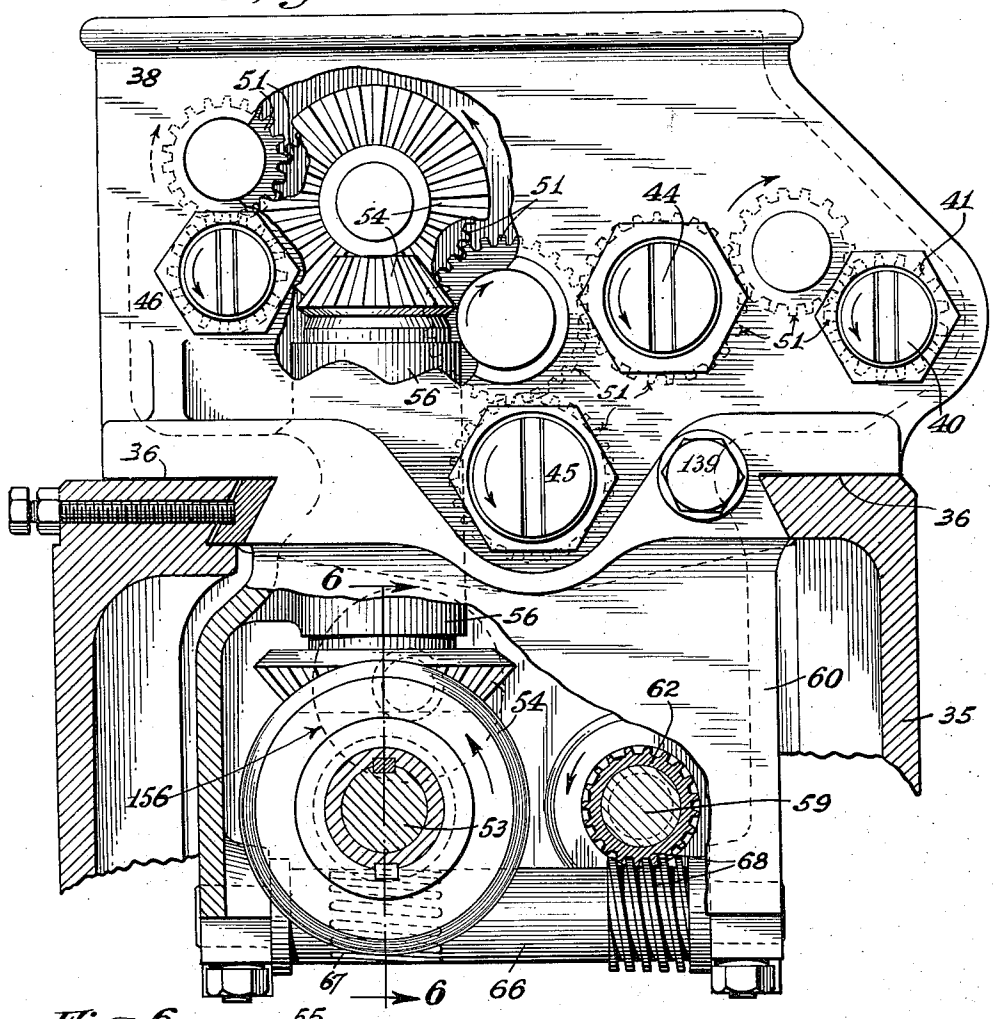
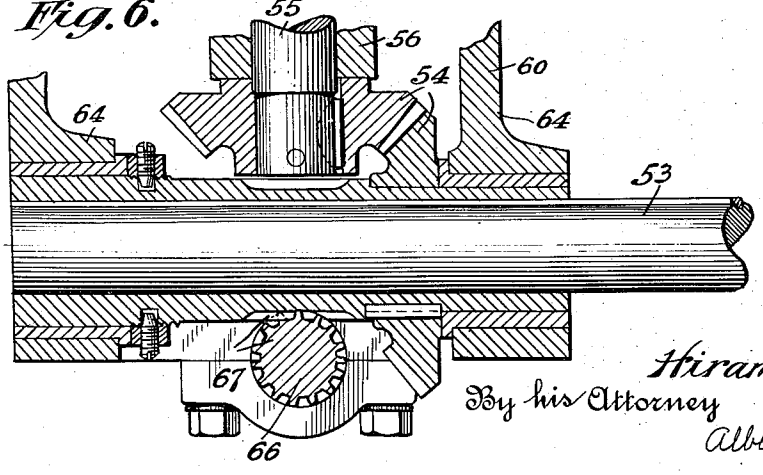


Fig. 6.



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POWER CONTROL FOR BORING MACHINES

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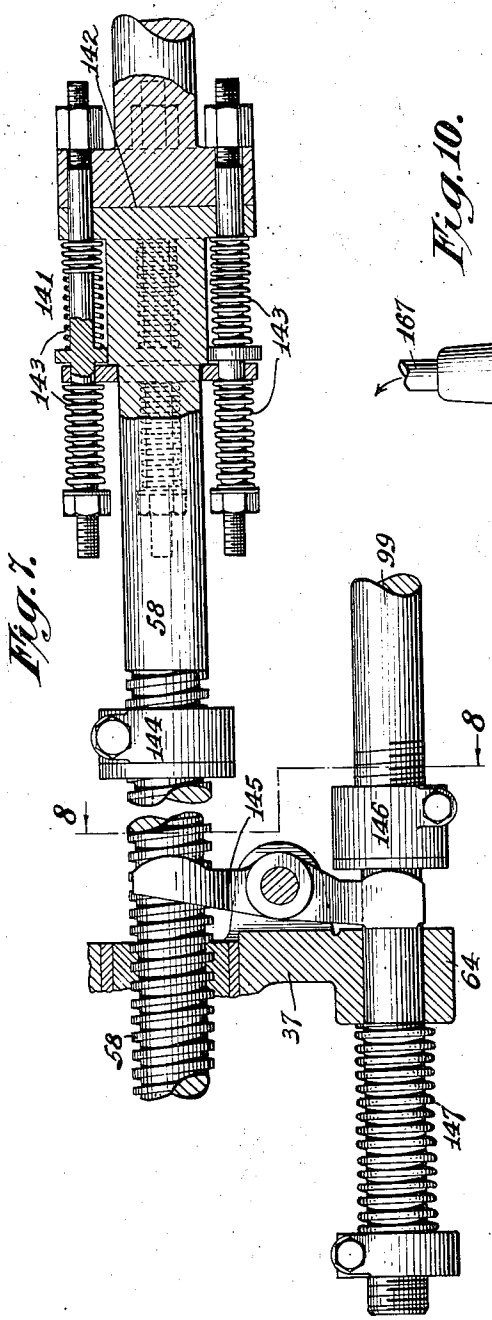

Fig. 7.

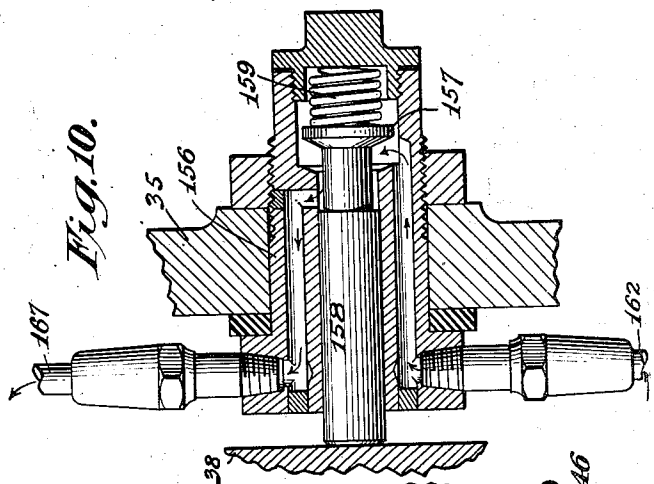

Fig. 10.

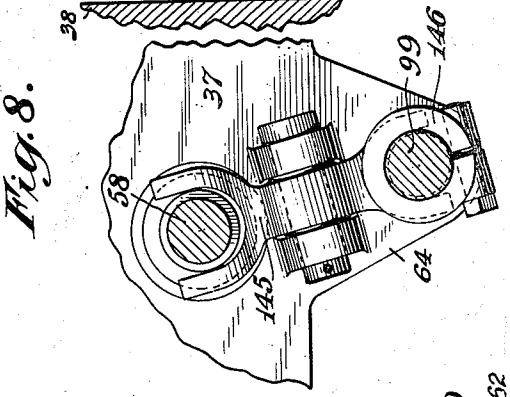

Fig. 8.

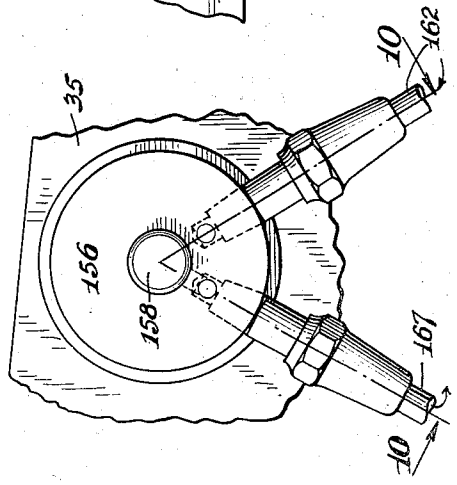

Fig. 9.

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POWER CONTROL FOR BORING MACHINES

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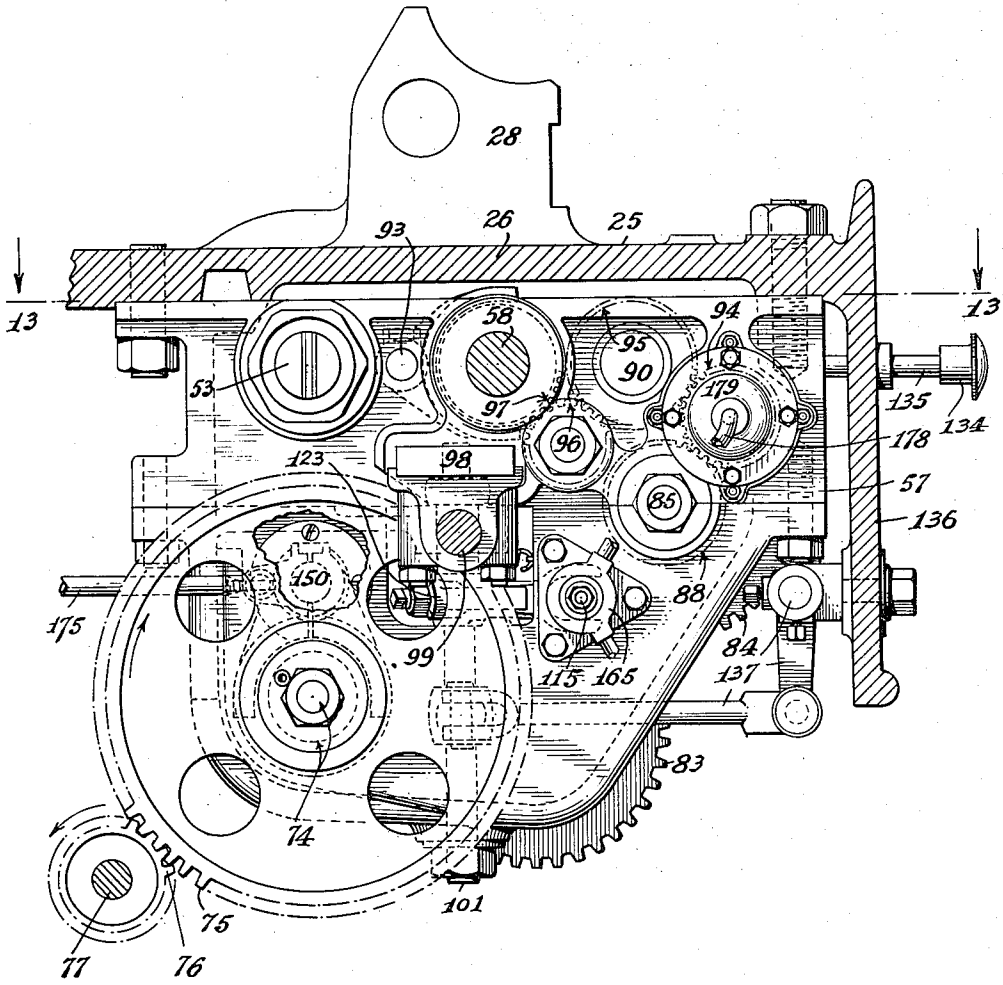
Fig. 11.



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POWER CONTROL FOR BORING MACHINES

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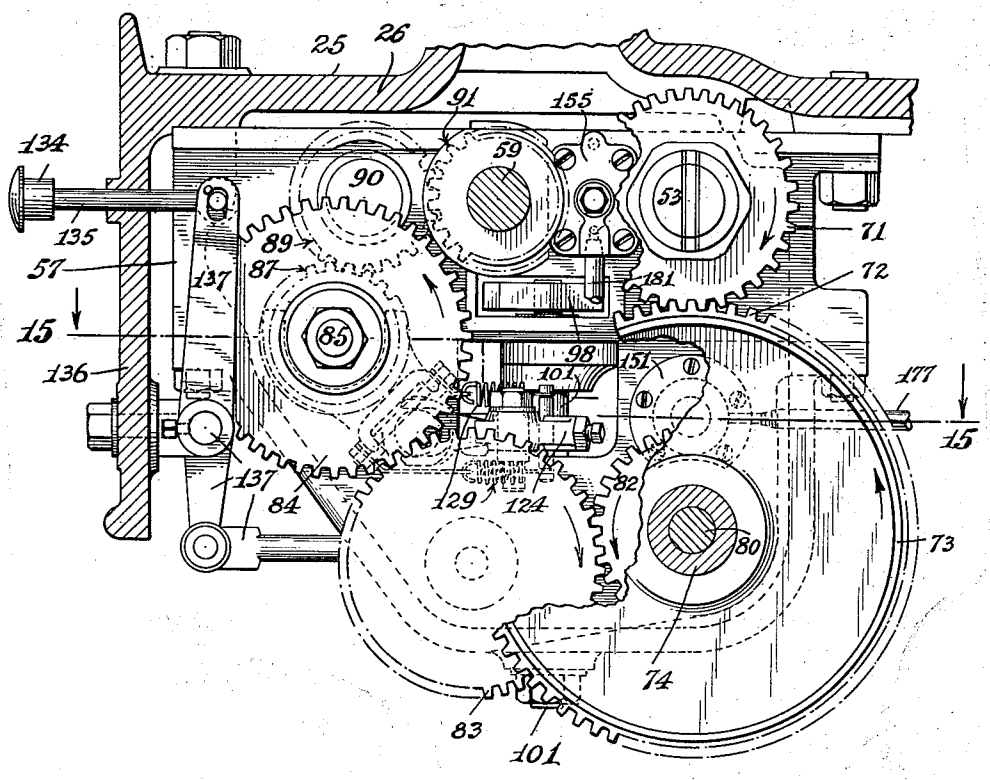
Fig. 12.



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POWER CONTROL FOR BORING MACHINES

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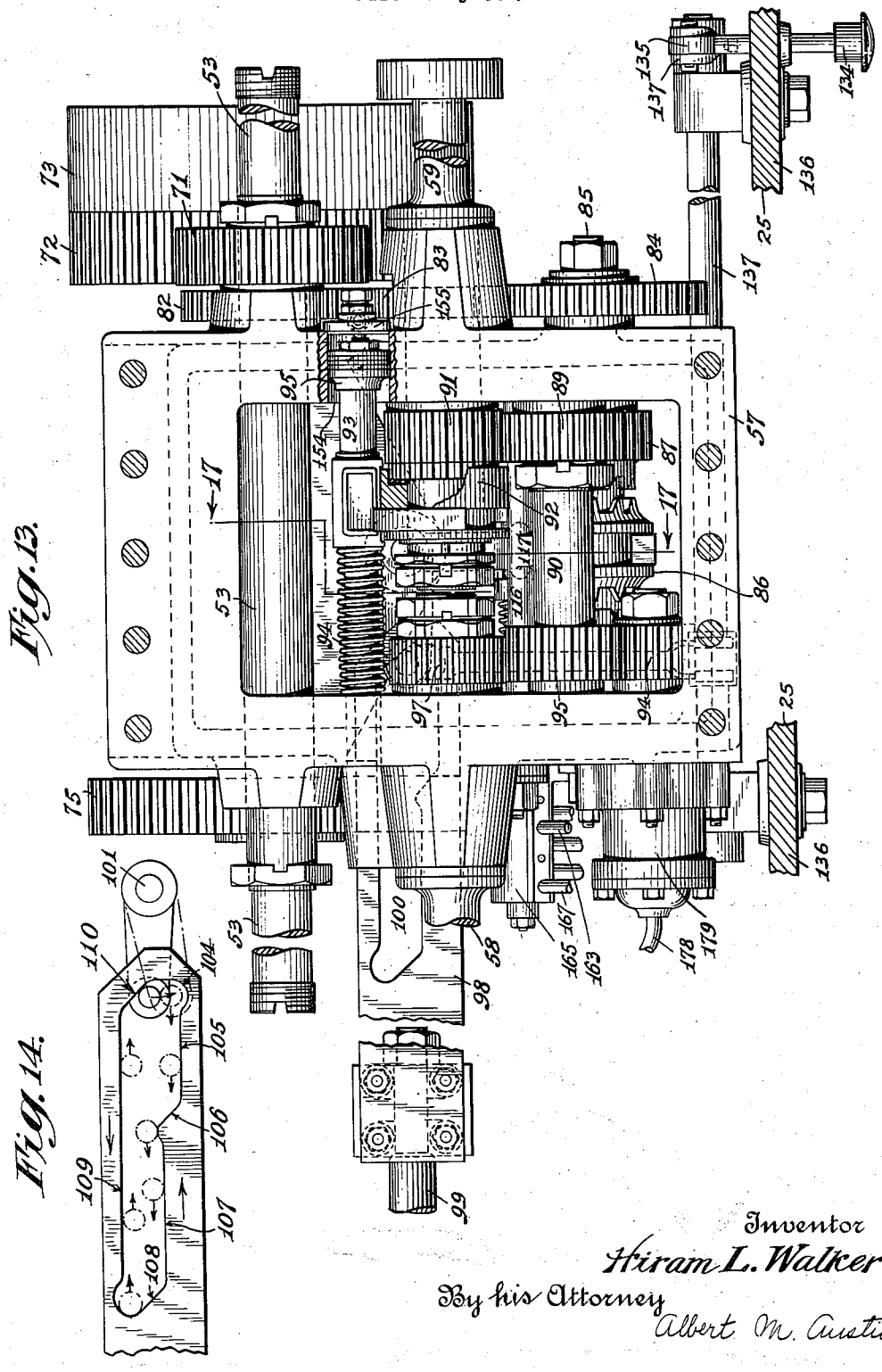

Fig. 13.

Fig. 14.

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POWER CONTROL FOR BORING MACHINES

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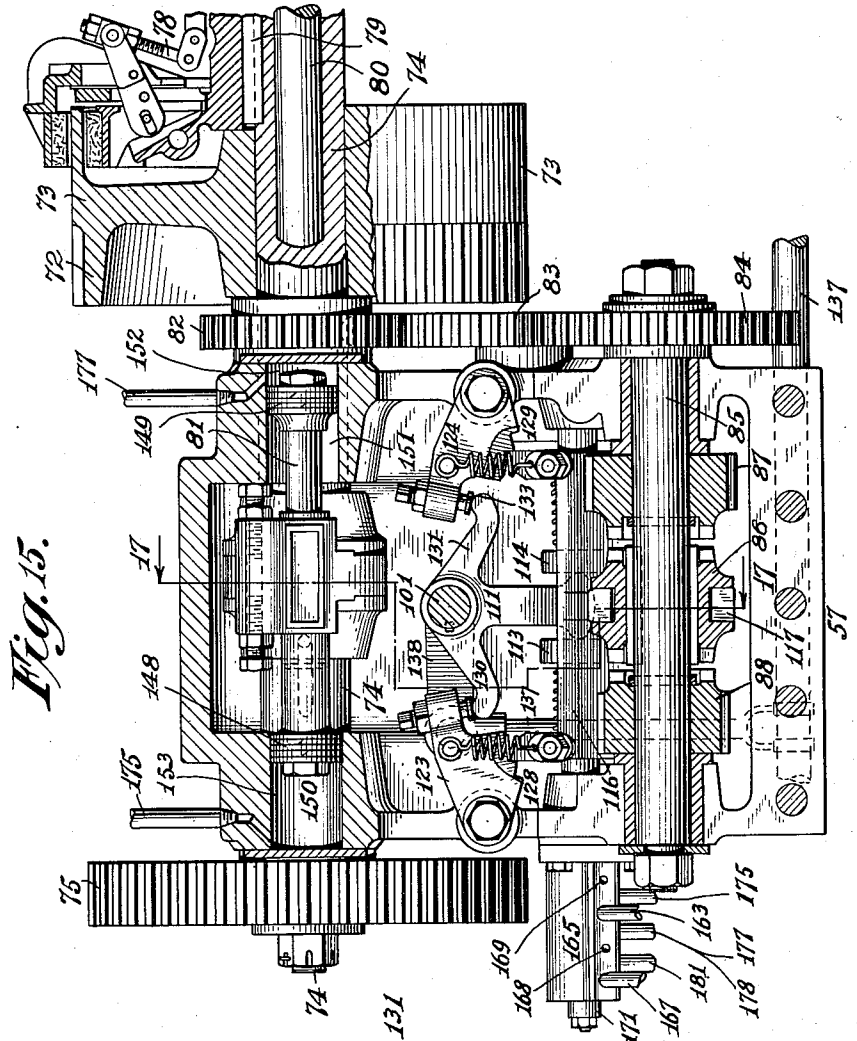

Fig. 15.

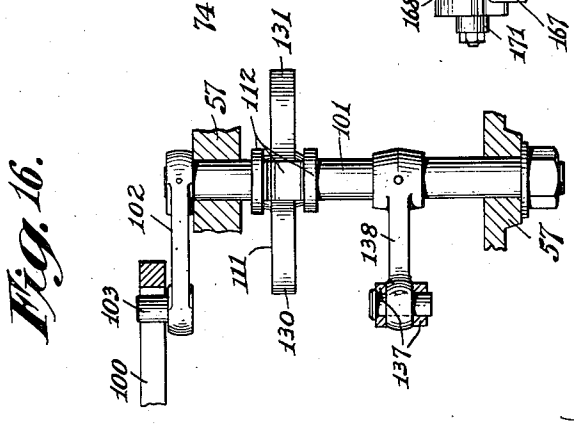

Fig. 16.

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POWER CONTROL FOR BORING MACHINES

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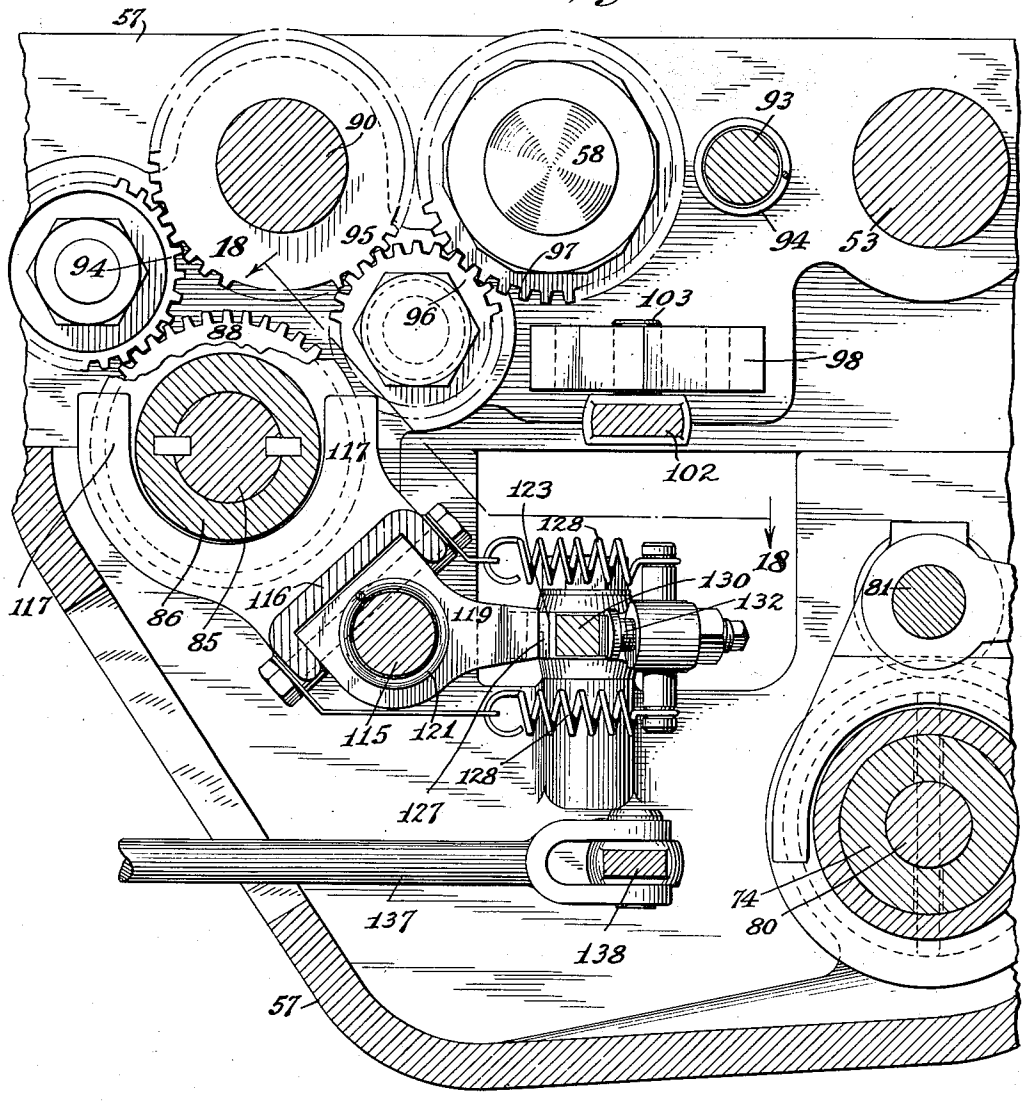
Fig. 17.



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POWER CONTROL FOR BORING MACHINES

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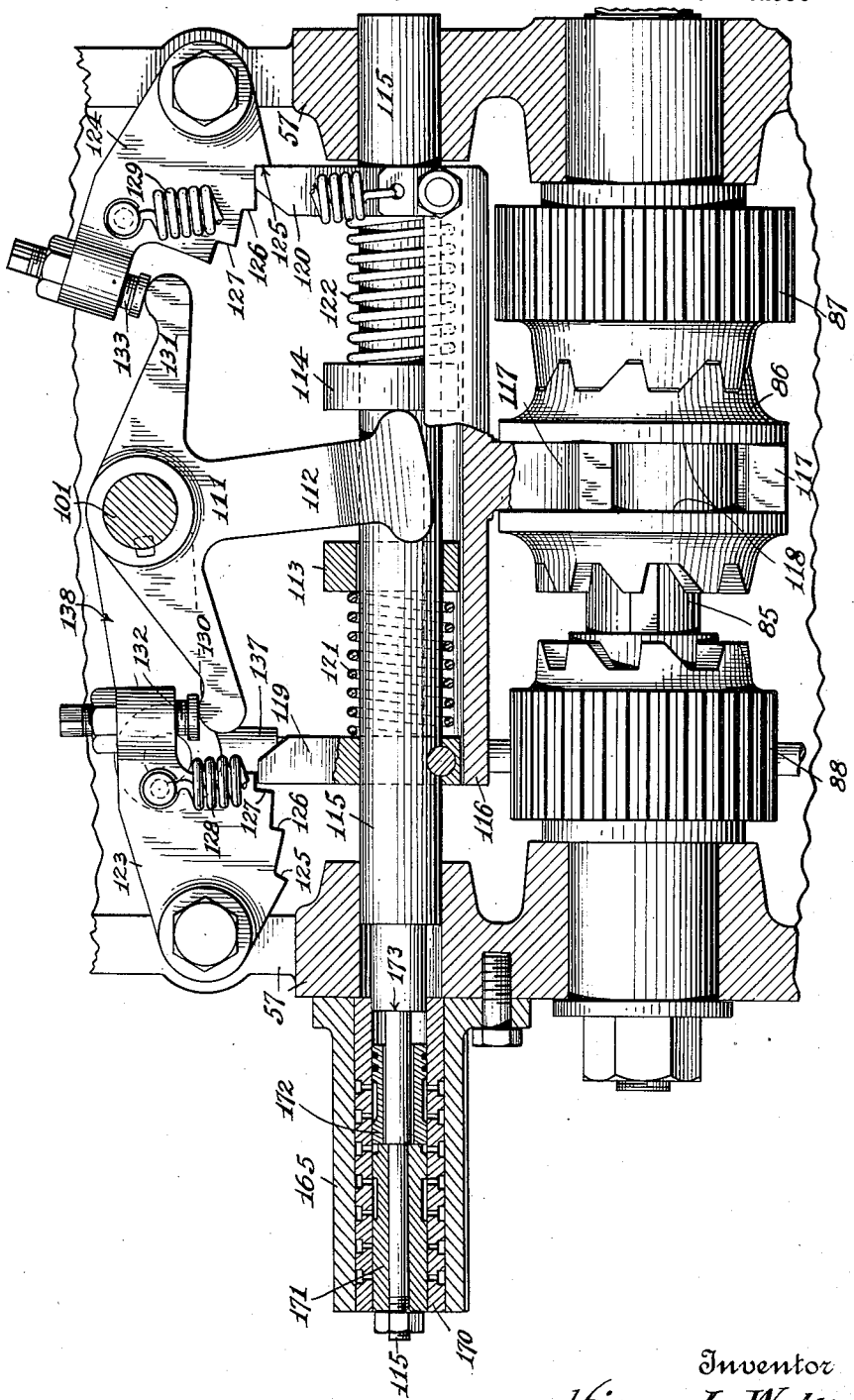

Fig. 18.

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POWER CONTROL FOR BORING MACHINES

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Fig. 19.

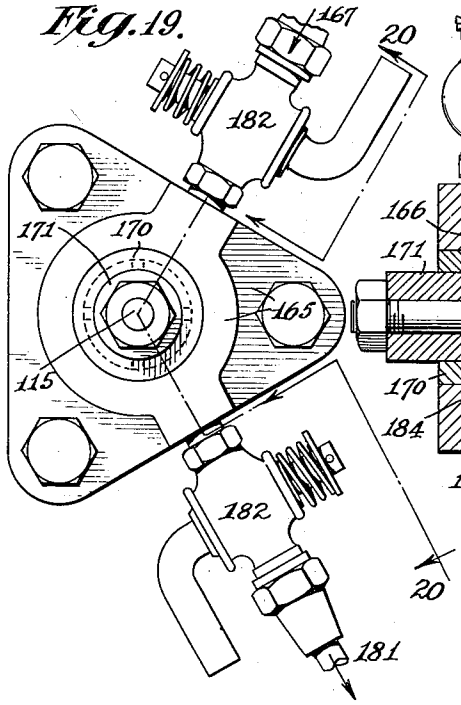


Fig. 20.

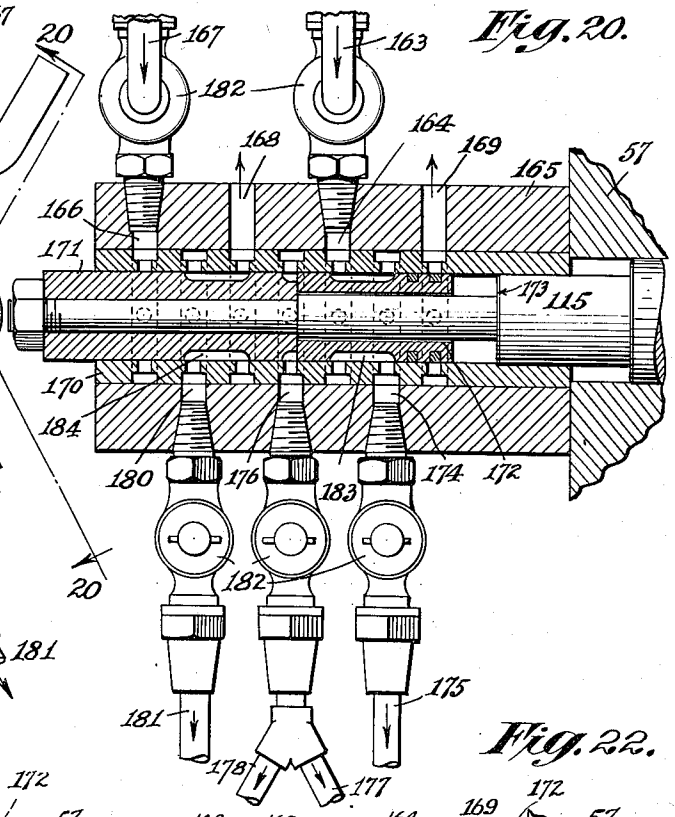


Fig. 21.

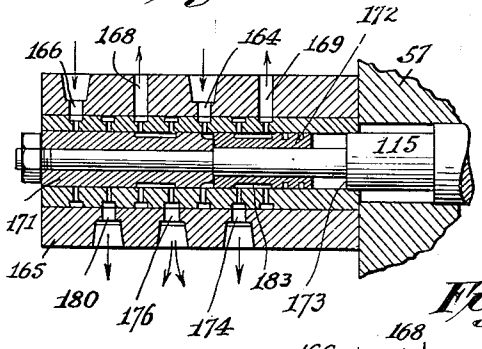


Fig. 22.

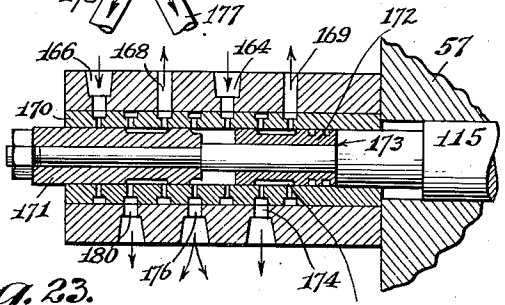
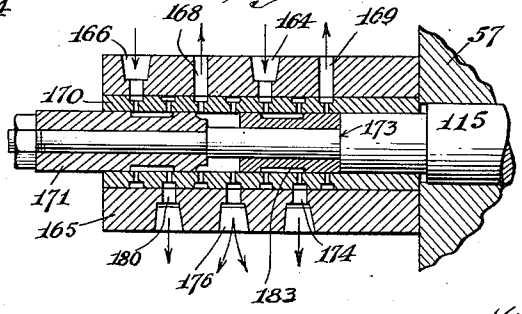


Fig. 23.



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POWER CONTROL FOR BORING MACHINES

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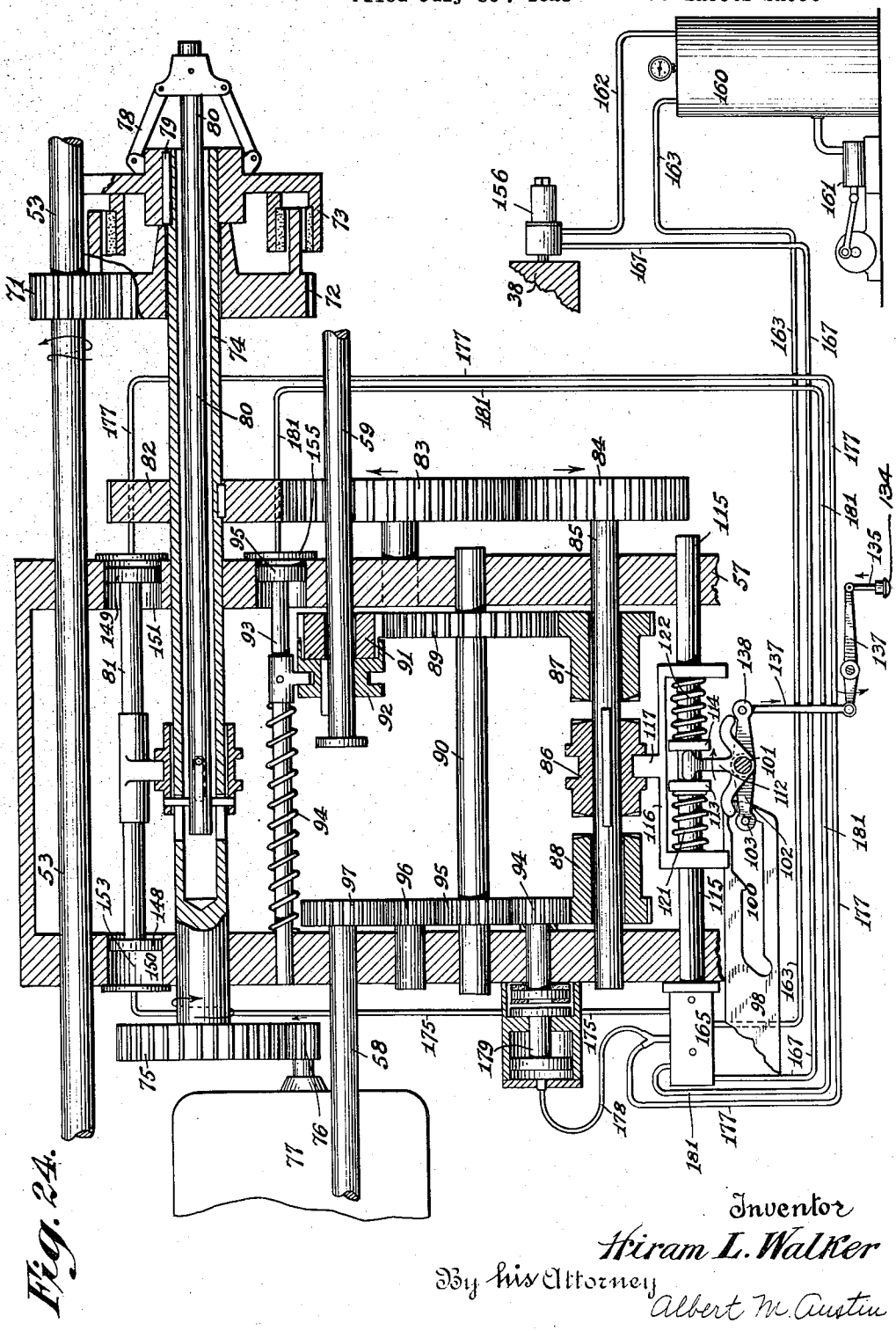

Fig. 24.

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Patented May 6, 1924. 1,493,301

UNITED STATES PATENT OFFICE.

HIRAM L. WALKER, OF CLEVELAND, OHIO, ASSIGNOR TO CHANDLER MOTOR CAR COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

POWER CONTROL FOR BORING MACHINES.

Application filed July 30, 1921. Serial No. 488,609.

To all whom it may concern:

Be it known that I, HIRAM L. WALKER, a citizen of the United States, and resident of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Power Controls for Boring Machines, of which the following is a specification.

The invention relates in general to a machine for causing a plurality of tools to function simultaneously and automatically in a timed cycle of succeeding operations and, specifically the invention relates to a self-controlled device for drilling, boring, reaming, facing and otherwise machining the bearings and bearing supports in a machined article where the parts to be machined are spaced apart in some definite preset relation, such for instance, as the aligned bearings in the crank casing of an automotive power plant.

Selecting for illustration the machining of the bearings in an automotive case for a detailed description of one situation where the invention is particularly applicable, it is noted that in one form of such case it is required that there be arranged in a preset definite relation four sets of bearings or bearing supports with the axis of the bearings in each set disposed accurately in alignment. These sets are disposed in offset relation and comprise three spaced apart cam shaft bearings; three spaced apart crank shaft bearings; three spaced apart water pump bearings and a generator shaft bearing. The completed machine, certain parts of which are featured in this disclosure, machine these bearings quickly in accurately preset alignment without vibratory movement and without chattering action which might affect the trueness of the alignment. These results are attained, in part by certain features of the machines described in my copending application, "crank and cam shaft line boring machines", Serial No. 425,315, filed November 20, 1920, and in part are attained by certain features of the tool control and tool actuating mechanism featured in this application.

One of the primary objects of this invention is to provide a simple form of machine which, when once set in operation, will effect the necessary boring, reaming and other machining operations without further attention on the part of the operator and which, at the same time will function in a manner to effect economy both in the lapsed time necessary to affect the sequence of operations and which will incidentally effect a saving in the power consumption necessary to do the required work.

The machine is of the type in which the work to be operated upon is disposed in fixed position in preset relation to the operating tools, and with axially disposed sets of these tools disposed to engage and operate on the work simultaneously from opposite sides thereof and in a preset time relation. The present invention features a construction of such machines in which tool carrying heads can be moved rapidly to bring their tools into a position adjacent their machining positions and in which both the heads and their tools are caused to function at their approved working speed and the heads so governed that at the completion of the machining operations the heads are rapidly moved with their tools into an inoperative position to permit the ready removal of the machined article and the replacement in the machine of another article to be machined.

Contributing to the objective for economy in lapsed time operation, another object of the invention is to provide an automatic control which may be readily varied to meet changes in conditions of the work operated upon, and which, when once set in operation, will complete its cycle of movement without further attention on the part of the operator and in which every article will be machined exactly as every other article was machined.

Another object of the invention, and featuring economy in power consumption is to provide a time relation in the actuation of the several machining tools so that all of the machining work will be performed during the machining of the longest bearing.

Still another object of the invention is to provide a machine of the type outlined which will be sufficiently flexible in its mode of operation to compensate automatically for small variations in the sizes of the dif-

ferent cases machined, and which will work quietly and in a manner to minimize shocks or vibration as the different movable parts are brought to a stop or caused to change their direction of movements.

In general the object of the invention as exemplified in the present disclosure is to provide a simplified form of machine for accurately boring the several bearings in a crank case in the least possible time and to do this with a machine which features a minimum number of movable parts compactly assembled into a machine which can be operated without the necessity of using skilled labor.

Various other objects and advantages of the invention will be in part obvious from an inspection of the accompanying drawings and in part will be more fully set forth in the following particular description of one form of mechanism embodying my invention, and the invention also consists in certain new and novel features of construction and combination of parts hereinafter set forth and claimed.

Referring to the accompanying drawings:—

Figure 1 is a top plan view of a machine constituting a physical embodiment of the invention and with the work to be machined positioned thereon and shown in an irregular horizontal sectional view;

Figure 2 is a view in front elevation of the machine shown in Fig. 1 with parts broken away and showing the work in vertical section.

Figure 3 is an enlarged vertical transverse sectional view taken on the lines 3—3 of Figures 1 and 2;

Figure 4 is a detail sectional view taken axially of the left head advancing shaft and taken on the line 4—4 of Fig. 3;

Figure 5 is a view similar to Fig. 3 taken on the lines 5—5 of Figs. 1 and 2;

Figure 6 is a detail sectional view taken axially of the main drive shaft at the right end thereof and taken on the line 6—6 of Fig. 5;

Figure 7 is a detail view partly in section of the left head advancing shaft and its spring coupling and cam control;

Figure 8 is a transverse sectional view taken on the line 8—8 of Fig. 7;

Figure 9 is a view in front elevation of the head controlling valve as viewed from the plane indicated by the section line 9—9 of Fig. 2;

Figure 10 is an irregular sectional view of the head controlling valve taken on the line 10—10 of Fig. 9;

Figures 11 and 12 are each transverse sectional views taken respectively on the broken lines 11—11 and 12—12 of Fig. 2;

Figure 13 is a horizontal sectional view taken on the line 13—13 of Fig. 11;

Figure 14 is a top plan view of the cam bar and lever shown in elevation in Fig. 16;

Figure 15 is a horizontal sectional view of gear box and adjacent parts taken on line 15—15 of Fig. 12;

Figure 16 is a detail view in elevation of the trip cam post and attached parts;

Figure 17 is an enlarged transverse sectional view taken on the line 17—17 of Fig. 13;

Figure 18 is an irregular sectional view taken on the line 18—18 of Fig. 17 showing the parts at the start of the machine;

Figure 19 is a view in end elevation of the pneumatic controlling slide valve;

Figure 20 is an irregular sectional view of this valve taken on the line 20—20 of Fig. 19 and showing the normal position of the valves with the machine at rest;

Figures 21, 22, and 23 are diagrammatic sections of the movable valves of Fig. 20 in the different succeeding positions and in which Fig. 21 shows the valve positions when the heads are rapidly advancing.

Figure 22 when the heads are slowly advancing with the tools rotating and

Figure 23 when the heads are on their high speed retreat; and

Figure 24 is a diagrammatic view of the main parts of the machine spread out in one plane to facilitate an understanding of the relation of the several parts.

In general it will be understood that the casing to be machined is first rough bored, and faced and then by replacing the boring tools with reaming or finishing tools, the bores and the end faces are reamed and otherwise finished. In each cycle of operation there are three succeeding operations, first the heads at opposite ends of the machine are advanced rapidly toward the crank case, the tools not rotating, and until the tools are within about $\frac{1}{4}$ inch from the parts to be machined, second the heads are advanced slowly towards the crank case, the tools rotating and otherwise functioning and, third the heads with the tools not rotating are returned rapidly to their original position ready to have the cycle of operations repeated.

In the drawings and referring particularly to Figures 1 and 2 for a general description of the machine there is disclosed a table-like bed casting 25, the top 26 of which provides a support for the work A to be machined. In the present disclosure this work is one of the crank cases usual in automotive power plants and includes three cam shaft bearings lettered from left to right b', b'', b''', three crank shaft bearings c', c'', c''', three water pump shaft bearings d', d'', d''', and a single generating shaft bearing e, the several sets of multiple bearings being in alignment as is well known in such constructions.

On top of the casting are four large projections 27, 28, 29, 30 constituting tool guiding members and which are accurately lined, bored and bushed with replaceable hard steel bushings and which constitute the guides in which the several boring bars and other tools rotate and slide while functioning to drill, bore, ream, face and otherwise machine the different bearings.

The case to be machined is located in position on the top 26 by four steel pins 31 projecting upwardly from the top of the bed casting and by two pilot pins 32 which project upwardly from the members 28 and 29 and engage in recesses in the top of the case as shown in Fig. 2. The crank case is securely fastened in its located position by two clamps 33 carried by the members 27 and 30.

Large hollow brackets 34 and 35 are demountably bolted to opposite longitudinal ends of the casting 25 with their upper surfaces machined to form tracks 36 (see Figs. 3 and 5) to form supports for longitudinally slidable heads 37 and 38, hereinafter referred to specifically as the left hand head 37 and the right hand head 38. Each head is provided with a plurality of driving shafts which connect with tools carried in the adjacent guiding members 27 and 30.

Specifically describing the several tools and their driving connections with their respective heads, it is noted that the generator shaft bearing *e* is machined by a generator shaft boring bar 39 guided in the projection 30, and driven from a shaft 40 mounted in the head 38 and hereinafter identified as a generator shaft. This shaft is coupled to the bar 39 by means of an Oldham coupling 41 which takes up any disalignment between the bar and shaft. It will be understood that in the following description of the several boring bars and their driving shafts in the heads all of the coacting drives are provided with these compensating couplings.

It is a feature of the machine disclosed that the machining tools for the several borings are guided in close proximity to the parts operated upon so as to minimize chattering and to eliminate any slight disaligning of the tools while in operation, and for this purpose the tools are supported in close proximity to the parts to be machined. The outside bearings are machined from opposite sides of the casing, and the internal bearings, such as the bearings *b''* and *c''*, are machined by means of tools 42 and 43 which are guided in the member 29 and are coupled to their driving elements in a manner more particularly described in my copending application above identified.

Referring to Figs. 1, 2, 3 and 5 for a description of the mechanism in the heads it will be noted that each of the heads 37 and 38 is provided with certain tool driving shafts, disposed in mutual alignment with the correspondingly named bar in the other head, and identified for convenience of expression as a cam shaft 44, crank shaft 45 and pump shaft 46 coupled as previously suggested respectively to a cam shaft boring bar 47, a crank shaft boring bar 48 and a water pump boring bar 49. The bars 47 and 48 from the left and right heads are guided respectively in the adjacent projections 27 and 30. The left hand water pump boring bar 49 is guided in a separate guiding member 50 at the back of the machine and the right hand water pump boring bar is guided in the projection 30. The shaft driving mechanism in the heads 37 and 38 are similar, except for obvious reversals in position and excepting for the presence of the generator shaft 40 in head 38 and which of course, is not present in head 37.

As shown in Figs. 3 and 5 the several shafts 40, 44, 45 and 46 are connected to be driven in unison by means of a gear train 51 so that all of the shafts, except the pump shaft 46 (Fig. 3) have an anti-clockwise movement in their machining operation. These gear trains are disposed in the upper parts 52 of the heads above their planes of support on the top of the brackets.

The gear trains 51 are connected to opposite ends of a main drive shaft 53 through a pair of bevel gear drives 54 (see Fig. 6) at opposite ends of upstanding shafts 55 journalled in bearings 56 forming internal projections from each of the heads.

The shaft 53 (see Fig. 13) is journalled at its center in a centrally positioned gear box 57 positioned within the casting 25 below the top 26. The shaft is adapted to be driven from mechanism in the gear box and it is to be understood that a rotation of this shaft in one direction, indicated by the arrows in Figs. 3 and 5, will cause all of the tools to function in unison and at a speed dependent on ratio of the gears in the gear train 51.

In the operation of the machine the heads are both advanced rapidly from an inoperative position, with the several tools clear of the case, into position with the tools adjacent their machining engagement with the casing. This movement is provided by means of a pair of head advancing shafts, a left head advancing shaft 58 and a right head advancing shaft 59 which extend in opposite direction from the gear box 57. The shafts 58 and 59 are in screw threaded engagement with the lower parts 60 of each of the heads. The portion of the head advancing shaft (see Fig. 4) which is within the path of travel of its corresponding head is provided with a screw 61 which works in a long nut 62 rotatably mounted in bearings 63 carried in opposite ends 64 of the head. The nut 62 is held against longitudinal

movement in its head by means of collars 65. The shafts 58 and 59 extend into opposite sides of the gear box and it will be understood that when the shafts are rotated by the mechanism hereinafter described in the gear box and with the nut held against rotation by means hereinafter described, the turning screw 61 acting on the held nut will cause the head controlled thereby to be advanced at high speed in either of its longitudinal directions depending upon the direction of rotation of the shafts.

The part of the main drive shaft in each head is operatively connected to the adjacent nut through a short auxiliary head driving shaft 66 which is journalled in the lower part of the head, and is connected to the shaft by means of a right angled spiral gear driving connection 67 and to the nut by means of an endless spiral gear connection 68. From this construction it will be understood that the rotation of the main drive shaft in the direction indicated by the arrow in Figure 3 will drive through the shaft 66 to turn the nut at a time when the head advancing shaft is held by mechanism in the gear casing and thus cause the head to be advanced simultaneously with the actuation of the several boring bars and at a relatively slow feeding speed.

The main drive shaft 53 is provided, just outside the gear box (see Fig. 13), with a relatively small pinion 71 (see Fig. 12) constantly in mesh with the tooth portion 72 of a clutch drum 73, loosely mounted on a main power shaft 74 journalled in the gear box below the shaft 53. The main power shaft is connected on the opposite side of the gear box by means of gears 75 and 76 with a source of power herein indicated as an electric motor 77. It will be thus understood that the main power shaft 74 is rotating during the time that the motor is actively disposed and that the main drive shaft 53 is active only when clutched to the main power shaft. The clutch drum 73 (see Fig. 15) constitutes one element of a ring clutch and is designed to be coupled to the main power shaft by the engagement therewith of a coacting clutch element 78. This latter element is secured by means of key 79 to the main power shaft 74 and is controlled in its movement to and from an operative position by means of a clutch rod 80 contained in the bore of the main power shaft and operatively controlled by a pneumatically actuated plunger 81 (see Fig. 15) hereinafter more fully described.

From Figures 13 and 24 it will be seen that the inner ends of each of the head advancing shafts 58 and 59 terminate within the gear box and are operatively connected to be driven in either direction from the main power shaft through a train of gears (see Fig. 15) which include gears 82, 83 and 84 positioned exteriorly of the gear box and driving a secondary power shaft 85 journalled in the gear box. The shaft 85 has a sliding clutch 86 keyed thereto (see Fig. 18) and designed when moved in one longitudinal direction, i. e. to the right to clutch with a clutch gear 87 loosely mounted on the secondary power shaft 85 and when moved to the left to clutch with a clutch gear 88 also loose on the shaft 85. The right gear 87 is in mesh with a relatively large gear 89 mounted on a shaft 90 paralleling the shaft 85 and likewise journalled in the gear box. The gear 89 meshes with a clutch gear 91 which normally has a driving connection with a coacting clutch member 92 slidably mounted on and keyed to the right head advancing shaft 59. The clutch member 92 is controlled by a shifting rod 93 and is moved into its clutching position by a spring 94 acting on the plunger rod and is moved into an inoperative position by a pneumatically controlled head 95 at one end of the rod.

The clutch 86, when moved in the opposite direction to engage the clutch gear 88, drives through a train of gears 94, 95, 96 and 97. The gear 94 will be indentified hereinafter as a braking gear; the gear 95 is fixed to the shaft 90 and the gear 97 drives the left head advancing shaft 58. It will be seen from this structure that both of the shafts 58 and 59 are rotating when the clutch 86 is in driving relation with either of the gears 87 or 88 and with the clutch member 92 completing the drive to the right head advancing shaft. With the member 92 in unclutched position the drive is confined to the left head advancing shaft and with the clutch 86 centered in neutral position both shafts 58 and 59 are idle. From the showing in the several figures it will be seen that the clutch 86 has two operative and one inoperative position, the neutral position shown in Figures 15 and 24 and the driving positions, one of which is shown in Figure 18 when the heads are advancing rapidly.

The clutch 86 is controlled by a horizontally disposed cam bar 98 resiliently connected by means of a cam bar shaft 99 with the left head 37 as shown in Figures 2 and 7. The bar is provided with a cam recess 100, and extends into the left side of the gear box, shown in Figures 13 and 14. An upstanding post 101 (see Figs. 11 and 16) is journalled in the gear box below and in advance of the free end of the cam bar. The post is provided at its upper end with a cam lever 102 (see Fig. 16) at the free end of which is a cam lever pin 103, mounted in the recess 100 and shifted by the cam outlining surfaces defining the recess, as the cam bar is reciprocated by the action of the head to which it is attached. The re-

cess is outlined by a starting pocket 104 leading from which to the left is a longitudinal pin riding surface 105, followed in order by an inward incline 106, an inner riding surface 107, and a left end incline 108; then from left to right by a longitudinal riding surface 109 leading to a right end incline 110 leading to the starting pocket.

The post 101 has a three-arm trip cam 111 keyed thereto, as shown in Figure 18, with one of the arms 112 extending forwardly and fitted between collars 113 and 114 slidably mounted upon a valve shifting shaft 115 which is disposed parallel to and offset rearwardly below the secondary power shaft 85. A shifting member 116 is rigidly mounted on the shaft 115 and is provided centrally thereof with a fork 117 which engages in a peripheral groove 118 in the clutch 86 so as to move the same with the shifting of the valve shaft 115. The shifting member is provided at opposite ends thereof with upstanding catches 119 and 120 between each of which catches and the sleeve collars 113 and 114 are disposed respectively coiled springs 121 and 122. The catches are disposed to coact with latches 123 and 124 which are pivoted on opposite walls of the gear box and are each provided on their underside with three stepped stops 125, 126 and 127 and are held in engagement with their respective catches by means of springs 128 and 129. The latches are lifted from their engagement with the catches by means of laterally extending arms 130 and 131 of the trip cam 111 which arms are designed to engage the adjustable heads 132 and 133 of the latches.

The machine is started by the pushing in of a button 134 on the forward end of a push rod 135 which projects forwardly through an apron 136 defining the front of the casting 25. The rod 135 is connected by means of reach rods and levers 137 to a crank arm 138 on the post 101 so as to shift the cam lever 102 and thus shift the clutch 86 into a head driving position in a manner hereinafter more fully described.

By means of the mechanism disclosed the heads are advanced towards each other until an adjustable stop 139 on each head engages with a bumper post 140 on the adjacent faces of the projections 27 and 30, which thus limits the inward movement of the heads. It is obvious, however, that with the heads thus held the head advancing shafts 58 and 59 working in the nuts 62 will continue to rotate and thus tend to pull the shafts from the gear box. This is avoided by permitting the shafts to elongate for the required continued movement of the head advancing shafts. The shafts are of two parts and as shown in Figure 7 the parts are connected by means of a spring coupling 141. This permits the separation of the shaft parts at 142 compressing the coupling springs 143 as the shafts are being drawn through the screw nuts in the heads, and the spring coupling will reunite the shaft parts on the rerotation of the head advancing shafts on the retreat of the heads to their initial positions.

In order to stop the advance of the shafts 58 and 59 an adjustable nut 144 is fixed to the shaft 58 and is caused at the end of its permitted movement to bear against the upper end of a lever 145. The opposite lower end of this lever engages against an adjustable nut 146 fixed to the cam bar controlling shaft 99 to shift the cam bar 98 into position to react on the cam lever and thus to shift the clutch 86 in a direction to cause the heads to be rapidly retreated into their initial positions. A spring 147 on the shaft 99 restores the cam bar to its initial position when free of the pressing effect of the lever 145.

Referring to the mechanism controlled by the pneumatic features of the disclosure it is noted that the pneumatic plunger 81 controlling the main drive clutch has opposite ends formed into plunger heads 148 and 149 (see Fig. 15) slidably mounted in cylinders 150 and 151 formed by drilling opposite sides of the gear box. The heads working in the cylinders form on the right hand side a main clutch pneumatic 152 which, when air pressure is introduced therein, causes the rod 81 to shift to the left and in a direction to cause the clutch to function, and similarly the other head and cylinder form a main clutch release pneumatic 153 which when energized acts to release the clutch.

The shifting rod 93 controlling the connection of power with the right head advancing shaft 59 is moved into clutching position by the spring 94 and in the opposite or unclutching direction by a head drive disconnecting pneumatic 155 formed by the plunger head 95 working in a cylinder 154 formed in one side of the gear box.

There is disposed in the path of retreat of the right hand head 38 a head controlled valve containing member 156 (see Fig. 10) mounted in the right hand bracket 35. The member houses a normally closed valve 157 at one end of a plunger 158 which projects towards the head. The valve is seated by a spring 159 and the connection with the plunger is such that the valve is unseated by the engagement therewith of the head 38 in its retreat into its position for receiving the work in place on the work support.

Compressed air is provided from a suitable supply reservoir 160 (see Fig. 24) supplied by a compressor 161, from which lead two supply pipes, one of which 162 leads to one side of the valve 157 and the other of which 163 leads to an inlet 164 in a valve

casing 165 mounted on the left side of the gear box (see Fig. 15). The valve casing is provided with another compressed air inlet 166 which is in communication by means of a pipe 167 with the opposite side of the valve 157 from the pipe 162. It will be seen from this connection that the inlet 164 is always open to a source of compressed air while the inlet 166 is open to the compressed air only when the head 38 is at the outer limit of its retreat from the work.

The valve casing 165 is of cylindrical open end form, is provided with two exhaust ports 168 and 169. The bore of the valve casing is fitted with a bearing sleeve 170 drilled diametrically to provide peripheral by-passes for connecting the several inlets and exhausts with the pneumatics hereinbefore described. Mounted within the sleeve are two barrel valves, an outer valve 171 fixed to a reduced end of the valve shaft 115 and movable therewith and an inner follower valve 172 slidably mounted on the valve shaft and having a limited freedom of movement between the outer valve and a shoulder 173 formed on the valve shaft. The valve casing is provided with three longitudinally spaced apart outlets, the one nearest the gear box and numbered 174 leading by means of pipe 175 to the main clutch release pneumatic 153; the second outlet 176 which is bifurcated and leads by means of a pipe 177 to the main clutch actuating pneumatic 152 and by means of a pipe 178 to the brake pneumatic 179 controlling the gear 94. The third outlet 180 leads by means of a pipe 181 to the head drive disconnecting pneumatic 155. It is understood that all of the inlet and outlet pipes are controlled by suitable pet cocks 182.

The follower valve is provided with a peripheral recess 183 which in one position, as shown in Figure 20, connects the inlet 164 with the main clutch release pneumatic and in another position connects this pneumatic with the exhaust 169 as shown in Figures 21 and 22. The outlet 176 leading to the brake and to the main clutch actuating pneumatic is disposed with reference to the inlet 163 so that when the valves are separated, as shown in Figure 22, the pneumatics 179 and 155 are directly opened to the pressure at the inlet 164. The outer valve 171 is provided with a similar recess 184 of a length such that when the valves are in their normal position, shown in Figure 20, the head drive disconnecting pneumatic 155 is opened to the exhaust 168 and when in the position shown in Figure 23 the inlet 166 controlled by the valve head is opened to the head drive disconnecting pneumatic.

In operation and assuming that the case A to be machined is located in clamped position on the work support, that the proper tools are in position, that the clutch 86 is in its neutral position, and that the parts are otherwise in their normal position as shown in the diagrammatic view (Figure 24) and that the valves are in their normal position shown in Figure 20 the machine is ready to function. The operator then pushes in the button 134. This shifts the cam lever pin 103 into the pocket 104 in the cam bar so that it will ride along the straight edge 105 so as to apparently take the succeeding positions, indicated by the arrowed dotted circles shown in Figure 14. This movement of the post 101 causes the trip cam to push on the sliding collar 114 moving the same to the right compressing the spring 122 on that side.

This initial movement of the starting mechanism will have the effect of causing the right hand catch 120 to be engaged by the stop shoulder 126 which holds the catch 120 from movement to the right, and at the same time will cause the spring 122 to be placed under tension until the movement of the arm 131 acting on the head 133 is sufficient to lift the latch 124 against the tension of the spring 129. Releasing the shoulder 126 from the catch 120 permits the member 116 to be snapped to the right. This action shifts the clutch 86 to the right and into the position shown in Figure 18 to form a driving connection between the shaft 85 and the gear clutch 87. This will cause the gear train formed by the gears 87, 89, and 91 to drive the right head advancing shaft 59 and to drive through the shaft 90 and the train formed by the gears 95, 96 and 97 to drive the left head advancing shaft 58. These shafts 58 and 59 will then coact to move the heads rapidly towards the work, but as the main drive clutch 73—78 at this time is in inoperative position, the main drive shaft gear 72 is not rotated and therefore the main or tool driving shaft 53 is not rotated.

As the left head 37 moves to the right it pushes before it the cam bar 58 and this movement continues until the incline 106 is brought into engagement with the pin 110. The incline 106 is disposed in such position that it will act on the pin 103 to shift the lever 102 into the full line position shown in Figure 14 and thus cause the trip cam 111 to react on the sleeve 113 in a right to left movement (see Fig. 18) to compress the spring 121 and thus snap the clutch 86 into neutral position at a time when the machining tools are in close proximity, about a quarter of an inch to the parts to be machined. This has the effect, of course, of disconnecting the power from the head advancing shafts 58 and 59.

During the advance of the heads the pneumatic controlling valves are in the position shown in Figure 21 at which time the pneumatics are all free of pneumatic pressure. As the clutch 86 is shifted into its neutral po-

sition at the end of the rapid advance of the heads the outer valve 171 is shifted into the position shown in Figure 22. It will be noted from this Figure 22 that the pneumatic pressure at the inlet 164 is acting through the pipe 178 on the pneumatic 179 which is interposing a frictional resistance to the rotation of the gear 94 and thus acts to secure the head advancing shafts 58 and 59 against rotation. At the same time the pneumatic pressure admitted to the pipe 177 is acting on the main clutch pneumatic to shift the same to the left and into a position to cause the movable element 78 of the clutch to effect a driving connection between the main power shaft and the main drive shaft 53. The rotation of the main drive shaft acts through the gear trains 51 in the oppositely disposed heads to rotate the several tool driving shafts, and acts through the auxiliary shafts 66 to turn the nuts 62 on the held screws. The advance of the heads towards the work is thus continued but at the proper relatively slow feeding speed necessary to cause the boring bars to function. As the left hand shaft continues to advance it pushes the cam bar with the pin 103 riding along the edge 107 until the cam bar reaches the incline 108. The incline 108 acts through the cam lever 102, and shifts the clutch 86 into driving engagement with the gear clutch 88 thus causing the head advancing shafts to be again rotated but in the opposite direction to the direction in which they were rotating to advance the heads towards the work.

It may so happen, however, that either one, or both, of the heads have reached their stopped positions by the engagement of the stop 139 with the bumper post 140 prior to the engagement of the incline 108 with the cam lever pin, but this will merely mean that the shafts will separate at the points 142 as previously described.

During the retreat of the heads into their original positions the cam pin rides along the surface 109 and as the incline surface 110 engages the pin it shifts the cam lever 102 and reacts through the trip cam 111 to reset the clutch into its neutral position, separated from both of the gears 87 and 88.

During this retreat the valves are in the position shown in Figure 23, in which position the follower valve provides open communication between the air pressure at the inlet 164 and the main clutch releasing pneumatic. The outer valve is at this time in position to provide communication between the inlet 166 leading from the head valve 156 and the head drive disconnecting pneumatic 95.

The gear ratios actuating through auxiliary head driving shaft 66 are so designed that when advancing the heads, the tools of both heads have finished their boring operation at the same time, and in returning to their starting position the right hand head 38 reaches its stopping place sooner than the head 37.

When the head 38 reaches its stopping place it engages the plunger 158 and acts thereon to open the valve 157 thus permitting the passage of air pressure through the inlet 166, and pipe 181, to the head drive disconnecting clutch 95, which moves the element 92 to the left of the position shown in Figure 24 and thus disconnects the driving gear 91 from the right head advancing shaft 59. This, of course, stops shaft 59 from rotating but allows shaft 58 to continue rotating until stopped by the action of the cam bar shifting the clutch 86. When the trip cam acting through the shaft 115 restores the parts to their normal position the valves are reset to exhaust the pneumatic 155 thus permitting the spring 94 to restore the clutch element 92 into its normal driving position.

This completes the cycle of operation and with proper substitution of tools the cycle may be repeated on the work or the work may be replaced with another piece and the operation repeated. It will be understood that the only manual actuation necessary after the work is mounted is the pressing of the button 134 at the front of the machine and the work is machined and the parts automatically restored to their normal inactive position independent of any further action on the part of the operator.

By means of a device of the class described, it is possible to design the bearings for the tools in accurately positioned relation to each other and to the support for the work, thus insuring the accurate machining of the different bearings and every casing machined will be a replica of every other casing so machined. Due to the close positioning of the part of the work to be machined to the guides and supports for the tools, tool chattering has been practically eliminated and the parts coact to insure an even, smooth, non-vibratory movement of the tools. The several bearings have been made as long as is physically possible thus providing a rugged connection between the several movable parts, and the sliding connection between the several parts tends to feature smoothness of operation of the machine as a whole. This smoothness of operation is further attained by the use of the pneumatics for controlling the several shifting devices and these pneumatics have been used wherever such control is possible. The grouping of the valve parts for controlling the pneumatics into one casing permits the localizing of the valves, thus facilitating ready inspection, cleaning and replacing of the valvular parts of the organization. The several pneumatics are disposed so that ready access may be provided thereto from

the outside of the gear box and most of the other parts of the machine can be readily replaced without any material dismantling of other parts of the construction.

Having thus described my invention, I claim:

1. In a device for machining a plurality of openings having different lengths of bore and differently positioned in an article of manufacture, the combination with means for securing the article in place and power means for driving the machine, of two sets of tools operatively connected to be driven from the power means and disposed to act on the article simultaneously from opposite sides thereof, means for advancing certain of the tools rapidly and simultaneously into position adjacent their operative engagement with the parts to be machined, means for stopping said rapid movement and for causing said tools to function automatically at the termination of said rapid movement, said tools having a rate of feed while functioning to cause all the machining to be completed at the termination of the machining of the opening having the longest bore, thereby tending to maintain the load on the power means uniform during the machining operation.

2. In a device for machining a plurality of openings having different lengths of bore and differently positioned in an article of manufacture, the combination with means for securing the article in place and power means for driving the machine, of a plurality of tools operatively connected to be driven from the power means, means for advancing certain of the tools rapidly and simultaneously into position adjacent their operative engagement with the parts to be machined, means for stopping said rapid movement and for causing said tools to function automatically at the termination of said rapid movement, said tools having a rate of feed while functioning to cause all the machining to be completed at the same time thereby tending to maintain the load uniform on the power means.

3. In a device for machining or boring an article of manufacture, the combination with a power means, a plurality of tools, means actuated by the power means for advancing the tools bodily and rapidly from an inoperative towards an operative engagement with the article, means for driving the tools from the power means, and means controlled by the bodily movement of the tools into operative engagement with the article for reducing the speed of the bodily advancing means and automatically connecting the tools with the driving means to cause the tools to machine the article.

4. In a device of the class described, the combination of a work support, a tool disposed in preset relation to said support, mechanical means for advancing the tool bodily towards said support, means acting on the tool to prevent it from rotating during said advance, means operatively connected with the tool at the termination of said advance for causing it automatically to function for a preset length of travel and means operatively connected to the tool at the termination of said functioning action automatically to return the same idly to its initial position.

5. In a device of the class described, the combination of a work support, a tool disposed in preset relation to said support, means for advancing the tool bodily towards said support, means acting on the tool to prevent it from rotating during said advance, means operatively connected with the tool at the termination of said advance for causing it to function for a preset length of travel, means operatively connected to the tool at the termination of said functioning action to return the same to its initial position, and means acting on the tool during said returning movement to prevent it from rotating.

6. In a device of the class described, the combination of a tool, a fixed guide for said tool, a longitudinally movable shaft operatively connected to the tool simultaneously to rotate and advance the same at a cutting speed, means for advancing the shaft at relatively high speed and without rotation, and a control governed by the arrival of the tool at a preset point to change the actuation of the tool from one of said means to the other of said means.

7. In a device of the class described, the combination of a tool, a fixed guide for said tool, a longitudinally movable shaft operatively connected to the tool simultaneously to rotate and advance the same at a cutting speed, means for advancing the shaft at relatively high speed and without rotation, and a control governed by the arrival of the tool at a preset point to change the actuation of the tool from one of said means to the other of said means, and means for stopping the longitudinal advance of the tool while permitting the continuation of the rotation thereof.

8. In a line boring machine, the combination with a central bed casting, hollow brackets secured to opposite ends thereof, means for mounting the work to be machined on the bed casting between the brackets, heads slidably mounted for longitudinal movement on said brackets, said heads each having an upper portion above the top of the supporting bracket and a lower portion depending into the bracket and tending to balance the head on opposite sides of their support on the brackets, a tool shaft carried by each upper portion projecting therefrom towards the position of

the work on the central bed casting, power means within the bed casting, head advancing means extending from the bed casting into the brackets and operatively connected to the lower portion of the heads to move the same towards the central bed casting, means for connecting the head advancing means to the power means and means including a gear train in the heads for driving the tool shaft from the power means.

9. In a machine for boring a crank casing, the combination of the support for a crank case, said support provided with a plurality of locating pins projecting upwardly from the support and adapted to engage in located recesses in the part of the crank case resting on the support, projections extending upwardly from the support, adapted to be contained in the case when located on the pins and provided with pilots for engaging in recesses in the case, clamps for securing the case in its located position and boring tools having a prefixed location relative to the locating pins and located in said projections for machining the located case.

10. In a machine for boring a crank casing, the combination of the support for a crank case, said support provided with a plurality of locating means projecting upwardly from the support and adapted to engage in located recesses in the part of the crank case resting on the support, projections extending upwardly from the support, adapted to be contained in the case when located on the pins and provided with pilots for engaging in recesses in the case, clamps for securing the case in its located position and means for boring the located case, said projections being in close proximity to certain parts of the located case and certain of said boring means being guided in said projections in close proximity to the parts to be machined.

11. In a device for machining the bearings in a crank case, the combination with a support for the case, of two sets of boring bars disposed on opposite sides of the case, one of said sets including a generator shaft boring bar, a water pump boring bar, a crank shaft boring bar and a cam shaft boring bar, the other set including a water pump boring bar, a crank shaft boring bar and a cam shaft boring bar, with the similarly named boring bars in axial alignment, a pair of heads positioned to the outside of the several bars, each of said heads provided with driving shafts operatively connected to the several boring bars to actuate the same and power means for causing the heads to advance the bars in operative engagement with the case to be machined.

12. In a device for machining the bearings in a crank case, the combination with a support for the case, of two sets of boring bars disposed on apposite sides of the case, one of said sets including a generator shaft boring bar, a water pump boring bar, a crank shaft boring bar and a cam shaft boring bar, the other set including a water pump boring bar, a crank shaft boring bar and a cam shaft boring bar, with the similarly named boring bars in axial alignment, means for guiding each of the boring bars, a pair of heads positioned to the outside of the several bars, and independent of the bar guiding means, each of said heads provided with driving shafts operatively connected to the several boring bars to actuate the same and power means for causing the heads to advance the bars in operative engagement with the case to be machined.

13. In a device for machining an article simultaneously from opposite sides thereof, the combination of a pair of tool supports adapted to accommodate the article therebetween, aligned tools guided by said supports, a pair of heads disposed to the outside of said supports, and slidably mounted for movement towards the tool supports, driving shafts mounted in said heads and movable axially therewith, flexible driving connections between said shafts and the tools to compensate for any disalignment and power means acting simultaneously on the heads to advance the same towards the article and acting on the shafts to rotate the same as they are advanced by the heads whereby the tools are caused to function in unison.

14. In a line boring machine, the combination with a support for the work to be machined, means for securing the work in place, extensions from opposite ends of the support, heads mounted to slide longitudinally on said extensions, a tool driving shaft mounted in each of said heads coacting to cause tools carried thereby to act on opposite sides of the work on the support, means for moving the heads towards the work, a single power means, a driving connection between said power means and both of said head advancing means to advance the heads with their shafts simultaneously towards the work, and means controlled by the advanced position of the heads for disconnecting the power means from both of said head advancing means.

15. In a line boring machine, the combination with a support for the work to be machined, means for securing the work in place, extensions from opposite ends of the support, heads mounted to slide longitudinally on said extensions, a tool driving shaft mounted in each of said heads coacting to cause tools carried thereby to act on opposite sides of the work on the support, means for moving the heads towards the work, a single power means, a driving connection between said power means and both of said

head advancing means to advance the heads with their shafts simultaneously towards the work, and means controlled by the advanced position of the heads for disconnecting the power means from both of said head advancing means and for connecting the shafts with the power means whereby the shafts commence to drive promptly at the termination of the advance of the heads.

16. In a machine for boring a crank case, the combination of a support and means thereon for locating the case to be machined, a pair of heads mounted on opposite sides of the support for movement towards each other and towards the case support, a plurality of tool shafts carried by each of said heads, projecting therefrom and spaced relative to each other corresponding to the spacing of the bearings in a crank case and in fixed relation to the locating means, said shafts including a water pump boring bar, a cam shaft boring bar and a crank shaft boring bar, certain of the bars from one head being in axial alignment with the correspondingly named bar from the other head and a third floating bar disposed in said axial alignment, normally separated physically from and adapted to be engaged by one of the bars from one of the heads to be moved thereby in its boring operation by said head bar.

17. In a device of the class described, the combination with a head support, a head slidably mounted for longitudinal movement on said support, said head including an upper part extending above the support and a lower part hanging below the support, a main drive shaft and a head advancing shaft extending into the lower part of the head, a screw and nut connection between the head advancing shaft and the head to move the latter in its longitudinal movement, a driving connection between said shafts to cause the main drive shaft to turn the head advancing shaft and thus move the head, a plurality of tool driving shafts mounted in the upper part of the head and projecting in one direction therefrom, a gear train in said upper part connecting the tool driving shafts and a gear drive between the main drive shaft and said gear train.

18. In a machine for boring a crank case, the combination of a support and means for locating the case to be machined, a head mounted for movement towards the case support, a plurality of tool shafts carried by said head, and projecting therefrom and spaced relative to each other corresponding to the spacing of the bearings in a crank casing and having a fixed relation to the locating means, said shafts including a water pump boring bar, a cam shaft boring bar and a crank shaft boring bar, the crank shaft boring bar and the cam shaft boring bar being formed of a plurality of separable parts to permit the installation of parts of the crank case between the bar parts, means for coupling said parts to drive one from the other and means for simultaneously driving all of the tool shafts.

19. In a device of the class described, the combination with a head mounted for longitudinal movement, and a tool driving shaft mounted for rotary movement in said head, a nut mounted in said head for rotary movement and held from longitudinal movement, a head advancing shaft threaded into said nut for advancing the head in its longitudinal movement at relatively high speed, a main drive shaft operatively connected to the tool driving shaft to rotate the same, an auxiliary head driving shaft journalled in the head, having an endless worm gear drive with the nut and a spur gear drive with the main drive shaft.

20. In a device of the class described, the combination with a head mounted for longitudinal movement, and a tool driving shaft mounted for rotary movement in said head, a nut mounted in said head for rotary movement and held from longitudinal movement, a head advancing shaft threaded into said nut for advancing the head in its longitudinal movement at relatively high speed, a main drive shaft operatively connected to the tool driving shaft to rotate the same, an auxiliary head driving shaft journalled in the head, having an endless worm gear drive with the nut and a spur gear drive with the main drive shaft and means for locking the head advancing shaft from rotating while the main driving shaft is rotating thereby permitting the main driving shaft to advance the nut and thus advance the head along the head advancing shaft.

21. In a device of the class described, the combination of a pair of head advancing shafts and a secondary power shaft disposed in parallel relation thereto, a gear train with one end gear driving one of the head advancing shafts and another gear constituting a clutch gear loose on the secondary shaft, a second gear train similarly connected to the other head advancing shaft, a clutch driven from the secondary shaft and movable in opposite directions into driving engagement with the clutch gears, power means for constantly driving the secondary shaft and means controlling the driving connection between one of the gear trains and the head advancing shaft controlled thereby, whereby one of the head advancing shafts may be driven during a period of time while the other head advancing shaft is inactive.

22. In a device of the class described, the combination of a pair of head advancing shafts and a secondary power shaft dis-

posed in parallel relation thereto, a gear train with one end gear driving one of the head advancing shafts and another gear constituting a clutch gear loose on the secondary shaft, a second gear train similarly connected to the other head advancing shaft, a clutch driven from the secondary shaft and movable in opposite directions into driving engagement with the clutch gears, means operative at the termination of a preset actuation of one of the head advancing shafts for shifting the clutch to interrupt the driving connection with said head advancing shaft, power means for constantly driving the secondary shaft and means controlling the driving connection between one of the gear trains and the head advancing shaft controlled thereby, whereby one of the head advancing shafts may be driven during a period of time while the other head advancing shaft is inactive.

23. In a device of the class described, the combination of a pair of heads mounted for longitudinal movement, two sets of head advancing means therefor, a single power means, operatively connected to both of said head advancing means to cause them to function in unison, and means controlled by a resistance to the advance of one of the heads for automatically disconnecting the power means from the corelated head advancing means.

24. In a device of the class described, the combination of a pair of heads mounted for longitudinal movement, two sets of head advancing means therefor, a single power means, operatively connected to both of said head advancing means to cause them to function in unison, and means controlled by the advance of one of the heads for automatically disconnecting the power means from one of said head advancing means, and means engaging the other head advancing means for braking the same.

25. In a device of the class described, the combination of a pair of heads mounted for longitudinal movement, two sets of head advancing means therefor, a single power means, operatively connected to both of said head advancing means to cause them to function in unison, and means controlled by the advance of one of the heads for causing it to travel in its operative direction first at high speed, then at a relatively slow boring speed and for automatically reversing the direction of drive of the head advancing means at the termination of the slow speed movement.

26. In a device of the class described, the combination with a head containing tool driving mechanism, head advancing mechanism, feeding means operatively connected to the head, advancing mechanism for advancing the head rapidly to a preset point while the tool driving mechanism remains idle, means controlled automatically by the arrival of the head at said point for causing said rapid head advancing feeding means to become inoperative and causing the tool driving mechanism to become operative for feeding the head at a relatively slow speed.

27. In a device of the class described, the combination with a head containing tool driving mechanism and mounted for longitudinal movement, feeding means operatively connected to the head for advancing the same rapidly to a preset point, means for locking the tool driving mechanism against rotation during said rapid advance, means controlled automatically by the arrival of the head at said point for causing said rapid feeding means to become inoperative, and for causing the tool driving mechanism to function and for feeding the head at a relatively slow speed, and means controlled by the arrival of the head at a second preset point for causing said mechanism to become inoperative.

28. In a device of the class described, the combination with a head containing tool driving mechanism and mounted for longitudinal movement, feeding means operatively connected to the head for advancing the same rapidly to a preset point, means controlled automatically by the arrival of the head at said point for causing said rapid feeding means to become inoperative, and means for actuating the tool driving mechanism and for feeding the head at a relatively slow speed, mechanism controlled automatically by the arrival of the head at said point for causing said rapid feeding means to become inoperative thereby to conserve the available power and for causing last named means to become operative.

29. In a device of the class described, the combination of two heads mounted for longitudinal movement and each containing a tool driving shaft, a main drive shaft operatively connected at opposite ends simultaneously to advance the heads and to rotate the shafts, a motor, a main power shaft operatively connected to be driven thereby, a clutch drive between the main power shaft and the main drive shaft, and means governed by the position of one of said heads for controlling said clutch.

30. In a device of the class described, the combination of two heads mounted for longitudinal movement towards each other and a shaft for controlling said heads, a main power shaft, a clutch including a driving element free to move on the power shaft and operatively connected to the same so as to be rotated thereby, and a driven element loose on the shaft, said head controlling shaft being geared to the driven element of the clutch, a control rod contained within the main shaft and connected to the movable element of the clutch to control the

same and pneumatically actuated means for moving said clutch controlling rod.

31. In a device of the class described, the combination of two tool carrying heads, bearing drilling tools carried by each head and offset laterally from each other to machine different bearings, means for causing said tools to function both in unison and in successive operations, means connected to each head and controlled by the completion of the boring for causing them to retreat towards an initial position and means controlled by the arrival of one of the heads at said initial position for intercepting the driving connection with said head while permitting the continuation of the driving connection with the other head until said other head has reached its initial position.

32. In a device of the class described, the combination of two tool carrying heads, tools carried by each head, means for causing said tools to function, means connected to each head for causing them to retreat simultaneously towards an initial position and means controlled by the arrival of one of the heads at said initial position for intercepting the driving connection with said head while permitting the continuation of the driving connection with the other head and means controlled by the arrival of said other head at its initial position for intercepting the driving connection with both heads.

33. In a device of the class described, the combination of a tool carrying head mounted for reciprocatory movement, means for moving the head in either direction, said means including mechanism controlled by the head for causing said head to advance in one direction at two different speeds and for causing said head to move in the opposite direction at a relatively high speed, and means for cushioning said high speed movement and means for intercepting the driving connection with the head moving means in case said cushioning means fails to function.

34. In a device of the class described, the combination of a pair of heads mounted for longitudinal movement, two sets of head advancing means therefor, a single power means, operatively connected to both of said head advancing means to cause them to function in unison, means controlled by the advance of one of the heads for automatically disconnecting the power means from one of said head advancing means, and pneumatically actuated means for braking one of said head advancing means.

35. In a device of the class described, the combination of a pair of heads mounted for longitudinal movement, two sets of head advancing means therefor, a single power means, operatively connected to both of said head advancing means to cause them to function in unison, means controlled by the advance of one of the heads for automatically disconnecting the power means from one of said head advancing means, and pneumatically actuated means controlled by the lapsed actuation of one of the head advancing means for braking one of said head advancing means.

36. In a device of the class described, the combination of a main power shaft, a motor for driving the same, a clutch including a driving element free to move on the power shaft and operatively connected to the same so as to be rotated thereby, and a driven element loose on the shaft, a head controlling shaft geared to the driven element of the clutch, a control rod in the main shaft and connected to the movable element of the clutch to control the same, and pneumatically actuated means for moving said clutch controlling rod.

37. In a device of the class described, the combination of a tool carrying head, means for moving said head in one direction including a driving clutch, and pneumatically actuated means controlled by the movement of said head for moving said clutch into an inoperative position thereby to intercept the action of said moving means.

38. In a device of the class described, the combination of a tool carrying head, means for moving said head in one direction including a driving clutch, and pneumatically actuated means controlled by the movement of said head for moving said clutch into an inoperative position thereby to intercept the action of said moving means, and resilient means acting on said clutch to restore the same to its operative position when free of the pneumatically actuated means.

39. In a device of the class described, the combination of a tool carrying head, means for moving said head in one direction including a driving clutch, pneumatically actuated means controlled by the movement of said head for moving said clutch into an inoperative position thereby to intercept the action of said moving means, resilient means acting on said clutch to restore the same to its operative position when free of the pneumatically actuated means and means operating in step with said head moving means for controlling said pneumatically actuated means.

40. In a device of the class described, the combination of a pair of tool controlling heads, feed means for advancing the heads towards each other, pneumatically actuated means controlled by the heads for reversing the direction of movement of the feeding means thereby to cause the heads to retreat away from each other.

41. In a device of the class described, the combination of a pair of tool controlling heads, feed means for advancing the heads

towards each other, pneumatically actuated means controlled by the heads for reversing the direction of movement of the feeding means thereby to cause the heads to retreat away from each other and pneumatically actuated means for stopping the retreat of the heads.

42. In a device of the class described, the combination of a tool actuating head mounted for longitudinal movement, power means including a driving clutch for actuating said head, a pneumatic operatively connected to the clutch to move the same to and from an operative position, valvular means actuated by the movement of the head for controlling said pneumatic.

43. In a device of the class described, the combination of a tool actuating head mounted for longitudinal movement, power means including a driving clutch for actuating said head, a pneumatic operatively connected to the clutch to move the same to and from an operative position, valvular means actuated by the movement of the head for controlling said pneumatic and means for restoring said pneumatic to normal position thereby to reset the driving clutch into its normal position.

Signed at Cleveland, in the county of Cuyahoga and State of Ohio, this 28th day of July, A. D. 1921.

HIRAM L. WALKER.