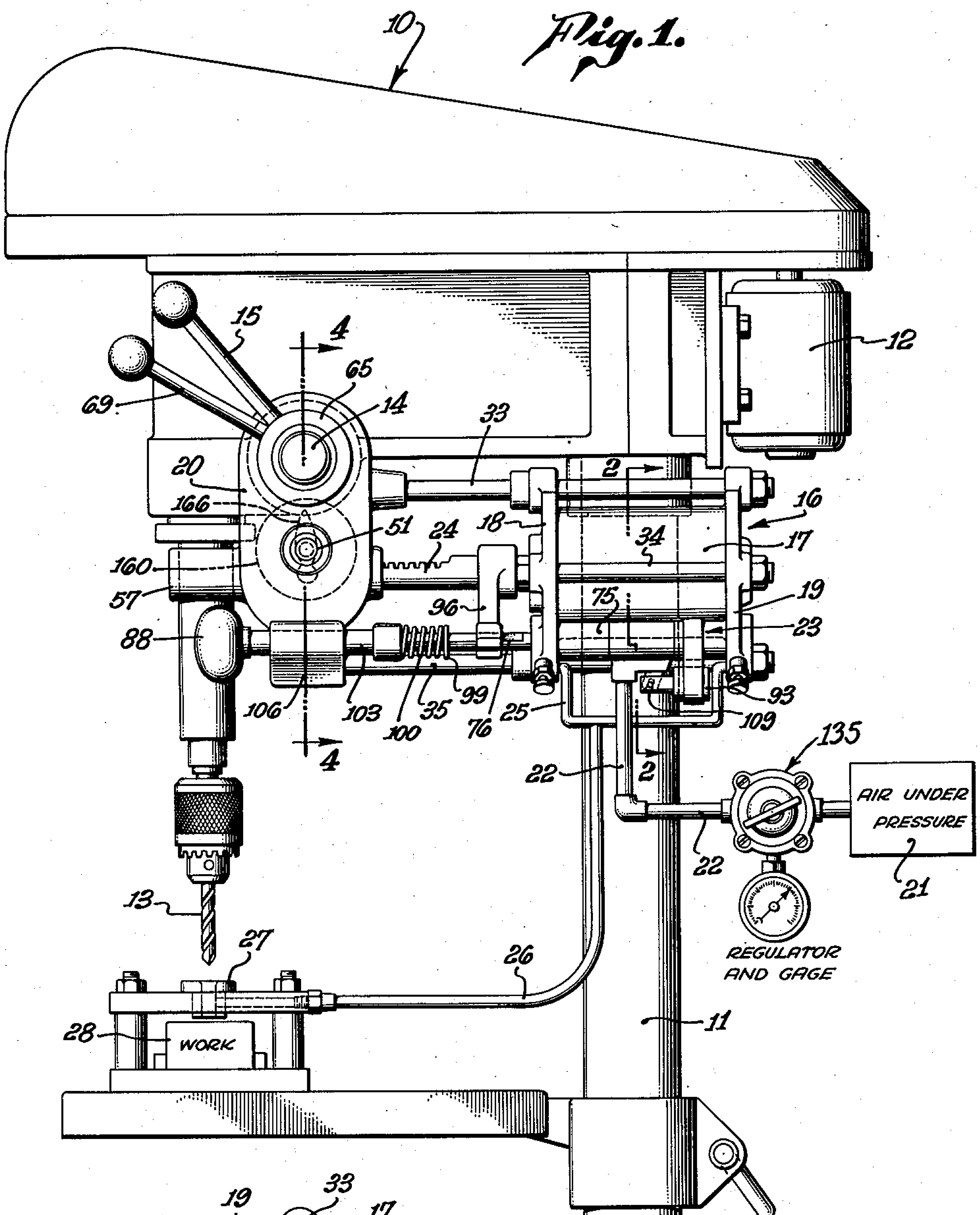
Jan. 6, 1953 D. HEYER 2,624,319

POWER FEED APPARATUS

Filed July 31, 1946 5 Sheets-Sheet 1

Fig. 1.



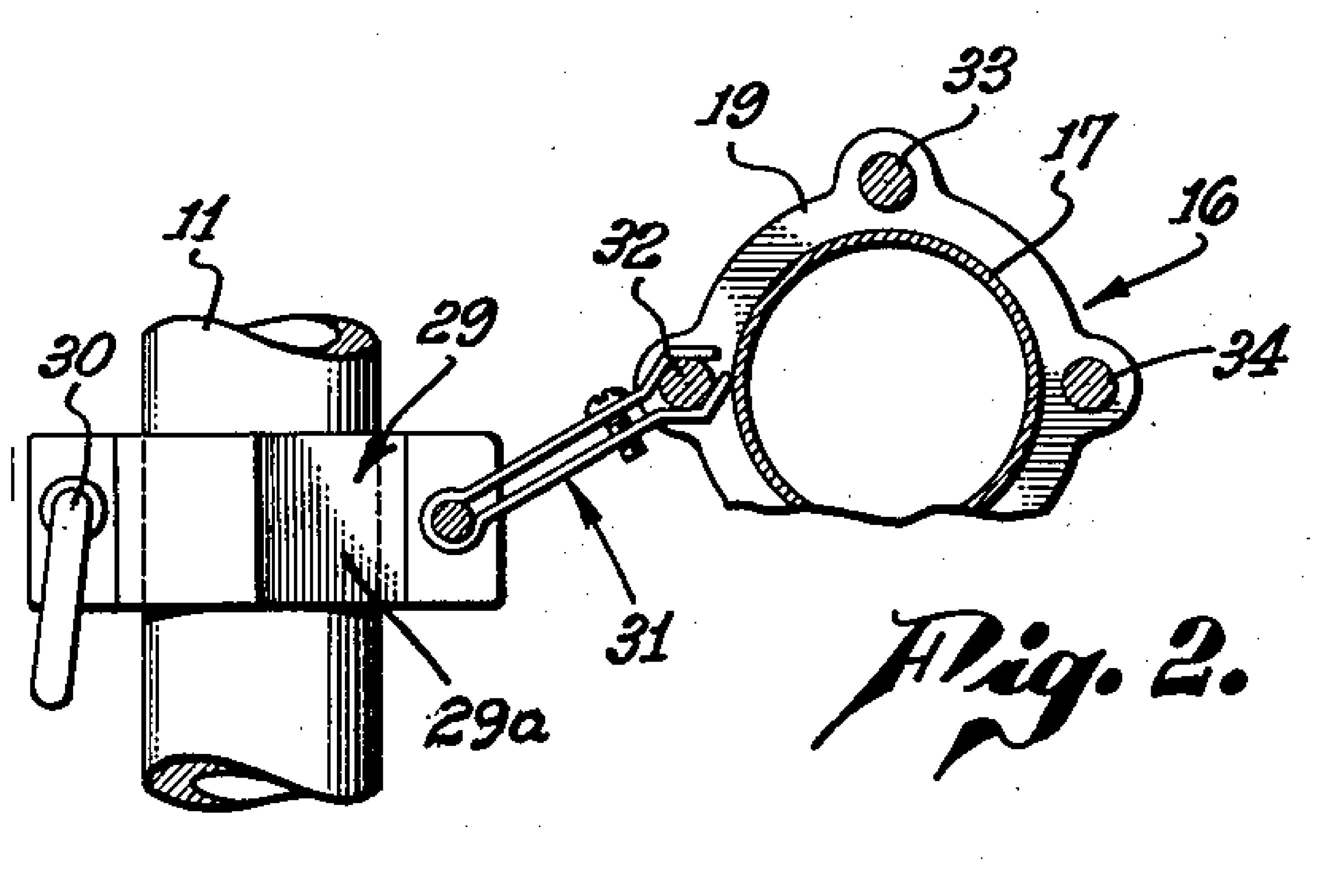


Fig. 2.

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Fig. 3.

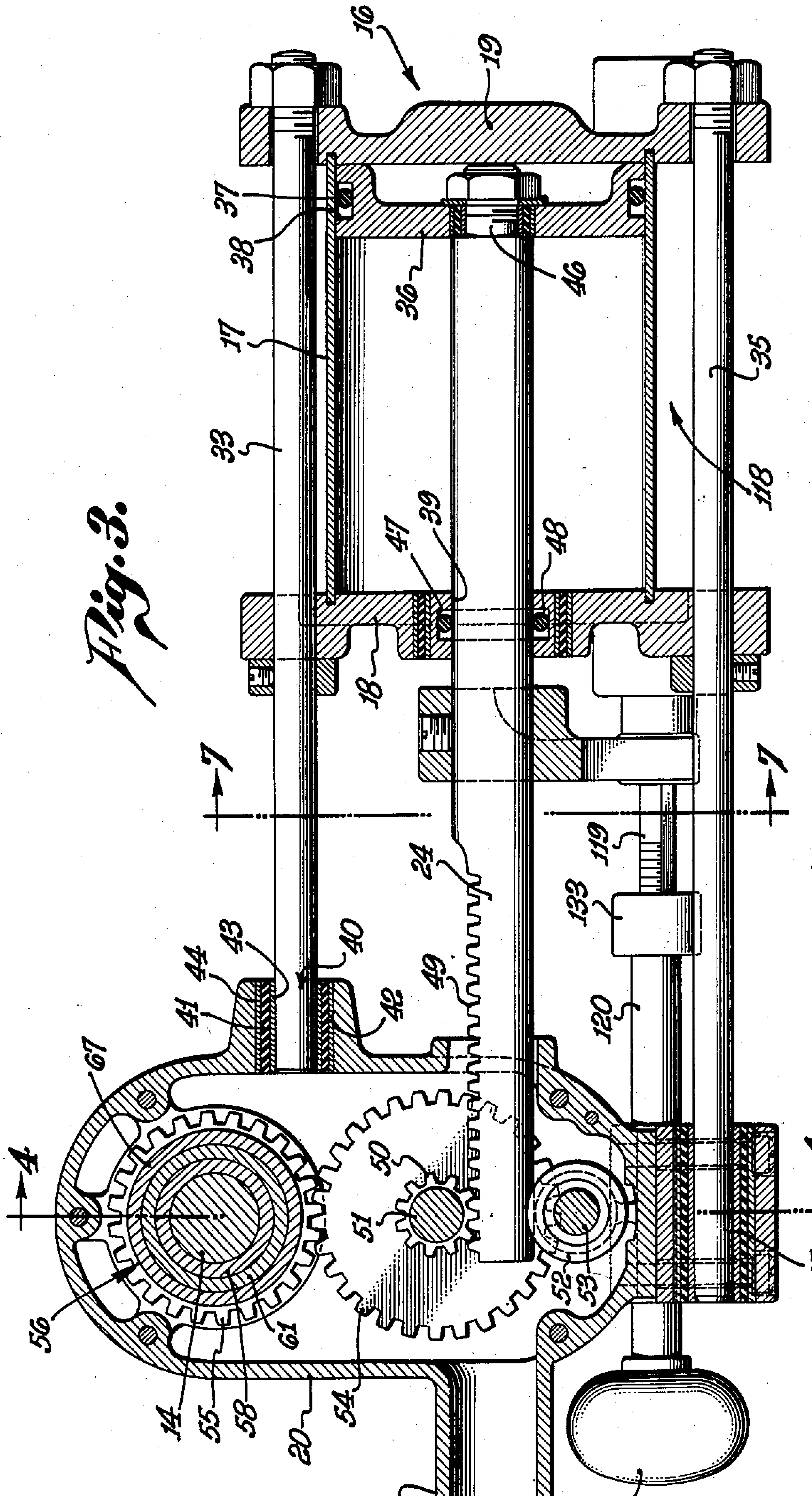

Fig. 13.

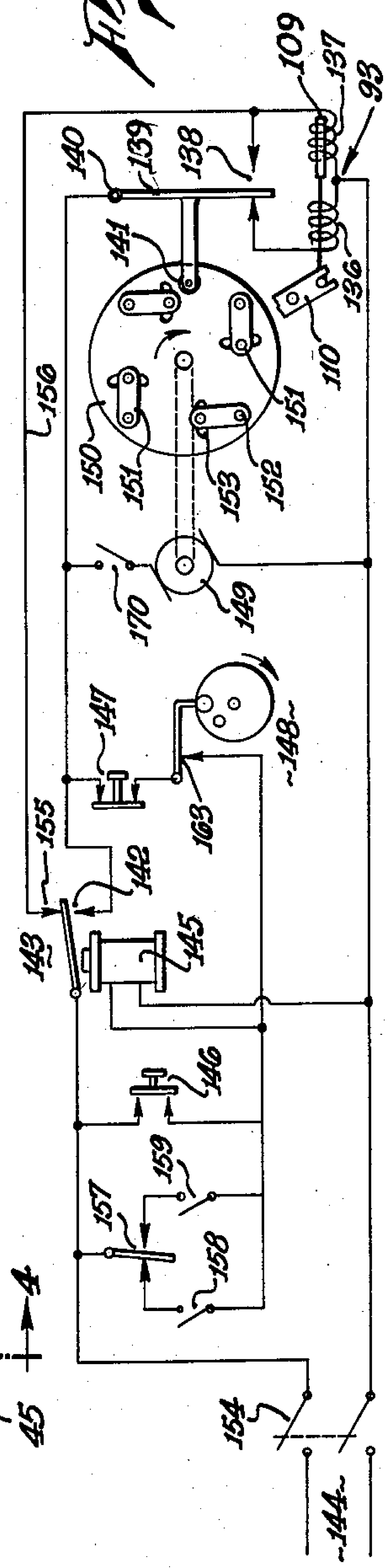

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Fig. 4.

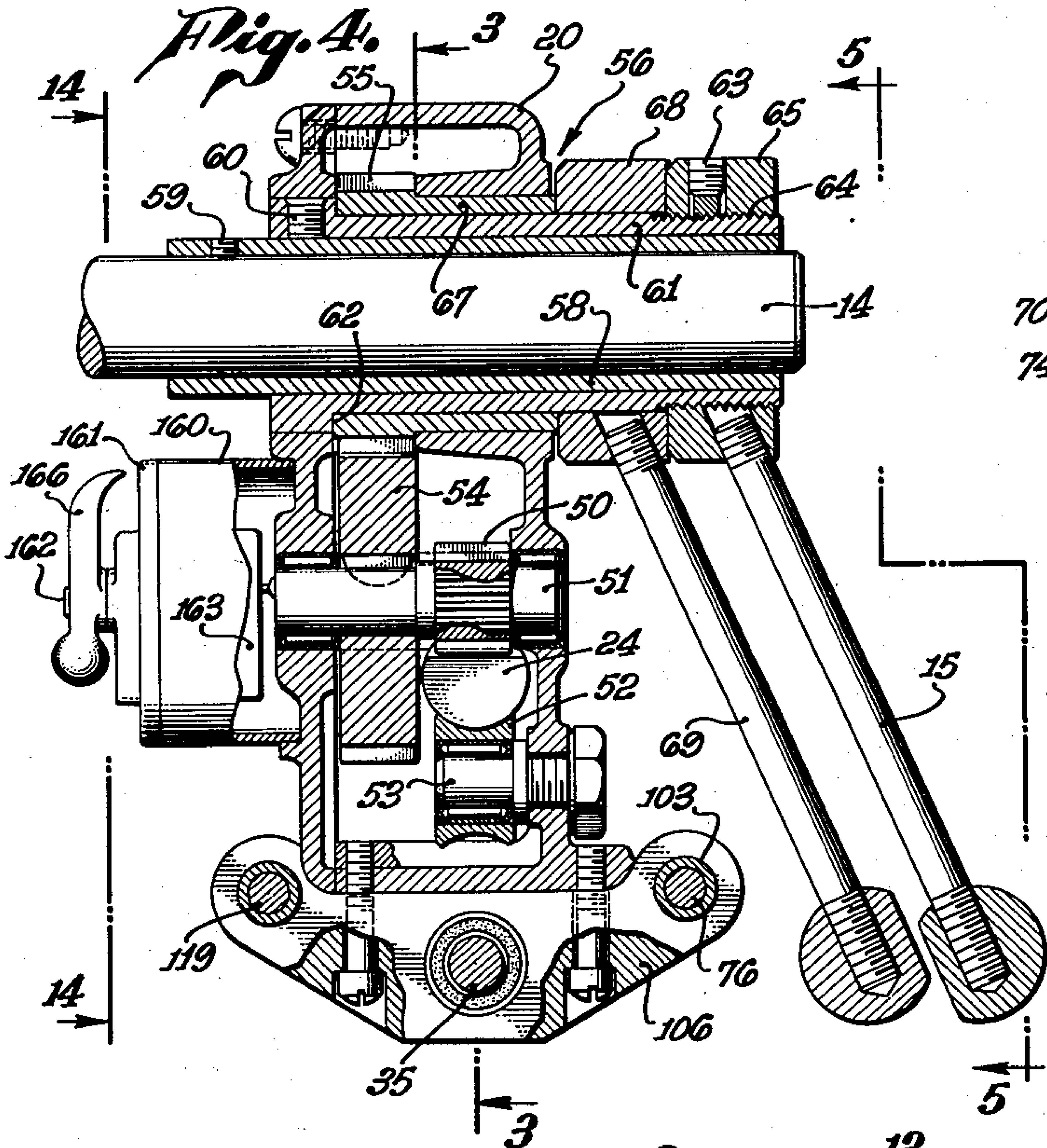


Fig. 5.

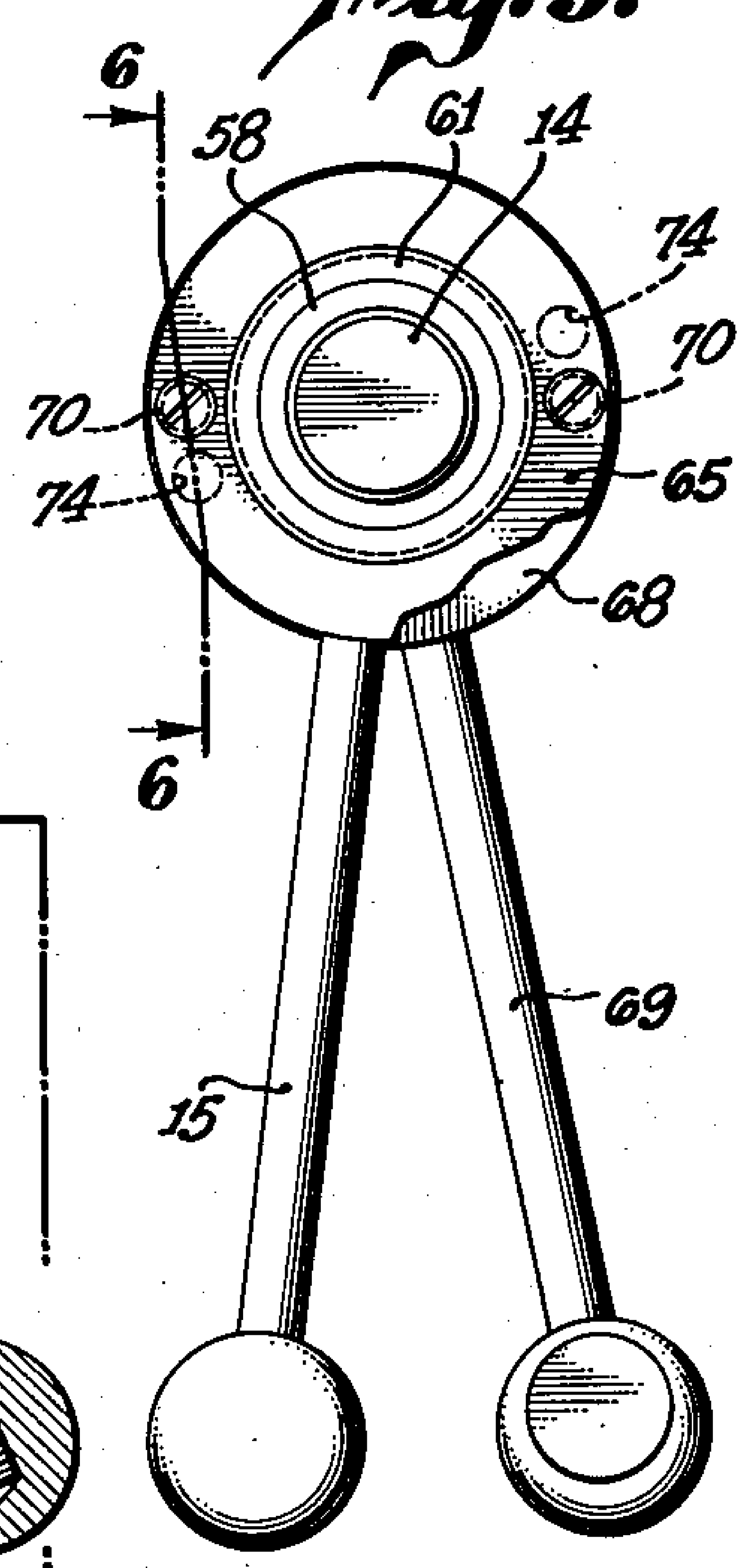


Fig. 7.

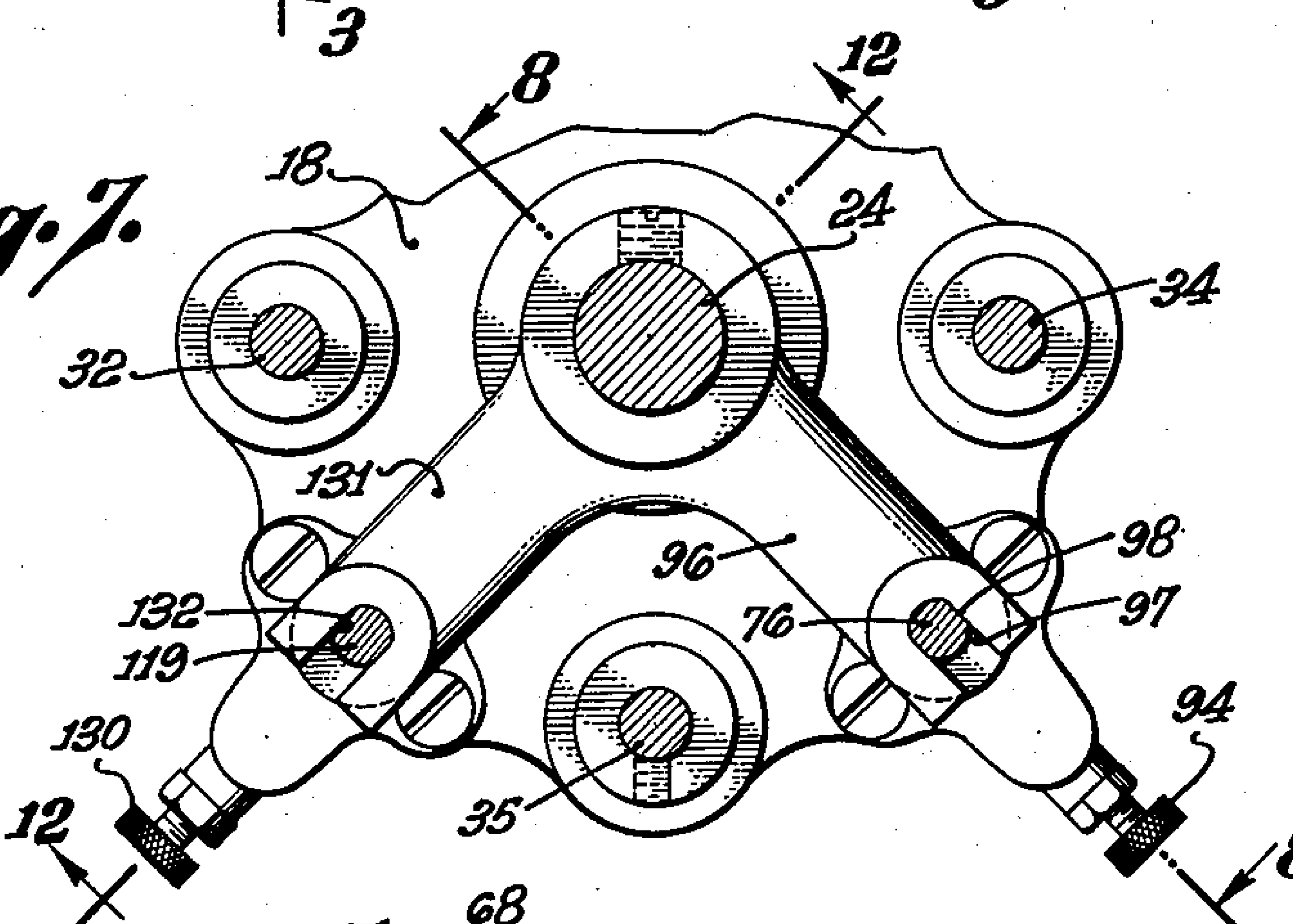
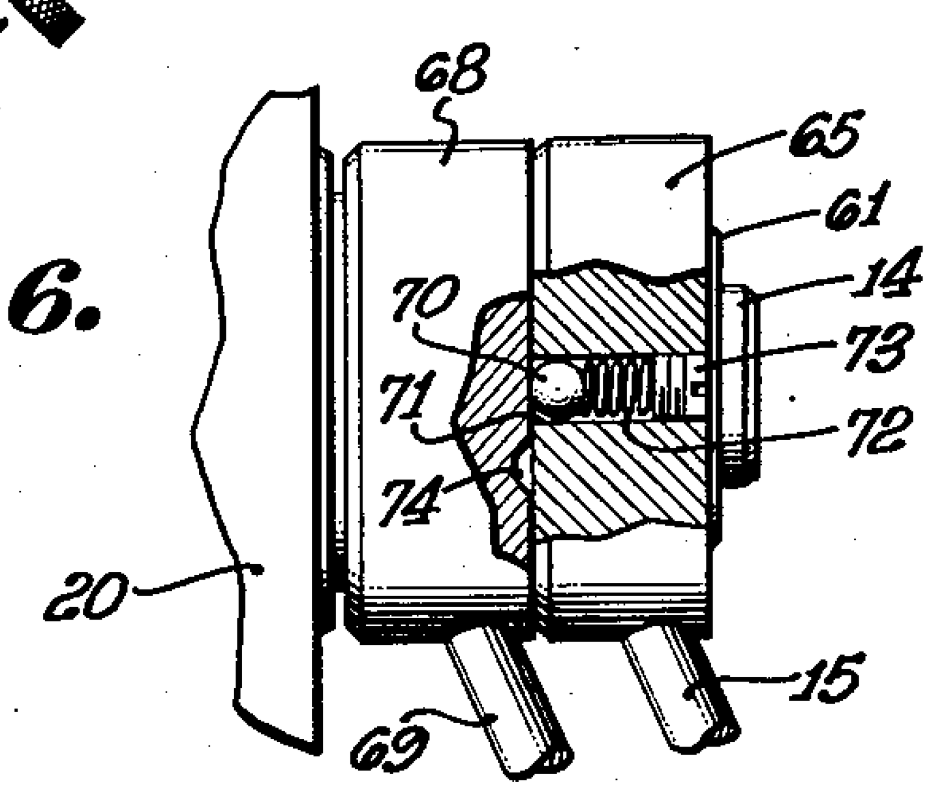


Fig. 6.



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POWER FEED APPARATUS

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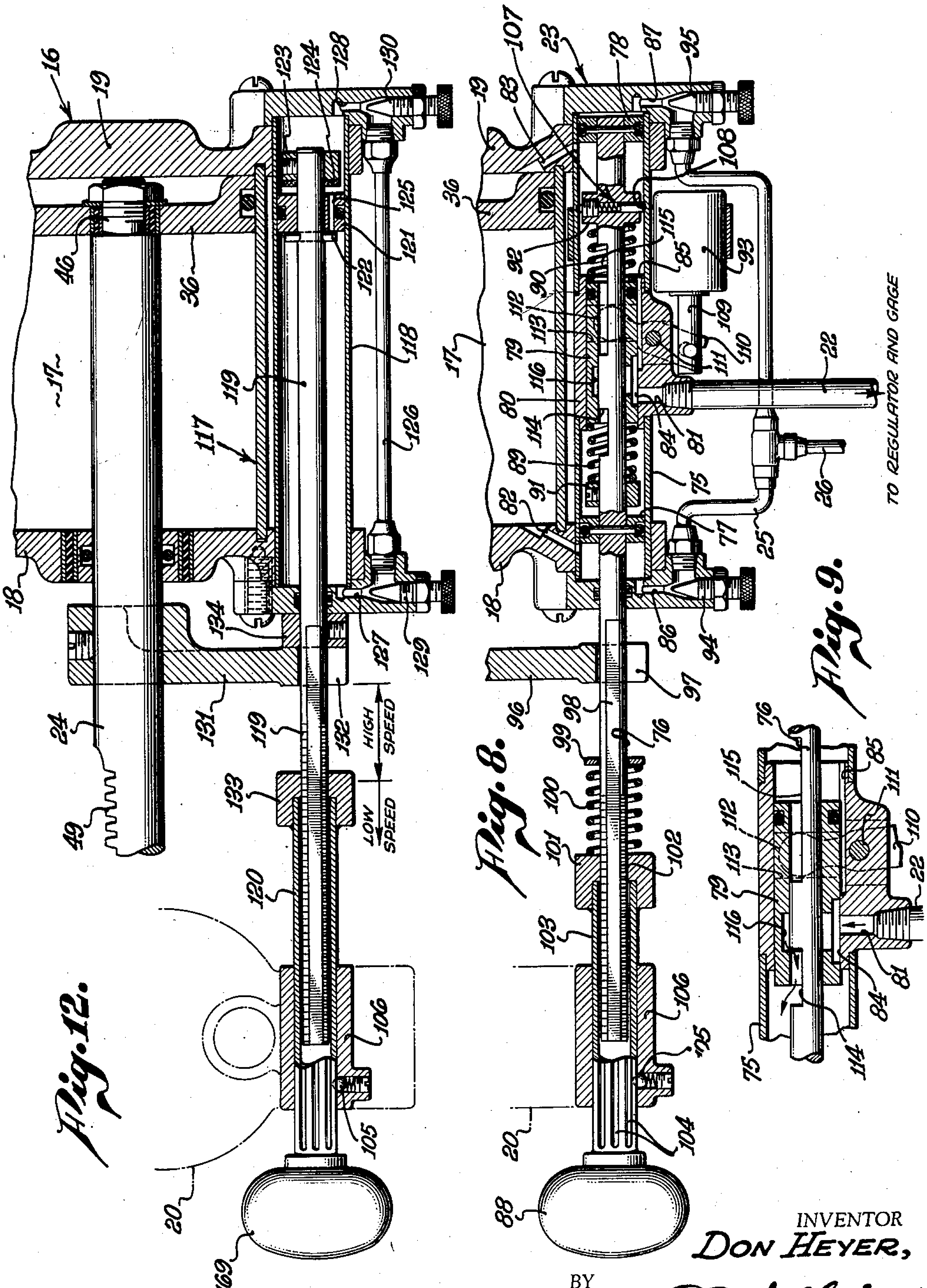

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Fig. 14.

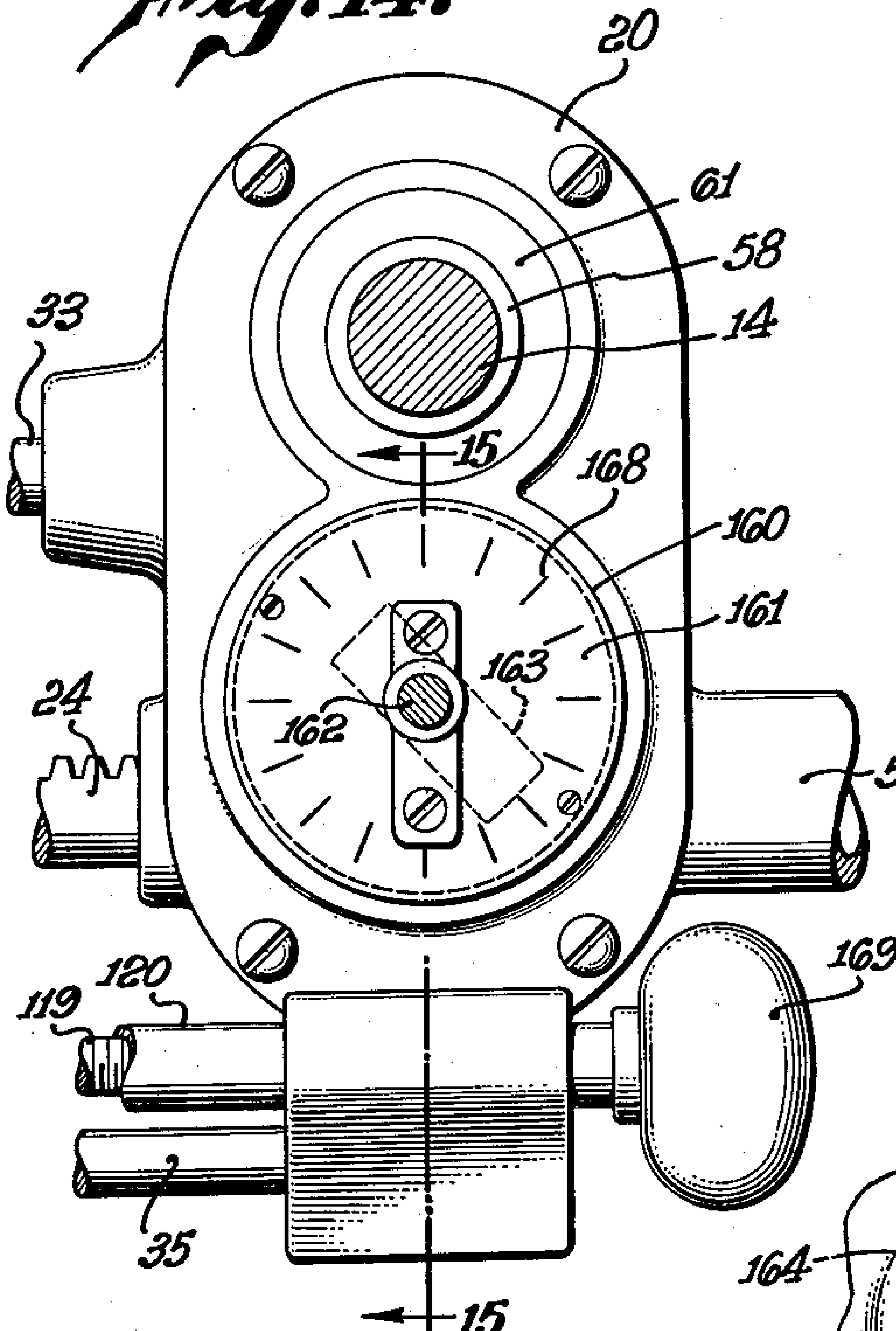


Fig. 15.

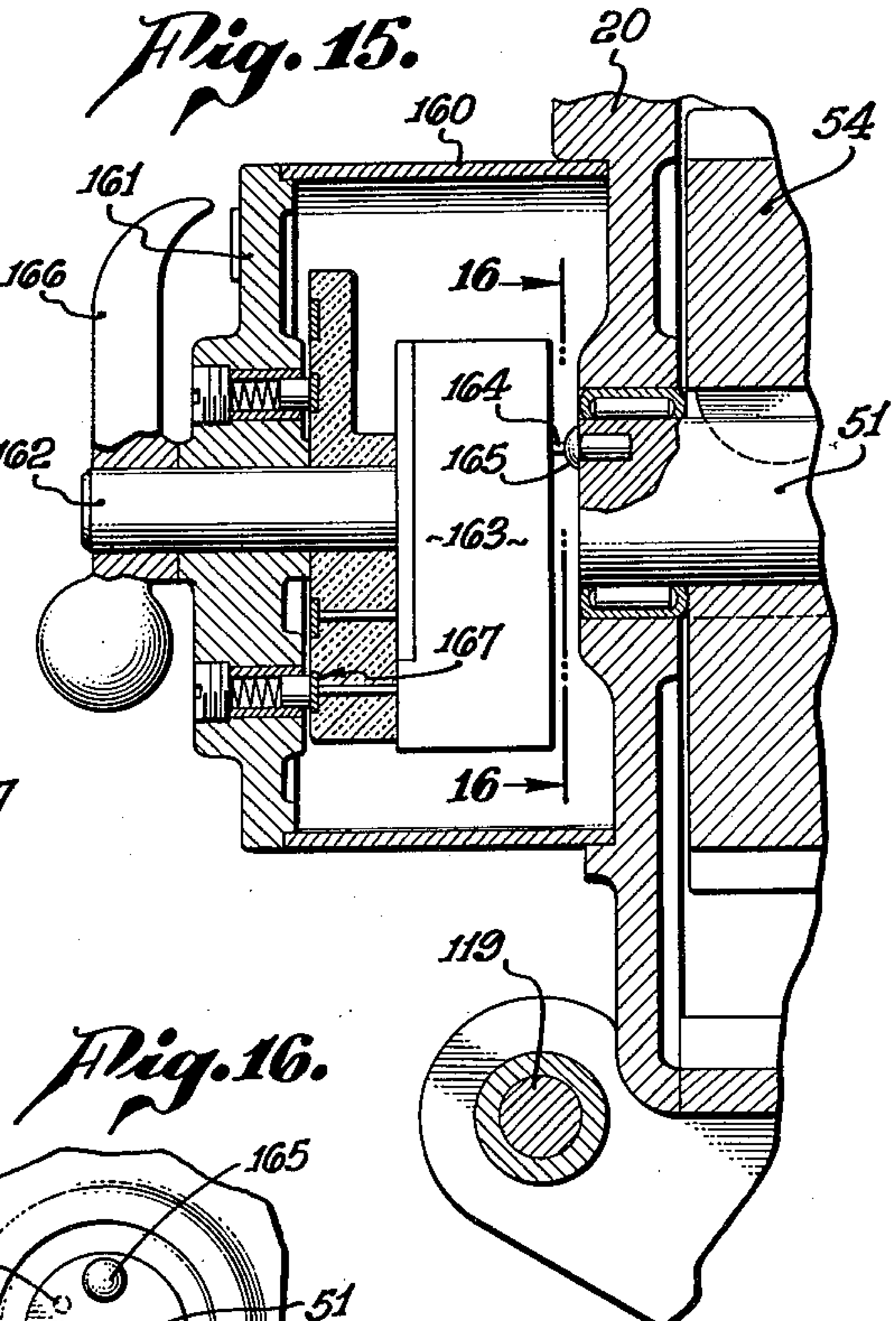


Fig. 16.

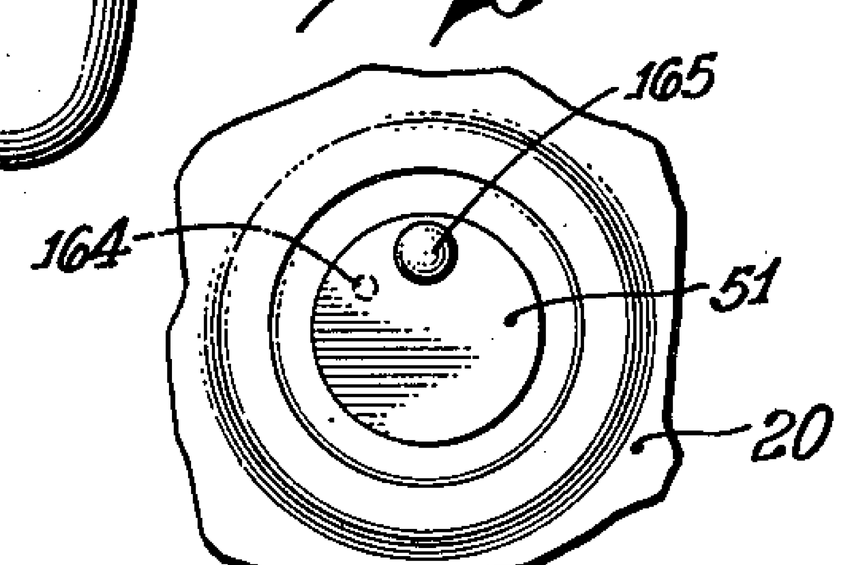
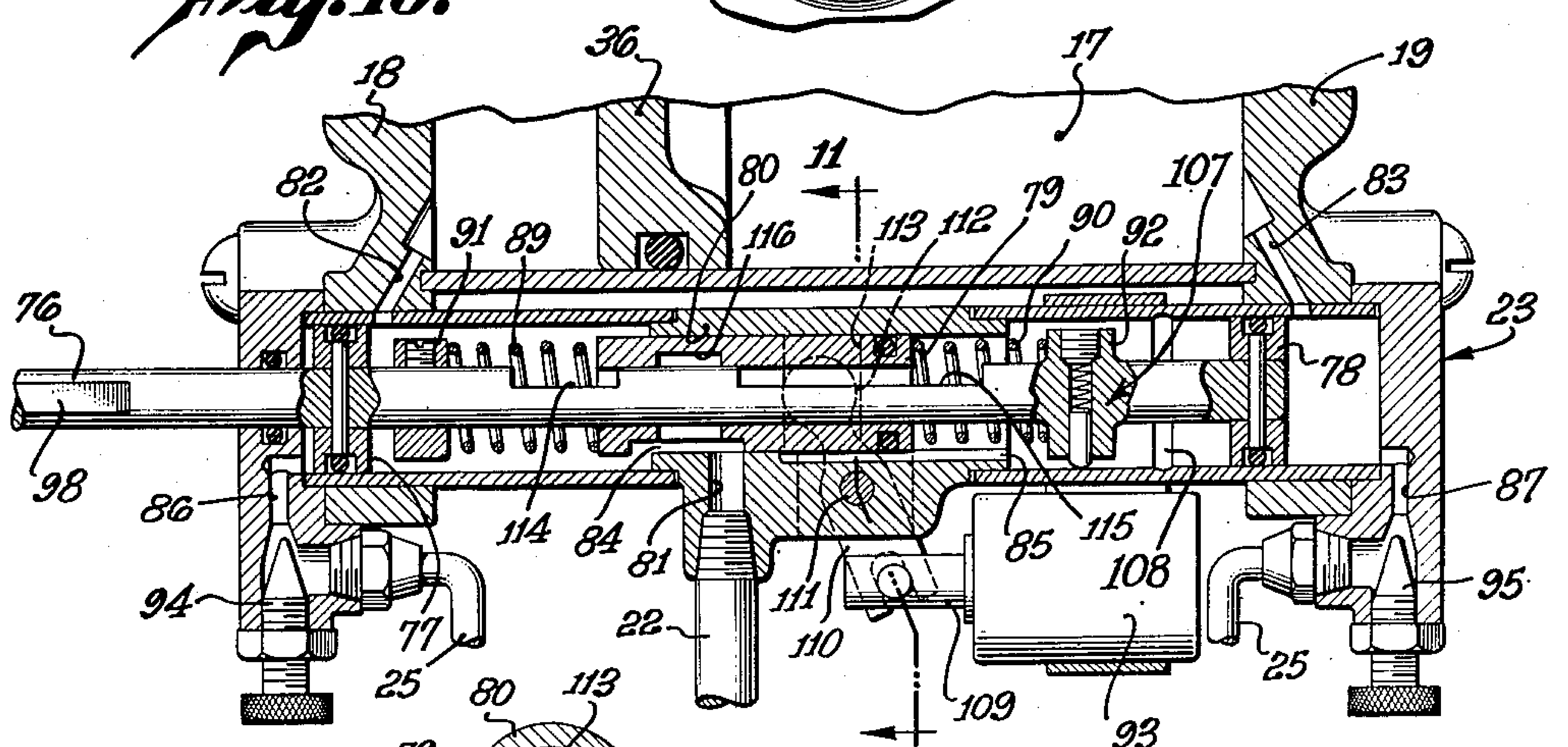


Fig. 10.



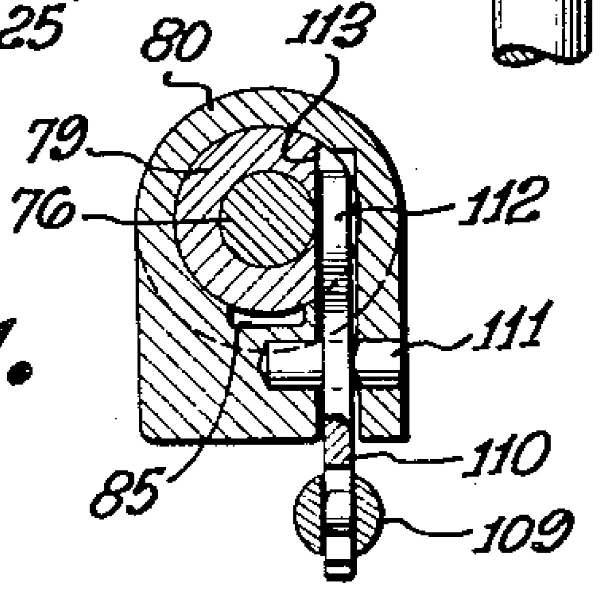


Fig. 11.

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Patented Jan. 6, 1953 2,624,319

UNITED STATES PATENT OFFICE

2,624,319

POWER FEED APPARATUS

Don Heyer, Los Angeles, Calif.

Application July 31, 1946, Serial No. 687,401

5 Claims. (Cl. 121—45)

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This invention relates to fluid actuated apparatus for producing relative advance and withdrawal between a tool and work material upon which the tool is to operate. The apparatus of this invention is particularly adapted for application to a drill press having a rotating bit; although it may readily be applied to many types of operating machinery, such as machine tools, bending and forming machines, transfer conveyors, hoists, boring machines, and similar apparatus where movement of an operating member is to be controlled. More particularly, this invention relates to such apparatus employing fluid actuated driving means.

In general, the apparatus herein disclosed comprises an assembly adapted to be attached to a standard machine, although it will be understood that the apparatus may be fabricated as a part of the machine if desired. Fluid actuated driving means are employed, preferably in the form of a cylinder and piston, the power-transmitting fluid preferably being compressed air.

The apparatus of this invention embodies numerous features of advantage, among which are a valve designed to be actuated either mechanically, as by hand, or electrically through a solenoid, said valve operating to control the application of air to the piston; and stabilizing means in the form of a velocity responsive damper, preferably of the viscous fluid type, said stabilizing means being arranged to be coupled to the driving means, i. e., the air driven piston, at a variable predetermined point in the travel in the piston.

Other features of this apparatus are an electrical control, use of which is optional, by means of which intermittent and momentary relative withdrawal between tool and work may be effected during the machine operation; a clutch whereby the air-powered driving means of the machine may be quickly de-coupled from the machine, thereby permitting the machine to be manually operated; limiting means both mechanical and, optionally, electrical for reversing direction of motion of the piston at a variable, predetermined point in the tool-advancing movement of the piston; a set of bushings, by proper use of which the apparatus may be adapted for mounting on machines having varying sizes of spindle control shafts; pliant mounting means whereby the apparatus may be easily and properly mounted on any given machine; and the integral unitary construction of power cylinder and valve cylinder having a common wall with ports therethrough, thereby eliminating cumbersome conduits between valve and power cylinder.

In controlling movement of a tool through use of externally powered driving means, it may be desirable to provide control means permitting optionally either mechanical control of the driv-

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ing means, or alternatively electrical control thereof.

To this end, it is an object of this invention to provide a valve for controlling admission of air to a cylinder, which valve may be controlled by a mechanical member, or alternatively by an electrical means such as a solenoid.

It is another object to utilize such control over air admission to the cylinder to provide automatic reversal of the advancement of the tool, whereby the hands of the operator may be freed for holding or otherwise guiding the work.

In the progression of a tool through material being worked, uneven impedance to advancement of the tool may be encountered. With substantially constant driving pressure from the powered driving means, such a phenomenon would result in uneven travel of the tool through the work. That is to say, in regions of low tool impedance the tool would move ahead rapidly, and upon encountering high impedance would be brought to a sudden virtual stop, which might result in strain to the machinery or in unsatisfactory finished work.

It is an object of this invention to obviate any such difficulty as above by the provision of stabilizing means coupled to the powered driving means whereby substantially constant tool velocity may be maintained regardless of varying impedance encountered.

In the present invention such a stabilizing means comprises a viscous fluid damper, which applies a damping force to the driving means increasing rapidly with increased velocity of the driving means, thereby tending to stabilize the velocity of the driving means.

Another object of the invention is to provide an arrangement in which the above described stabilizing means or damper may be coupled to the driving means at a variable, predetermined point in the tool advancing movement of the driving means, thereby permitting relatively rapid movement of the tool to the surface of the work, and relatively slow, stabilized movement of the tool while it operates upon the work.

As the tool operates upon the work, it is desirable to intermittently and momentarily lift the tool from the work. This not only aids in cooling the tool, but also breaks up cut-away material into short, easily disposable shavings of lessened danger to personnel.

Accordingly, it is an object of this invention to provide means, preferably including an electrical circuit, for controlling the valve of this invention whereby the tool is intermittently and momentarily lifted from its operation upon the work.

For employment in the above mentioned electrical control circuit there is provided a readily accessible limit switch, the setting of which may be altered to give variable control of the limiting position at which it is desired that the tool should be automatically withdrawn completely from the work.

Under certain circumstances it is desirable that longitudinal movement of the tool be controlled manually, without use of the powered driving means of this invention.

To this end, it is an object to provide a simple and effective clutch whereby the driving means may be quickly de-coupled from the machine spindle control shaft.

Many machine tools now in use, particularly drill presses, employ control shafts of different diameters. To render the apparatus of this invention adaptable to many standard drill presses, it is an object to provide means for adapting the output member of the driving means of this invention to fit numerous different diameters of drill press spindle control shafts. In the embodiment to be described such adapting means comprises bushings of various sizes to fit various sizes of spindle control shafts.

To further aid in cooling the tool during its operation upon the work, and to disperse small shavings, it is an object of this invention to provide a flow of air around the tool. This object is adroitly accomplished in the instant invention by the employment of discharge air from the driving cylinder, carried to the vicinity of the tool through a suitable conduit.

Inasmuch as the assembly of this invention is adapted for mounting on a wide range of types of machines, it is an object of this invention to provide pliant mounting means whereby the assembly will automatically, within relatively narrow limits, adjust itself to mounting on any given machine. This pliant mounting means in the instant invention comprises judiciously disposed, cylindrical, resilient bushings interposed between the assembly and the drill press proper.

It is a further object to eliminate bulky and expensive conduit fittings between a fluid cylinder and its control valve by fabricating the valve as an auxiliary cylinder integral with the power cylinder, said cylinders having a common wall with fluid ports therethrough.

This invention possesses many other advantages and has other objects which may be made more easily apparent from a consideration of one embodiment of the invention. For this purpose there is shown in the drawings accompanying and forming part of the present specification, a form of this invention exemplified as applied to a drill press having a spindle which controls the longitudinal position of a drill bit with respect to the work into which the bit is designed to penetrate. This form will now be described in detail, illustrating the general principles of the invention. It is to be understood that, while exemplified in apparatus applied to a drill press, the teachings of this invention are similarly applicable to many types of machines and machine tools; therefore this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a side elevation of a drill press with the powered driving apparatus of the present invention mounted thereon;

Figure 2 is a sectional elevational view taken along line 2—2 of Figure 1, showing a portion of the mounting means for securing the apparatus of this invention to a drill press;

Figure 3 is a sectional view taken along line 3—3 of Figure 4, showing the driving cylinder and piston, together with the rack and pinion connection to the clutch shown in Figures 4, 5 and 6;

Figure 4 is a sectional view taken on line 4—4 of Figures 1 and 3, showing particularly the clutch arrangement and related gearing assembly through which motion of the driving means is transmitted to the conventional spindle control shaft of the drill press;

Figure 5 is an elevational view taken along line 5—5 of Figure 4, showing the clutch control handles positioned for powered operation of the drill, i. e., for clutch engagement;

Figure 6 is an elevation partially sectioned, taken along line 6—6 in Figure 5;

Figure 7 is a section along line 7—7 of Figure 3;

Figure 8 is a sectional view taken along line 8—8 of Figure 7, showing the air valve actuated to bit-advancing position;

Figure 9 is a fragmentary sectional view showing part of the valve of Figure 8 disposed in a position attained momentarily during transfer from bit-advancing to bit-withdrawing position;

Figure 10 is an enlarged sectional view of the valve of Figure 8, with the parts shown in bit-withdrawing position;

Figure 11 is a section taken on line 11—11 of Figure 10, showing the lever through which movement of the solenoid plunger is transmitted to the valve;

Figure 12 is a section taken on line 12—12 of Figure 7, showing the viscous fluid damping or stabilizing means;

Figure 13 is a circuit diagram illustrating the electrical control means of the apparatus;

Figure 14 is a view along line 14—14 in Figure 4, showing the limit switch which may be mounted on the housing of the coupling means shown in Figure 4;

Figure 15 is an enlarged sectional view taken on line 15—15 of Figure 14 and includes portions of the housing shown in Figure 4; and

Figure 16 is a view taken along line 16—16 of Figure 15.

Referring now specifically to Figure 1, there is shown a conventional form of drill press 10, having an upright standard 11, a drill rotating motor 12, and a drill bit 13. Bit 13 is raised and lowered in accordance with the angular position of rotatable spindle control shaft 14 controlled by handle 15, which latter may form a portion of the control apparatus of this invention.

Mounted on the conventional drill press thus far described is the air-powered driving means 16 of this invention, including a cylinder 17 having end plates 18 and 19, to which is secured a clutch housing 20, the latter being mounted over spindle control shaft 14. A suitable source 21 of air under pressure is connected through pipe 22 to a valve 23 preferably formed as a unitary structure with cylinder 17 and utilizing end plates 18 and 19.

Air from source 21, applied selectively through valve 23 to cylinder 17, serves to reciprocate a rack 24 coupled through gearing and clutch means in housing 20 to shaft 14, thereby raising and lowering drill bit 13. Air exhausted from cylinder 17 returns through valve 23 to outlet pipes 25 forming a common duct at 26 leading to a hole in bit guide 27 affixed above the work 28. In this manner, an intermittent flow of air is discharged against the rotating bit 13 during operation thereof.

The several portions of the assembly thus far described generally will now be fully described in detail.

The driving means 16 including cylinder 17 is mounted on the standard 11, as shown in Figure 2. Clamping means 29, including a spliit ring 29a and a clamping bolt 30, serve to anchor adjustably on standard 11 a clamp 31, which in turn supports cylinder 17, by the engagement of clamp 31 with bolt 32, one of the bolts which serves to hold together end plates 18 and 19. Of the remaining three bolts 33, 34 and 35, bolts 33 and 35, situated respectively at the top and bottom of cylinder 17, continue forwardly of plate 18 and serve to strengthen the apparatus through connection with housing 20.

Referring particularly to Figure 3 showing the driving means 16 and housing 20, it will be seen that the right hand end of rack 24 constitutes a piston rod to which is attached, within cylinder 17, a piston 36 having a piston ring 37 forming an air-tight, slidable seal between piston 36 and the inside wall of cylinder 17, and preferably in the form of a toroid of elastic material such as oil resistant synthetic rubber. As is known in the art, ring 37 is free to roll slightly in annular groove 38 in the edge of piston 36. In so doing it stretches, thereby forming a good air seal between piston 36 and the inside of the wall of cylinder 17.

Inasmuch as driving means 16 is mounted on one portion of drill press 10 and housing 20 is mounted on another portion thereof, it is desirable to provide that the mounting and other connections between driving means 16 and housing 20 shall be pliant within small limits. To this end the engagement of rack 24 with piston 36, and the port 39 through which rack 24 emerges from cylinder 17 include pliant mounting means. Such a mounting means is shown, for example, at end 40 of rod 33, in the form of a sleeve 41 of resilient material, such as oil resistant synthetic rubber, interposed between end 40 and opening 42 in housing 20 in which end 40 is received. The pliant mounting means includes, in addition to resilient sleeve 41, inner and outer metal sleeves 43 and 44, respectively. Similar pliant mounting means are provided at 45 on extended bolt 35, and at 46 where rack 24 is attached to piston 36; also around port 39 where rack 24 emerges from cylinder 17 through end plate 18. It will be noted that end plate 18 at port 39 includes a groove 47 and elastic ring 48 functioning in the manner described for groove 38 and elastic ring 37 of piston 36.

Teeth 49 of rack 24 co-act with pinion 50 mounted on shaft 51 journaled in housing 20, being held thereagainst by a saddle shaped roller 52 (Figure 4) mounted on shaft 53 likewise journaled in housing 20.

To transmit reciprocation of the rack 24, impelled by air-powered driving means 16, to spindle control shaft 14, a gear 54 also mounted on shaft 51 meshes with a gear 55 journaled coaxially around shaft 14 and coupled thereto through a clutch 56 to be presently described in connection with Figure 4. Extreme forward movement of piston 36 necessitates the inclusion of a hollow boss 57 on housing 20 for the reception of the end of rack 24.

Clutch 56 is shown in detail in Figure 4, which also illustrates the manner in which housing 20 is mounted on shaft 14.

To accommodate the apparatus of this invention to spindle control shafts of various diameters, a bushing 58 is provided, which is secured to shaft 14 by means of set screw 59. Mounted on bushing 58 and secured thereto by a set screw 60, is a sleeve 61 having an annular shoulder 62 at one end thereof. On the other end of sleeve 61 from shoulder 62 is mounted, by means of set screw 63 and threads 64, a collar 65 from which extends a control handle 15. The outer surface of sleeve 61 constitutes a bearing surface on which is rotatably mounted a sleeve 67 preferably formed integral with gear 55. It will be noted that sleeve 67 extends axially a short distance beyond housing 20, where it contacts a collar 68 interposed between collar 65 and sleeve 67 and having also a handle 69 extending therefrom. Collar 68 is mounted on sleeve 61 so as to be axially and angularly slidable thereon.

Reviewing the assembly thus far described, it will be seen that sleeve 67, oscillating in accordance with reciprocation of rack 24 through the coaction of gears 50, 54 and 55, imparts this oscillation to shaft 14 through sleeve 61, and bushing 58, by selective coupling of sleeve 61 with sleeve 67. Such coupling is accomplished through collars 65 and 68 as will be explained in connection with Figure 5.

Selective axial pressure between collars 65 and 68 is effected by the action of a ball 70 (Figures 5 and 6) contained in an axial hole 71 in collar 65 and biased against the surface of collar 68 by a spring 72 held in position by an inset screw 73. To relieve pressure on ball 70 against collar 68, a hemispherical recess 74 is provided in which ball 70 may seat when a predetermined angular relation exists between collars 65 and 68.

When handles 15 and 69 are juxtaposed, ball 70 register with recess 74 thereby relieving pressure between collars 65 and 68, and shaft 14 is free to turn relative to sleeve 67. Upon relative angular separation of handles 15 and 69, as shown in Figure 6, ball 70 is moved from recess 74, whereupon the pressure of spring 72 against ball 70 and of ball 70 against collar 68 presses collar 68 against sleeve 67, and sleeve 67 against shoulder 62. The frictional engagement thus provided between shoulder 62 of sleeve 61 and sleeve 67, and between the end of sleeve 67 and collar 68 serves to clutch sleeve 61 to sleeve 67, whereby movement of rack 24 is imparted to shaft 14. If desired, a pair of pressure-producing means consisting of the assembly 70, 71, 72, 73 and 74 may be provided as shown in Figure 5, diametrically disposed in collar 65.

Handles 15 and 69, when together, signify "Manual" operating position, in which driving means 16 is completely de-coupled from the drill press. Handles 15 and 69, when separated, as shown in Figures 5 and 6, signify the "Powered" operating position, in which longitudinal movement of drill bit 13 is controlled by driving means 16.

The manner in which air under pressure is admitted from pipe 22 through valve 23 selectively to either side of piston 36 in order to advance or withdraw bit 13 from work 28 will now be described. Referring to Figures 7, 8, 9 and 10, valve 23 is shown comprising a valve cylinder 75 in which reciprocates a valve shaft 76 extending externally forward of cylinder 75. Mounted on valve shaft 76 near each end of cylinder 75 are valve pistons 77 and 78. Surrounding shaft 76 intermediate pistons 77 and 78, and slidable with respect to cylinder 75 and shaft 76, is a valve sleeve 79 riding in inset portion 80 of cylinder 75.

Air from pipe 22 enters cylinder 75 at inlet port 81 and emerges therefrom at either outlet port 82 or outlet port 83, each of which communicates, respectively, with an end of cylinder 17 forming part of driving means 16. Whether air entering valve 23 through port 81 will emerge from port 83 to advance piston 36, or from port 82 to withdraw piston 36, is determined by the position of pistons 77 and 78 mounted on shaft 76. In Figure 8 valve 23 is shown in bit-advancing position, wherein air passes from inlet port 81 through an axial groove 84 in valve sleeve 79, to an axial groove 85 in portion 80 of cylinder 75, into the body of valve 23, and thence out port 83 and into the right hand end of cylinder 17, thereby advancing piston 36. With the advancement of piston 36 in cylinder 17, air emerges from cylinder 17 through port 82, into the body of valve cylinder 75, and out exhaust port 86 to exhaust pipe 26, through which it is conveyed to bit guide 27 (Figure 1) where it cools bit 13 and disperses small shavings.

When valve 23 is in bit-withdrawing position (as shown in Figure 10) a converse flow of air occurs. Air enters at port 81, flows through axial groove 84 into the left hand body portion of cylinder 75, and out port 82, into cylinder 17, causing piston 36 to withdraw. In a similar manner exhaust air passes from cylinder 17, through port 83, into cylinder 75, and out exhaust port 87 into exhaust pipe 25—26.

To determine the setting of valve 23, shaft 76 is manually reciprocated by means of a knob 88. In order that sleeve 79 may move with shaft 76 upon manual reciprocation of the latter, helical springs 89 and 90 disposed around shaft 76 bracket sleeve 79, being biased thereagainst by collars 91 and 92, respectively. The limited movement of sleeve 79 with respect to shaft 76 permitted by the use of springs 89 and 90 is for a purpose to be described in connection with the electrical operation of valve 23 through a solenoid 93, which contrasts with mechanical operation of the valve through shaft 76 and knob 88.

From the above it will be seen that reciprocation of shaft 76, by determining the position of pistons 77 and 78 in cylinder 75, determines the direction of air-impelled movement of piston 36 in cylinder 17.

Egress of air from cylinder 17 through valve 23 may be controlled, if desired, by means of needle valves 94 and 95 located in exhaust pipe 26 immediately adjacent outlet ports 86 and 87, respectively.

To provide limiting means for automatically reversing the direction of travel of piston 36 when a variable, predetermined point in the advance of bit 13 has been reached, an arm 96 (Figures 7 and 8) is mounted on rack 24 extending downwardly therefrom toward shaft 76. Arm 96 is bifurcated at 97 (Figure 7) to encompass shaft 76, the sides of which are flattened as shown at 98 for coaction with the inside surface of bifurcation 97, thereby preventing rotation of shaft 76 while permitting longitudinal movement thereof with respect to arm 96. Arm 96 actuates shaft 76 during bit-advancing movement of the former through the mediacy of a disc 99 (Figure 8) slidable on shaft 76 and backed by a spring 100 bearing against a collar 101 threadedly mounted on shaft 76 for axial adjustment thereon. Collar 101 is fixedly mounted on one end of a tube 103 telescoped over the end of shaft 76. On the other end of tube 103 is attached the knob 88. Tube 103 has a series of axial grooves 104 on its outer surface coacting with any suitable detent mechanism 105 held in tube bearing housing 106. Bearing housing 106 is mounted on the bottom of housing 20, as shown in Figures 4 and 1.

From the above it will be seen that shaft 76 may be reciprocated in cylinder 75 and in bearing housing 106 either manually through knob 88, or automatically, by pressure of arm 96 against collar 101 through spring 100 and disc 99. Furthermore, the axial position on shaft 76 of collar 101 and associated spring 100 and disc 99, may be altered by rotation of tube 103 through knob 88; detent mechanism 105 coacts with grooves 104 to prevent accidental rotation of tube 103, for example by vibration, while still permitting unimpeded longitudinal movement of tube 103 in bearing housing 106.

The provision of spring 100 (and associated disc 99) is to insure that sufficient energy will be available to actuate valve 23 fully and abruptly from bit-advancing position (Figure 8) to bit-withdrawing position (Figure 10), without the intervention of an indecisive period during which neither port 82 nor 83 is open. That is to say, arm 96 advancing along shaft 76 and contacting collar 101 would, in the absence of spring 100, produce slow actuation of valve 23, and might thereby introduce a stalemate in which neither port 82 nor 83 would be open, thereby stopping further movement of piston 36, rack 24, and, of course, arm 96.

Cooperating with spring 100 to produce rapid actuation of valve 23, is a spring biased detent 107 mounted transversely in shaft 76 and coacting with a circumferential groove 108 on the inner surface of cylinder 75. As arm 96 carried on rack 24 advances, it first contacts disc 99 and then begins to compress spring 100. When a predetermined force on collar 101 has been produced by arm 96 through spring 100, detent 107 is pulled abruptly from groove 108, and shaft 76 is actuated fully to bit-withdrawing position by virtue of the energy stored in spring 100.

The limiting point in the advancement of bit 13 at which arm 96 actuates shaft 76 to reverse bit movement is determined by the longitudinal position of collar 101 (and spring 100 and disc 99), which is in turn determined by the rotative setting of knob 88. Thus, by angular adjustment of knob 88, the opertaor may adjust the limiting bit-advanced position of bit 13. An alternative limiting means is available for use with the electrical control of driving means 16, to be described in connection with Figures 13 through 16.

In the mechanical control and actuation of valve 23 thus far described, sleeve 79 responds as though fixed to shaft 76. This response is brought about by the provision of springs 89 and 90, sleeve 79 being sufficiently light with respect to valve shaft assembly 76, 77, 78 and 103 that springs 89 and 90 remain substantially unflexed.

To provide for electrical actuation of valve 23, in which full movement of the assembly of shaft 76 is aided by the very flow of air which valve 23 controls, a solenoid 93 is mounted below cylinder 75. On plunger 109 of solenoid 93 is pivotally arranged a lever 110, pivotally mounted near its midpoint on a shaft 111 journaled in the housing of valve 23. A knob-like portion 112 on lever 110 extends into cylinder 75 and coacts with a slot 113 cut in sleeve 79 (see Figure 11).

It will thus be seen that oscillation of lever 110 by solenoid 93 reciprocates sleeve 79 on shaft 76 and within cylinder 75. It is to permit such relatively limited reciprocation of sleeve 79 on shaft 76 that springs 89 and 90 are provided.

In connection with the electrical operation of valve 23 through solenoid 93, shaft 76 is notched as shown at 114 and 115. These notches provide, in connection with an internal annular groove 116 on sleeve 79 a passage for inlet air from port 81 into the body of cylinder 75 prior to the full reciprocation of sleeve 79 in cylinder 75.

This will be understood by a brief description of the electrical operation of valve 23 from its bit-advancing position to its bit-withdrawing position. Such operation shifts valve shaft 76 from the position shown in Figure 8, through that shown in Figure 9, to the position shown in Figure 10.

Let it be imagined that solenoid 93 has been energized to retract plunger 109; the resulting counterclockwise rotation of lever 110 pushes sleeve 79 to the left in Figure 8 against the bias of spring 89. Referring to Figure 9, lever 110 has moved sleeve 79 until groove 116 in the sleeve has broken communication with axial groove 85 and is just beginning to register with notch 114 in shaft 76. At this point air under pressure from inlet port 81 flows into axial groove 84, around annular groove 116, into notch 114, and thence into the left hand end of cylinder 75, where it produces pressure against piston 77, moving shaft 76 to the bit-withdrawing position, shown in Figure 10. With shaft 76 moved to its extreme left position, air from inlet port 81 flows through valve 23 and into cylinder 17 through port 82, where the pressure produced on the left hand face of piston 36 initiates its bit-withdrawing movement. It is preferred to design the valve so that groove 116 breaks communication with groove 85 before making communication with notch 114, thereby precluding having air pressure simultaneously against both pistons 77 and 78.

The small amount of fluid trapped between member 78 and sleeve 79 by the interruption of communication between groove 116 and groove 85 does not exert sufficient pressure to prevent movement of the valve assembly to the left in response to the inlet pressure acting on the member 77, it being noted that sleeve 79 is allowed limited movement independently of members 77 and 78 since the sleeve floats on rod 76 between springs 89 and 90.

It will thus be seen that sleeve 79 provides a means whereby valve 23 may be made virtually self-actuating insofar as movement of the relatively heavy assembly associated with shaft 76 is concerned. That is to say, the relatively light force produced by solenoid 93 acting through sleeve 79 opens a passage to piston 77, thereby utilizing piston 77 as a valve actuating means as well as a valve opening means. It will be understood that in solenoid actuation of the valve from bit-withdrawing to bit-advancing position, notch 115 fulfills the same function as above described for notch 114.

With solenoid 93 so completely de-energized, lever 110 is free to oscillate with movement of sleeve 79 produced by mechanical reciprocation of shaft 76.

While mechanical control of valve 23 has previously been described, it now remains to describe electrical control thereof by the circuit of Figure 13 acting through solenoid 93. Before this is done, however, there will be described a velocity responsive, viscous fluid means serving to stabilize advancement of piston 36 as bit 13 encounters varying resistance to advancement.

The stabilizing means 117 of this invention comprises a cylinder 118 filled with viscous fluid preferably mounted below cylinder 17 and disposed symmetrically with respect to cylinder 75 of valve 23. The stabilizer 117 is best seen by reference to Figure 12 which is a view taken along line 12—12 of Figure 7. In Figure 12, cylinder 118 is shown mounted below cylinder 17 and utilizing end plates 18 and 19 to close the ends thereof. A shaft 119 is arranged to reciprocate in cylinder 118 and extends externally forward thereof to receive telescoped tube 120. The assembly associated with tube 120 is physically identical with that shown in connection with tube 103, except for the omission of spring 100 and disc 99; and further description thereof is deemed unnecessary, except for the operaton to be explained hereinafter.

Slidably mounted on shaft 119 near the end thereof is a piston 121 which is free to reciprocate on shaft 119 between a pin 122 and a valve member 123 both fixedly attached to shaft 119. Valve member 123 is in the form of a collar having an annular sealing portion 124 which serves, when pressed against piston 121, to close an axial passage 125 in the latter. Flow of the damping fluid impelled by piston 121 is through a pipe 126 paralleling cylinder 118 and connecting the ends thereof through ports 127 and 128. In the fluid circuit 127, 126, 128, thus described, are disposed needle valves 129 and 130, the setting of which determines the degree of damping provided by stabilizer 117. Fluid passage 125 in piston 121, mentioned hereinbefore, cooperates with collar 123 to provide in effect a unidirectional check valve, whereby stabilizer 117 acts as a damper during bit-advancing movement of shaft 119 but is rendered ineffective during bit-withdrawing movement of shaft 119 by the free passage of fluid through passage 125.

Stabilizer 117 is coupled to driving means 16 through an arm 131 suitably mounted on rack 24 (Figures 7 and 12). Physically, arm 131, with its bifurcated end 132, is identical to arm 96, which serves to couple driving means 16 to valve 23 as hereinbefore described. The symmetry of these members with respect to rack 24 is evident from Figure 7. This symmetry extends to the adjustability of tube 120 on shaft 119, the functions of which correspond exactly to those of tube 103 and shaft 76, respectively.

It will be noted that collar 133 mounted adjustably on shaft 119, is shown spaced from collar 134, also mounted adjustably on shaft 119, thus allowing a region of lost motion in which stabilizer 117 is not coupled to driving means 16. The purpose of this lost motion is to provide means whereby the initial portion of the bit-advancing movement of driving means 16 is free from the damping effect of the viscous fluid in cylinder 118. In this way rapid progression of bit 13 to its entrance into work 28 may be provided, at which point arm 131 encounters collar 133 and thereby couples stabilizer 117 to driving means 16.

A brief description of the operation of stabilizer 117 will serve to clarify the functions of the parts thus far described. With piston 36 advancing by virtue of pressure applied thereto through valve 23, rack 24 rapidly progresses until arm 131 contacts collar 133 and, through shaft 119, pulls collar 123 firmly against piston 121. At this point further progression of piston 36 is resisted by the viscous fluid in cylinder 118, which must be forced out of cylinder 118 through port 127, needle valve 129, pipe 126, needle valve 130, and port 128, back into cylinder 118. The viscous nature of the fluid in cylinder 118 appreciably impedes further movement of piston 36 so that continued advancement thereof proceeds at a much slower rate than previously. Such retarded and stabilized progression continues until valve 23 is operated, either by mechanical control (arm 96, shaft 76) or electrical control (solenoid 93, sleeve 79), or manually (knob 88, shaft 76), to the bit-withdrawing position, whereupon pressure on piston 36 is reversed, reversing its movement.

The bit-withdrawing movement of piston 36 proceeds rapidly, in the course of which arm 131 encounters collar 134 and pushes shaft 119 back to its starting position. During the bit-withdrawing motion of shaft 119, little impedance is encountered because of the opening of passage 125 occurring upon withdrawal of collar 123 from engagement with piston 121.

The stabilizing character of stabilizer 117 is attributable to the velocity responsive nature of the impedance offered to forward movement of shaft 119. That is to say, with shaft 119 being drawn forward slowly, the impedance offered by stabilizer 117 is of a relatively nominal value as determined by the setting of needle valves 129 and 130. Should, however, rack 24 tend to accelerate, the impedance offered by stabilizer 117 would rapidly increase with increasing velocity, tending in this manner to stabilize the velocity of movement of driving means 16 at a value dependent largely on the setting of needle valves 129 and 130, and on the air pressure in cylinder 17 as determined by a regulator 135 interposed in line 22 between source 21 and valve 23.

The importance of this function will be readily seen by hypothesizing that work 28 consists of a member which will offer varying resistance as bit 13 advances. Assuming that work 28 initially offers great impedance to advancement of bit 13, piston 36 advances slowly by virtue of the impedance offered by the work and the greater impedance offered by stabilizer 117. When a portion of lowered impedance is encountered in work 28, the tendency of bit 13 to accelerate is resisted by the viscous fluid in stabilizer 117. Conversely, when a portion of increased impedance is encountered in work 28, the tendency of bit 13 to decelerate is compensated by decreased impedance in stabilizer 117, resulting from lowering velocity. Inasmuch as the impedance offered by stabilizer 117 may be made large in proportion to the maximum impedance to be encountered in work 28, the stabilized velocity of advancement of piston 36 may be made substantially independent of the character of work 28. The integral, unitary fabrication of power cylinder 17 and stabilizer cylinder 118 simplified greatly the problem of coupling stabilizer shaft 119 to rack 24.

Electrical control of valve 23 through solenoid 93, and the control of a complete work cycle made possible thereby will now be described.

Referring to Figure 13, the electrical control circuit is shown, including the above described lever 110 actuated by plunger 109 of solenoid 93, which is preferably of the dual-actuation type having coils 136 and 137. Energization of coil 136 pushes out plunger 109 (toward the left); energization of coil 137 retracts plunger 109 (toward the right). Energizing current for coils 136 and 137 is applied through a double throw switch 138 actuated by an arm 139 pivoted at 140 and operated by pressure against roller 141 in a manner to be described hereinafter in connection with the intermittent bit-withdrawal feature of this invention. Energization of coil 136 causes plunger 109 to push lever 110, thereby sliding sleeve 79 to the right to operate valve 23 to the bit-advancing position (Figure 8); energization of coil 137 causes plunger 109 to pull lever 110, thereby sliding sleeve 79 to the left to operate valve 23 to the bit-withdrawing position (Figure 10). Energy is applied to arm 139 through front contact 142 of a relay 143 energized from a suitable source of power 144. Coil 145 of relay 143 is customarily energized through push button start switch 146. Relay 143 holds itself closed through a circuit including normally closed stop switch 147 and limit switch 148, the latter to be described more particularly in connection with Figures 14, 15, and 16.

Inasmuch as a continuous drilling operation not only produces long shavings which, when metal, are dangerous to personnel, but also causes the bit to heat dangerously; it is desirable to intermittently withdraw bit 13 from work 28 for brief intervals. To this end the circuit of Figure 13 includes an electric motor 149 energized through front contact 142 of relay 143 and driving a disc 150 on which are mounted a plurality of cams 151 pivoted at 152 and adjustable in slots 153. Clockwise rotation of disc 150 by motor 149 causes cams 151 to intermittently and momentarily bear against roller 141, shifting arm 139 and switching double throw switch 138 from its position energizing coil 136 to the position wherein coil 137 is energized. In this manner valve 23 is maintained for the greater portion of the time in bit-advancing position (coil 136 energized); but is momentarily reversed to bit-withdrawing position as cams 151 intermittently engage roller 141 and actuate switch 138 to energize coil 137. The percentage time during which bit 13 is being withdrawn in this intermittent operation is determined by the adjustment of cams 151 in slots 153. For most operations it is satisfactory that bit 13 be lifted only slightly before re-insertion in work 28 and in this case cams 151 are adjusted for only short contact with roller 141. The rate at which the momentary withdrawing of bit 13 occurs is determined by the speed of motor 149 which may be made variable at will. Electrical control without the intermittent bit-withdrawal above described is effected simply by opening switch 170 in the circuit of motor 149.

During electric control of the drilling operation, master switch 154 is closed. Momentary closing of start button switch 146 energizes relay 143 which holds itself closed through circuit 147, 148. The energy thus applied to switch 138 energizes coil 136, whereupon plunger 109 pushes lever 110 to the bit-advancing position as illustrated in Figure 7. Simultaneously rotation of disc 150 is begun. Piston 36 advances steadily until one of the cams 151 bears against roller 141 causing switch 138 to energize coil 137. This abruptly shifts valve 23 to the bit-withdrawing position, and piston 36 reverses its motion withdrawing bit 13 from work 28. When roller 141 drops from cam 151, switch 138 returns to the bit-advancing position, energizing coil 136, which position it retains until another cam 151 actuates roller 141. In this manner, drilled shavings being forced from work 28 are broken into short lengths which are less dangerous to personnel, and at the same time bit 13 is allowed to cool momentarily.

When the desired predetermined limit of forward travel of the bit 13 has been attained (independent of the setting of collar 101, which, during electrical operation, is fully retracted from arm 96), limit switch 148 (Figures 14, 15, and 16) is opened, de-energizing relay 143. De-energization of relay 143 causes energization of coil 137 through back contact 155 and circuit 156, actuating sleeve 79 and operating valve 23 to the bit-withdrawing position.

In parallel with push-button start switch 146 may be connected a foot switch 157 which is preferably of the double throw type, whereby through selective use of switches 158 or 159 the circuit may be either opened or closed upon pressing on foot switch 157.

Limit switch 148, described above in connection with the electrical circuit of Figure 13 will now be described in detail with reference to Figures 14, 15 and 16.

Actuation of limit switch 148 is preferably effected through shaft 51 (Figure 15) journaled in housing 20 and in which gears 50 and 54 are mounted. On the side of housing 20 opposite control handles 15 and 69 is mounted a small housing 160, in the outer wall 161 of which is journaled, coaxially with shaft 51, a shaft 162. Mounted on the inner end of shaft 162 is a microswitch 163 having a reciprocable pin 164 extending therefrom. Inward movement of pin 164 serves to open microswitch 163. Pin 164 is spaced radially from the rotative axis of microswitch 163 a distance equal to the radial displacement of a small button 165 in the end of shaft 51 (Figures 15 and 16). It will thus be seen that when shafts 51 and 162 are in a predetermined angular relation, and only when they are in this angular relation, pin 164 will be depressed by button 165, thereby opening microswitch 163.

The angular position of microswitch 163 is controlled by the setting given a radial finger 166 mounted on the outer end of shaft 162. Continuous, uni-directional rotation of shaft 162 is made possible through the employment of a conventional brush and slip ring assembly shown at 167 by which connections to microswitch 163 are carried externally of housing 160.

In operation, finger 166 is given a desired angular setting as indicated with reference to a dial 168 on wall 161. This determines the angular spacing betwen pin 164 of microswitch 163 and button 165 on shaft 51. When shaft 51 has rotated through this angular spacing, button 165 depresses pin 164, opening microswitch 163 and de-energizing relay 143 (Figure 13). In this manner the limiting bit-advanced position is determined through the electrical control rather than through the mechanical control of arm 96 acting on collar 101 as shown in Figure 7.

Use and operation of the powered driving apparatus for controlling the longitudinal position of bit 13 will now be described in detail.

The apparatus is applied to drill press 10 with driving means 16 (Figure 1) anchored to standard 11 by cooperative clamp members 29 and 31 (Figure 2). A bushing 58 (Figures 3 and 4) of proper internal diameter to fit snugly on shaft 14 of drill press 10 is selected and anchored to shaft 14 by set screw 159. Sleeve 61 is slipped over bushing 58 and anchored thereto by set screw 60, thereby providing support for housing 20 of the apparatus. In this manner each end of the apparatus, 16 and 20, is supported on drill press 10. Any slight discrepancy in the mounting is absorbed in the pliant mounting means at ends 40 and 45 of rods 33 and 35, respectively.

With the apparatus securely mounted to drill press 10, three types of operation are possible: manual, mechanically controlled power, or electrically controlled power.

For manual operation, it is necessary only to juxtapose handles 15 and 69 from their positions shown in Figures 4, 5 and 6, thus causing balls 70 to seat in recesses 74. This relieves pressure on sleeve 67 and allows shaft 14 to be manually turned by juxtaposed actuation of handles 15 and 69. Sleeve 67 and the remainder of the power driven assembly are effectually de-coupled from shaft 14 during this operation, and the operator controls press 10 as though the apparatus of this invention were not present.

Powered operation, mechanically controlled, will now be described. Switch 154 (Figure 13) is opened, thereby allowing plunger 109 (Figures 8 and 10) to reciprocate loosely in solenoid 93 and offer no impedance to free oscillation of lever 110 about shaft 111. Under this condition sleeve 79 is functionally an integral part of shaft 76, being retained relatively fixedly thereon by springs 89 and 90.

It will be assumed that a sufficient number of identical operations are to be performed to justify setting up the power speed feature effectuated through employment of stabilizer 117. Clutch 56 (Figure 4) is engaged by separating handles 15 and 69, causing sleeve 67 and collar 68 to be frictionally clamped between shoulder 62 and collar 65. Valve 23 is actuated to the bit-advancing position by pushing on knob 88 (Figure 8). This done, bit 13 advances relatively rapidly passing through guide 27, the speed of advance being controlled by regulator 135.

Knob 169 (Figure 12) is turned, advancing collar 133 until it abuts arm 131, establishing coupling between stabilizer 117 and driving means 16 just before the bit engages work 28. Further bit-advancing movement of rack 24 quickly takes up the slack between piston 121 and collar 123, and from then on advancement of rack 24 is stabilized, or dampened, by stabilizer 117. Thus the bit 13 penetrates work 28 relatively slowly, the advancement thereof being impeded and stabilized by stabilizer 117.

When bit 13 has advanced far enough into work 28, for example after passing through work 28, knob 88 is turned, advancing disc 99 (Figure 8) until it engages arm 96 and spring 100 is compressed sufficiently so that upon release of knob 88 shaft 76 will be actuated by spring 100 to the bit-withdrawing position against the restraining action of pin 107.

With stabilizer 117 and valve 23 thus properly set by knobs 169 and 88, respectively, repetitive operation on identical work pieces 28 may proceed, being mechanically controlled automatically. That is to say, a work piece 28 is inserted beneath bit guide 27 (Figure 1). By means of knob 88 shaft 76 is pushed in, actuating valve 23 to the bit-advancing position (Figure 8), applying air through pipe 22, inlet port 81, axial groove 84, axial groove 85, outlet port 83, into cylinder 17, where it pushes against piston 36. Relatively rapid, unimpeded advance of rack 24, and consequent advancement of bit 13, then takes place until arm 131 (Figure 12) abuts collar 133 and begins to push shaft 119 causing collar 123 to close passage 125 in piston 121. This point having been predetermined (as illustrated above) as the point at which bit 13 enters work 28, the actual drilling operation is carried on under the stabilizing influence of stabilizer 117. That is to say, rack 24 being coupled through arm 131 to shaft 119 of stabilizer 117, advancement of rack 24 is impeded and stabilized by the damping action of piston 121 being pulled forward in cylinder 118. The degree of damping, or stabilizing, is determined by the setting of needle valves 129 and 130, which control the external flow of viscous damping fluid from one end of cylinder 118 to the other through pipe 126.

During the advance of piston 36, exhaust air emerges from cylinder 17 through ports 82 and 86, and valve 94, into pipe 26, from which it exhausts to the atmosphere around bit 13, thereby cooling the bit and dispersing drilled-out shavings which have been lifted to the surface of work 28 by bit 13.

Stabilized advance of bit 13 proceeds until the predetermined limit is reached. At this point, arm 96 (Figure 8) abuts disc 99 and compresses spring 100 sufficiently to pull shaft 76 to the bit-withdrawing position, i. e., to the left, overcoming the restraining action of pin 107. By virtue of the energy stored in spring 100, shaft 76 is moved abruptly and completely from its extreme right hand position (bit-advancing) to its extreme left hand position (bit-withdrawing). When this occurs air pressure formerly applied through port 83 to advance piston 36 is applied through inlet port 81, groove 84, and port 82 to the other side of piston 36 (Figure 10) thereby commencing withdrawal of bit 13.

During bit-withdrawal movement of piston 36, exhaust air passes through ports 83 and 87 and needle valve 95 into pipe 26, thereby continuing the shaving dispersing action in guide 27. Bit-withdrawal movement of rack 24 causes, in effect, de-coupling of stabilizer 117 from driving means 16 (Figure 12), by virtue of the departure of arm 131 from collar 133 as rack 24 withdraws. Upon abutment of arm 131 against collar 134, shaft 119 is returned to its starting position, this operation being undamped because of the opening of passage 125 through withdrawal of collar 123 from piston 121. When piston 36 (Figure 8) has reached end wall 19 of cylinder 17, driving means 16 has returned to its original position, being held there by the pressure of air against the left hand side of piston 36.

Work piece 28 may then be removed and another, identical operation performed by placing another work piece 28 beneath guide 27 and pushing in on knob 88 as described above.

For situations where repetitive identical work operations are not to be performed, it may be desirable to manually advance bit 13 to the surface of work 28 and allow powered driving means 16 to assume control at that point. For this operation, handles 15 and 69 are juxtaposed, thereby disengaging clutch 56 and de-coupling driving means 16 from bit 13. The two handles, 15 and 69, are then manually turned until bit 13 touches the surface of work 28. The handles are then angularly separated, causing engagement of clutch 56; and knob 88 is pushed in, instituting powered advancement of bit 13. Automatic reversal of bit 13 is accomplished through actuation of valve 23 by arm 96 in the manner heretofore described and at the setting predetermined as described above.

For the partially manual-partially powered operation described above, stabilizer 117 may be employed or not as desired, or alternatively may be coupled to driving means 16 at any point in the movement of bit 13. If it is desired to employ stabilizer 117 during the entire powered advance of bit 13, knob 169 is turned until arm 131 is clamped between collars 133 and 134. With this setting, stabilizer 117 is continuously coupled to driving means 16, there being no lost motion connection between arm 131 and shaft 119.

Powered operation, electrically controlled, will now be described.

Knob 88 is turned so that disc 99 is withdrawn completely from the travel span of arm 96. This removes any possibility of mechanical reversal of valve 23 by arm 96, leaving that function to limit switch 148.

Stabilizer 117 is employed in the same manner as described in connection with mechanical control, and may or may not be coupled to driving means 16, as desired.

As in the case of mechanical control of driving means 16, described above, it is advisable to employ the electrical control only when a reasonably large number of identical operations are to be performed by bit 13.

To set the electrical control for the predetermined desired operation, switch 154 (Figure 13) is closed, energizing coil 137 of solenoid 93 through back contact 155 of relay 143. This moves lever 110 to the position shown in Figure 10 and causes complete withdrawal of piston 36, and hence of bit 13, if not already completely withdrawn. One of the switches 146 or 157 is momentarily closed, energizing coil 145 of relay 143 which holds itself closed through the circuit including front contact 142 and switches 147 and 148. Closing of contact 142 allows power to be applied to coil 136 of solenoid 93 through switch 138, thereby actuating valve 23 to the bit-advancing position (Figure 7). As bit 13 advances, coupling of stabilizer 117 to rack 24 is accomplished in the same manner as described above in connection with mechanical control of powered operation. When bit 13 has penetrated the desired depth in sample work piece 28, finger 166 of switch 148 (Figure 15) is manually rotated until pin 164 engages button 165, which engagement opens microswitch 163, de-energizing relay 143, back contact 155 of which causes energization of coil 137 of solenoid 93, thus initiating withdrawal of bit 13.

The settings of stabilizer coupling knob 169 and of limit switch 148 having been thus properly determined, automatic, repetitive working of similar work pieces 28 is accomplished as follows:

A work piece 28 is inserted under bit guide 27, and switch 146 is momentarily closed. The resulting energization of relay 143 causes energization of motor 149, which rotates disc 150. For the greater portion of rotation of disc 150, switch arm 139 is in position energizing coil 136 of solenoid 93. This rotates lever 110 clockwise (Figure 8), in turn pushing sleeve 79 to the right against the bias of spring 90. As the right hand edge of groove 116 in sleeve 79 passes the left hand edge of notch 115 in shaft 76, air from pipe 22 flows through inlet port 81, slot 84, ground groove 116, into notch 115, and thence into the right hand portion of cylinder 75 where presses against piston 78. At this point the air pressure assumes control of the actuation of valve 23 and pushes piston 78 to the right, the valve quickly assuming the position illustrated in Figure 8. It is thus seen that by providing sleeve 79 in valve 23, low power actuation (through solenoid 93) sets in motion a more powerful force (represented by the compressed air) which completes actuation of valve 23.

With valve 23 in the position shown in Figure 8, air from pipe 22 flows through inlet port 81, slot 84 in sleeve 79, groove 85 in valve body 80, and thence into the right hand portion of cylinder 75. From there it enters driving cylinder 17 through port 83 and pushes against piston 36, thereby initiating bit-advancing movement of driving means 16.

Bit-advancing movement thus commenced proceeds relatively rapidly until arm 131 (Figure 12) engages collar 133, thereby coupling stabilizer 117 to driving means 16, as fully described above in connection with mechanical control. Stabilized, or damped, bit advancement continues until shaft 51 (Figures 5 and 4) has turned sufficiently to bring button 165 into engagement with pin 164 on micro-switch 163. At this point switching means 148 (Figures 13 and 15) is opened, de-energizing coil 145, and opening relay 143. This transfers energization from coil 136 of solenoid 93 to coil 137, thereby rotating lever 110 (Figures 9 and 10) counterclockwise. As sleeve 79 is pushed to the left by lever 110 (Figure 9), the left hand edge of groove 116 overlaps the right hand edge of notch 114 in shaft 76. At this point air pressure from source 21 assumes control by entering cylinder 75 through port 81, slot 84, groove 116, and notch 114, where it bears against piston 77 pushing shaft 76 to its extreme left position as shown in Figure 10.

Air is thus cut off from port 83 and admitted to port 82, reversing air pressure on piston 36 and instituting bit-withdrawal movement of driving means 16. Withdrawal movement continues until piston 36 is stopped by wall 19 of cylinder 17.

Meantime, piston 36 has been momentarily and intermittently jerked from work 28 by the action of disc 150, as follows: During electrical control of bit-advancing movement, it will be recalled that front contact 142 of relay 143 is energized. This energizes motor 149 causing disc 150 to rotate at a substantially constant speed. During the major portion of each revolution of disc 150 roller 141 on arm 139 is unrestrained, causing the bias inherent in arm 139 to effect electrical contact with the left hand side of switch 138, thereby energizing coil 136 (the bit-advancing coil) of solenoid 93.

As disc 150 rotates, one of the cams 151 is brought into contact with roller 141, causing switch arm 139 to transfer energization from the left to the right in switch 138, thereby energizing coil 137 (the bit-withdrawing coil) of solenoid 93. Thus, for the duration of engagement between roller 141 and cam 151, valve 23 is thrown to the bit-withdrawing position (Figure 10).

Inasmuch as roller 141 engages cam 151 only during a minor portion of a complete revolution of disc 150, it will be seen that the action produced is that of normally advancing bit 13, but intermittently and momentarily withdrawing it in its progress through work 28. This action breaks up the shavings drilled out by bit 13, which results in a cooler running bit due to less friction created by the short chips, allowing it to cool during this operation; and the shorter chips do not form as neat an obstruction to cutting oils and thereby allow more oil to enter the work.

Should operation without the intermittent withdrawal feature be desired, switch 170 is opened, care being taken to leave roller 141 free of cams 151 so that switch 138 is thrown to energize coil 136.

I claim:

1. Fluid actuated apparatus for a machine having a movable member, comprising: a power cylinder having a port near each end thereof; a piston movable in said cylinder; a shaft attached to said piston, extending outside said cylinder, and operatively arranged to actuate said movable member; a valve cylinder having an outlet port near each end thereof as well as an exhaust port, and an inlet port, each said outlet port being connected respectively to a corresponding port of said power cylinder, said inlet port being disposed intermediate said outlet ports, and being adapted for connection with a source of fluid under pressure; a valve piston operable in said valve cylinder to control passage of fluid from said inlet port to said outlet ports respectively, and between said outlet ports and said exhaust ports respectively; a valve shaft attached to said valve piston, and extending outside said valve cylinder to a region near said machine for operation by the shaft attached to said piston; a valve sleeve slidable in said valve cylinder to control application of fluid from said inlet port to said piston for effecting operation of said piston in said valve cylinder; and means effective to slide said sleeve in said valve cylinder.

2. Fluid actuated apparatus for a machine having a movable member, comprising: a power cylinder having a port near each end thereof; a piston movable in said cylinder; a shaft attached to said piston, extending outside said cylinder, and operatively arranged to actuate said movable member; a valve cylinder having an outlet port near each end thereof as well as an exhaust port, and an inlet port, each of said outlet ports being connected respectively to a corresponding port of said power cylinder, said inlet port being disposed intermediate said outlet ports, and being adapted for connection with a source of fluid under pressure; a valve piston operable in said valve cylinder to control passage of fluid from said inlet port to said outlet ports respectively, and between said outlet ports and said exhaust ports respectively; a valve shaft attached to said valve piston, and extending outside said valve cylinder for operation by the shaft attached to said piston; and auxiliary valve means in said valve cylinder effective to control application of fluid to said valve piston for moving said piston.

3. A valve comprising a cylinder having an outlet port, an inlet port spaced longitudinally with respect to said outlet port, and an axial passage in the inner surface of said cylinder, located intermediate said ports; a piston fitting transversely in said cylinder and slideable axially therein; a shaft attached to said piston and extending axially outside said cylinder, a sleeve disposed around said shaft in said cylinder and generally opposite said inlet port, slidable longitudinally with respect to said cylinder and to said shaft, and having a passage therein effective to register with said axial passage; and means ef-

fective to reciprocate said sleeve within said cylinder.

4. A valve comprising a cylinder having outlet port near each end thereof, an inlet port intermediate said outlet ports, and an axial passage in the inner surface of said cylinder, located intermediate said outlet ports; an axial shaft in said cylinder extending outside thereof; pistons mounted on said shaft, one near each outlet port; a sleeve disposed around said shaft in said cylinder and generally opposite said inlet port, slidable longitudinally with respect to said cylinder and to said shaft, and having a passage therein effective to register with said axial passage; a spring engaging said shaft and said sleeve effective to bias said sleeve to a predetermined position on said shaft; and means effective to reciprocate said sleeve within said cylinder.

5. Fluid actuated apparatus for a machine having a movable member, comprising: a power cylinder having a port near each end thereof; a piston movable in said cylinder; a shaft attached to said piston, extending outside said cylinder, and operatively arranged to actuate said movable member; a valve cylinder having an outlet port near each end thereof as well as an exhaust port, and an inlet port, each of said outlet ports being connected respectively to a corresponding port of said power cylinder, said inlet port being disposed intermediate said outlet ports, and being adapted for connection with a source of fluid under pressure; a valve piston operable in said valve cylinder to control passage of fluid from said inlet port to said outlet ports respectively, and between said outlet ports and said exhaust ports respectively; a valve sleeve slidable in said valve cylinder to control application of fluid from said inlet port to said valve piston for effecting operation of said piston in said valve cylinder; and means effective to slide said sleeve in said valve cylinder.

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