Aug. 18, 1942. E. J. HIRVONEN 2,293,059

HYDRAULIC DRILLING MACHINE

Filed Oct. 28, 1938 3 Sheets-Sheet 1

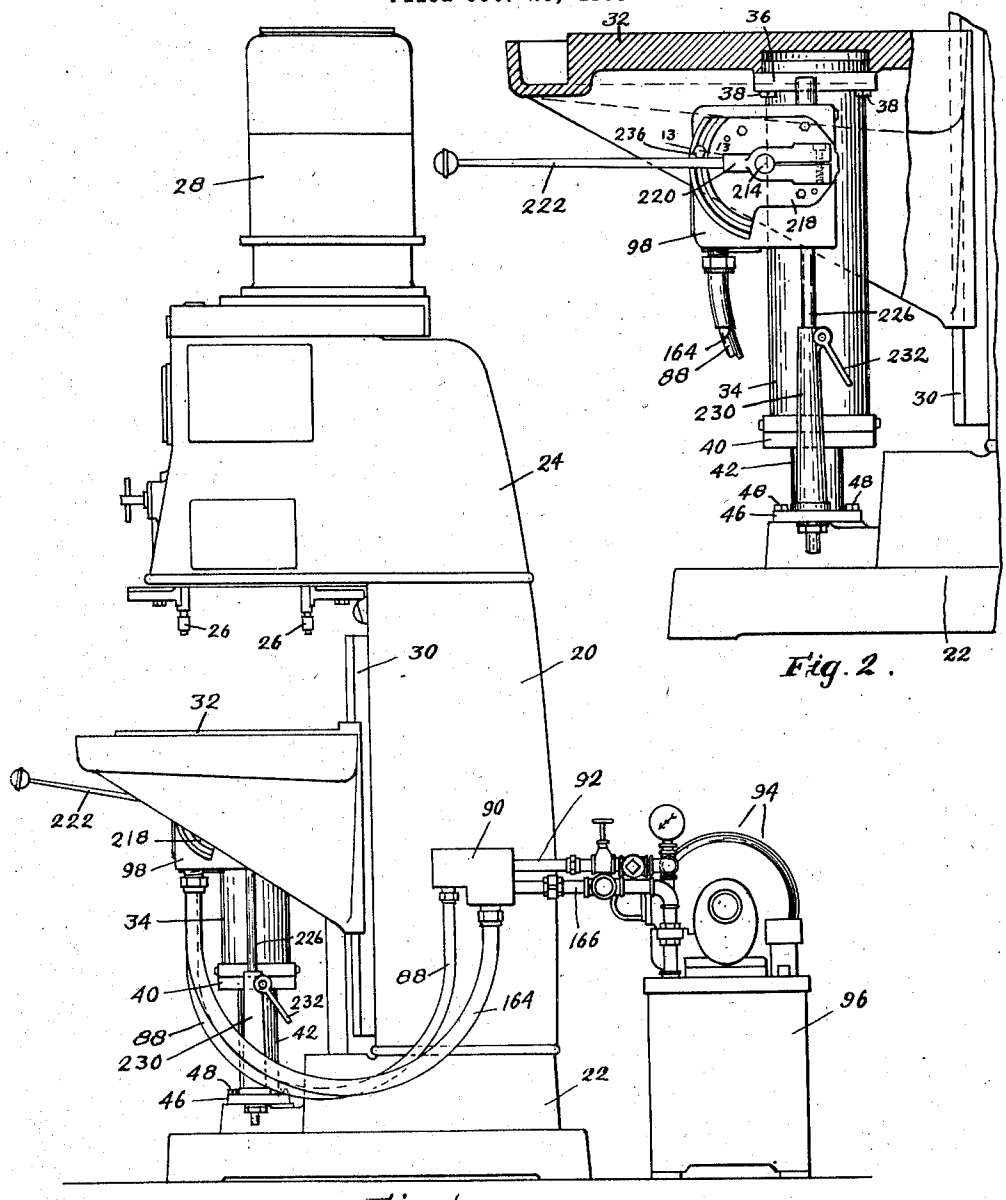


Fig. 2.

Fig. 1.

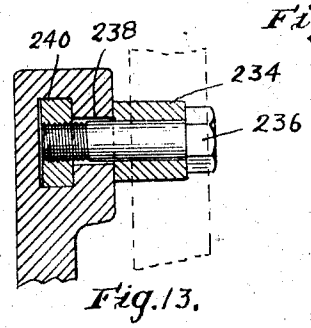


Fig. 13.

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HYDRAULIC DRILLING MACHINE

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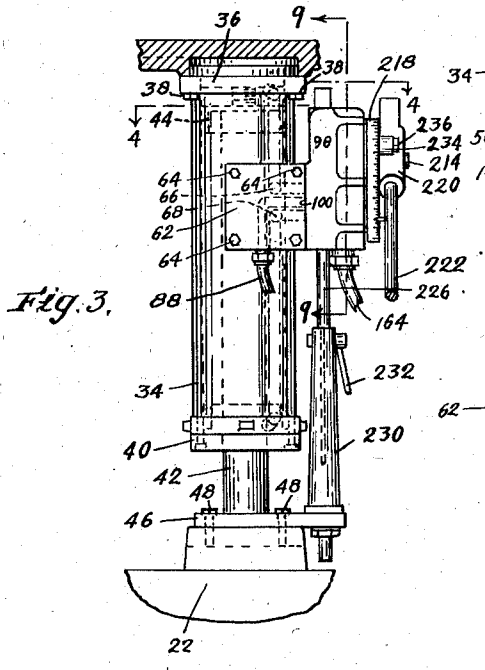


Fig. 3.

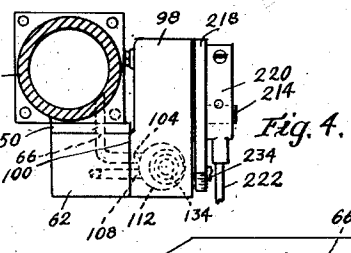


Fig. 4.

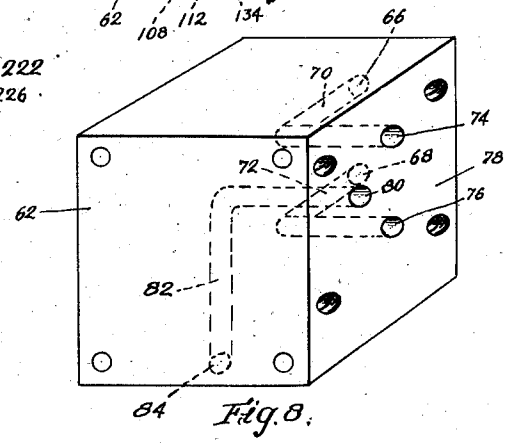


Fig. 8.

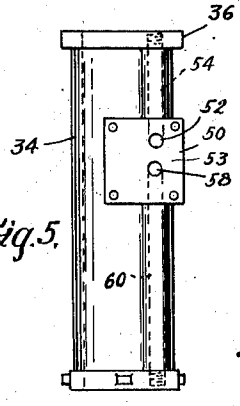


Fig. 5.

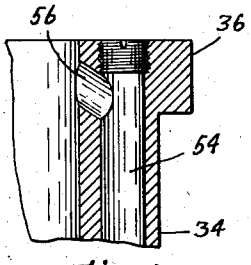


Fig. 7.

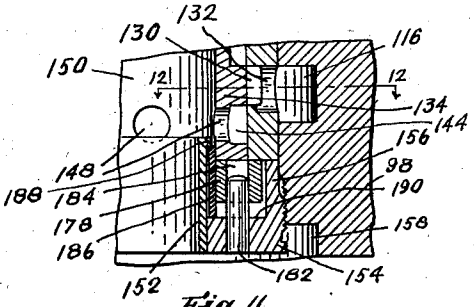


Fig. 11.

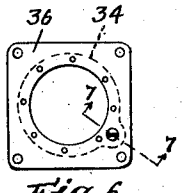


Fig. 6.

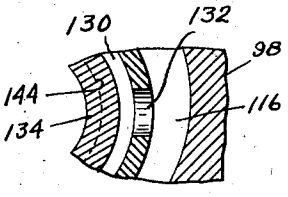


Fig. 12.

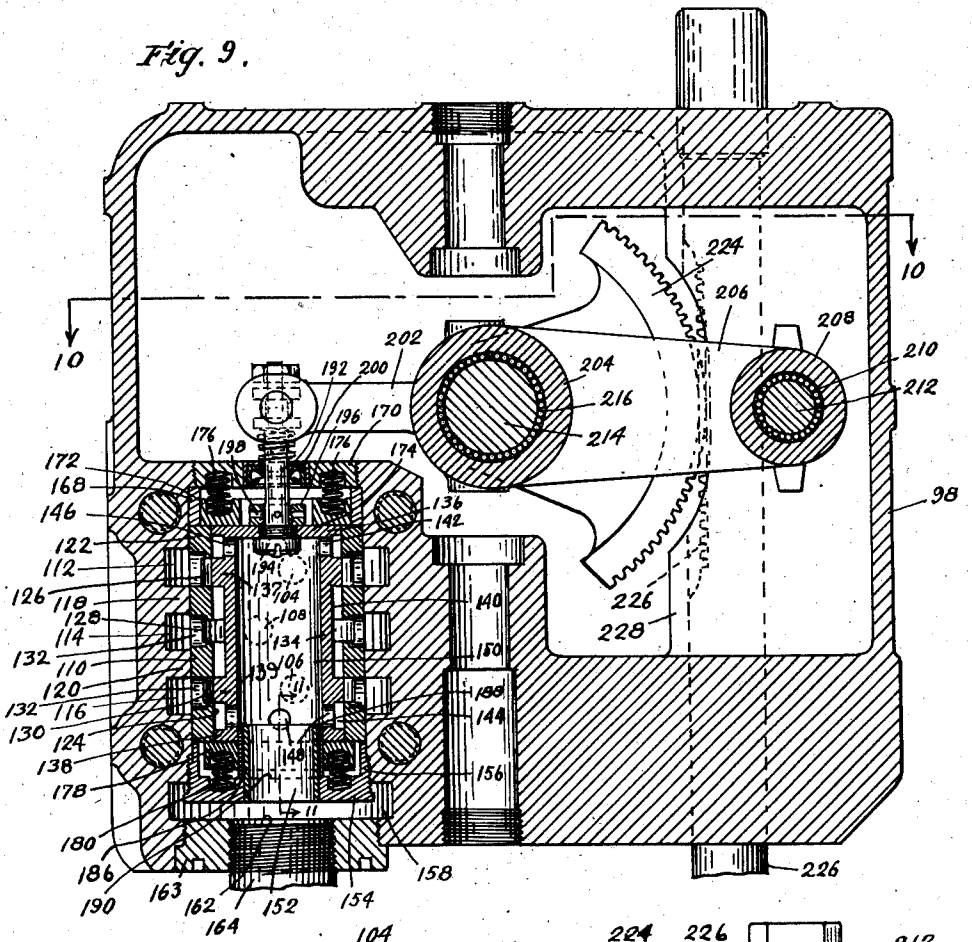
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Fig. 9.



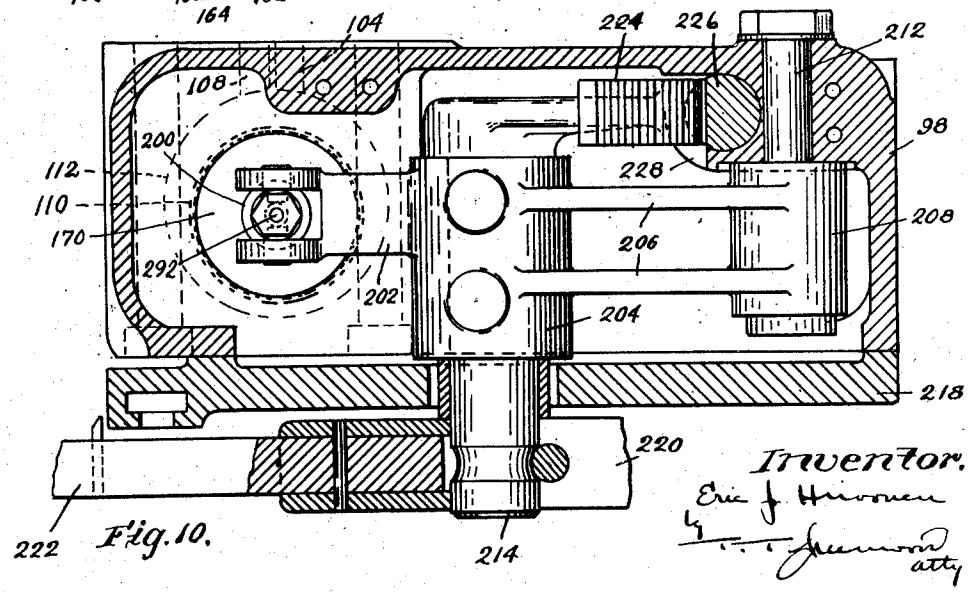


Fig. 10.

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Patented Aug. 18, 1942 2,293,059

UNITED STATES PATENT OFFICE

2,293,059

HYDRAULIC DRILLING MACHINE

Eric J. Hirvonen, Worcester, Mass., assignor to Leland-Gifford Company, Worcester, Mass., a corporation of Massachusetts

Application October 28, 1938, Serial No. 237,510

27 Claims. (Cl. 77—32)

This invention relates to hydraulic drilling machines and has particular reference to a hydraulic drilling machine capable of being operated in many respects like a mechanical sensitive drill.

In a sensitive drilling machine of the purely mechanical type the drill and the work are fed together by the manual operation of a lever which, usually, controls the advance and retraction of the drill.

One of the advantages of the sensitive drilling machine is that the action of the drill on the work can be felt or sensed by the operator by means of the pressure required to force the drill into the work and hence the operation of the machine can be governed by the feel of the drill as gained through the operating handle. The rate of drilling is governed by the rate at which the operator moves the lever and the rate is changed by changing the rate of movement of the lever.

One of the objects of the present invention is the provision of a drilling machine where the work and the drill or tool are brought into cutting engagement by hydraulic power mechanism under control of an operating handle in such manner that the machine can be operated in many respects like a sensitive drilling machine of the mechanical type.

Another object of the invention is the provision of a drilling machine where the drill and the work are brought into cutting engagement by hydraulic power mechanism under control of an operating handle, the movement of the work and drill toward and away from each other being accomplished by movements of the handle in opposite directions and the rate of movement being governed by the rate of movement of the handle.

A further object of the invention is the provision of a drilling machine of the type above outlined where increased pressure on the operating handle is required to effect an increase in the cutting rate of the tool.

A yet further object of the invention is the provision of a hydraulically-operated manually-controlled drilling machine that is capable of automatic operation.

Another object is generally to improve the construction and operation of hydraulically operated drilling machines.

The mechanism herein described and claimed is also described in my copending application Serial No. 348,389, filed July 30, 1940.

Fig. 1 is a side elevation of a hydraulically operated drilling machine embodying the present invention.

Fig. 2 is a side elevation of the hydraulic cylinder and piston and control mechanism of Fig. 1, part of the movable work supporting table being broken away.

Fig. 3 is a front elevation of the mechanism of Fig. 2.

Fig. 4 is a plan view of the mechanism of Fig. 2 taken along line 4—4 of Fig. 3.

Fig. 5 is a side elevation of the hydraulic cylinder of Fig. 3 with the control mechanism removed.

Fig. 6 is a plan view of the top end of the cylinder of Fig. 5.

Fig. 7 is a sectional detail taken along line 7—7 of Fig. 6 illustrating the construction of the oil passage to the end of the cylinder.

Fig. 8 is a perspective and more or less diagrammatic view of the block connecting the manually controlled valve mechanism with the hydraulic cylinder and particularly illustrating the oil passages therein.

Fig. 9 is an enlarged sectional detail of the control mechanism taken along line 9—9 of Fig. 3.

Fig. 10 is a section of the control mechanism taken along line 10—10 of Fig. 9.

Fig. 11 is an enlarged sectional detail taken along line 11—11 of Fig. 9.

Fig. 12 is a sectional detail taken along line 12—12 of Fig. 11.

Fig. 13 is a sectional detail of the adjustable stop mechanism for the handle taken along line 13—13 of Fig. 2.

The invention is herein illustrated as embodied in the multiple spindle drilling machine comprising the vertical column 20 supported on the base 22 and carrying a drill head 24 provided with a plurality of drill spindles 26 which are adjustable as to positions and are driven by the motor 28. the column 20 is provided with a vertical guideway 30 on which a work supporting table 32 is vertically movable. A hydraulic cylinder 34 is vertically disposed beneath the table and has an outstanding flange 36 at the top by which it is fixed to the under face of the table by bolts 38. The cylinder and the table move vertically as a unit. The lower end of the cylinder is provided with a head 40 containing a packing through which a vertical piston rod 42 is movably extended, the rod having a piston 44 at its upper end, see Fig. 3. The lower end of the piston rod has an outstanding flange 46 fixed rigidly to the base 22 by bolts 48.

The cylinder is provided with a flat vertical pad or flange 50 intermediate its length having an upper port 52 open in its front face 53 which comunicates with an upwardly directed passage 54 in the wall of the cylinder, the passage at its upper end having a side outlet 56 which opens into the top part of the cylinder. The pad also has a lower port 58 in its front face which communicates with a fluid passage 60 similar to the passage 54 but extending downwardly and opening into the lower end of the cylinder. A block 62 is secured removably to the face 53 of the pad 50 by bolts 64. Said block, see especially Fig. 8, has a rear face provided with ports 66 and 68 which register respectively with the ports 52 and 58 of the cylinder. Said ports 66 and 68 communicate with internal passages 70 and 72 in the block which terminate in vertically disposed upper and lower ports 74 and 76 in the side face 78 of the block. Said side face also has a high pressure oil inlet port 80 disposed intermediate the ports 74 and 76 and forwardly of the vertical line through said ports. Said port 80 communicates with a passage 82 which communicates with a port 84 in the lower face of the block. The port 84 communicates with a flexible high pressure oil pipe 88 the other end of which is secured to a junction box 90 fixed to the side face of the column 20.

Said junction box and high pressure conduit receive high pressure oil through a pipe 92 from a constant speed motor driven gear pump unit 94 which unit is provided with means not necessarily shown to maintain a constant oil outlet pressure irrespective of the demand for oil on the unit. Said unit is mounted upon the top of an oil storage tank 96 into which exhaust or low pressure oil from the system is discharged, as will presently be explained, to be recirculated by the pump. The oil supply apparatus is now well known in the art and is illustrated in my joint patent with Benjamin S. T. Bishop No. 1,905,133, issued April 25, 1933.

A control casing or housing 98, having a side face 100 bolted to the side face 78 of the block 62, carries valve structure and manual operating mechanism therefor for effecting control of the table 32. The face 100 has ports 104 and 106, see Fig. 9, which register with the cylinder ports 74 and 76 respectively of the block 62 and a third port 108 which registers with the high pressure port 80. The ports 104 and 106 thus communicate with the top and bottom of the cylinder respectively while the port 108 communicates with the high pressure oil supply.

The casing 98, see especially Figs. 9 and 10, is provided at one side thereof with a vertical cylindrical bore or passage 110 which is surrounded by vertically spaced annular oil recesses or channels 112, 114, 116, respectively, separated by intervening ribs 118, 120, respectively. The channels 112, 114, 116 communicate respectively with the ports 104, 108, 106. Thus the upper channel 112 communicates with the top of the hydraulic cylinder, the channel 116 with the bottom of the cylinder, and the channel 114 with the high pressure oil inlet.

A cylindrical sleeve or bushing 122, comprising a valve cylinder, is received snugly within the cylindrical passage 110 so that the oil cannot flow directly between the channels 112, 114, and 116. The bushing has an internal cylindrical bore or passage 124 therein and vertically spaced internal grooves or channels 126, 128 and 130, registering with the channels 112, 114, 116, respectively, and communicating respectively therewith through a series of holes 132, drilled or otherwise formed through the wall of the valve cylinder.

A tubular or hollow cylindrical valve member or piston 134 is freely movable within the passage 124 of the bushing and is provided with piston sections 136, and 138 near its ends and intermediate piston sections 137 and 139, respectively, which latter sections in the normal or at rest position of the valve and the machine confront the oil channels 126 and 130 and are axially wide enough to close said channels so that no oil can flow from the high pressure channel 114 through the annular groove 140 between the pistons to either the upper or the lower parts of the cylinder; nor can any oil flow out of these parts of the cylinder. Movement of the valve either upwardly or downwardly, however, places one cylinder port in communication with the high pressure port and the other cylinder port in communication with the exhaust.

Communication with the exhaust is established by annular grooves or channels 142 and 144 located at the upper and lower ends of the valve respectively and above and below the pistons 136, 138 and communicating through drilled holes 146 and 148 respectively with the interior passage 150 of the valve piston. The oil escapes from the interior of the valve through a tube 152 which is fixed in a cover plate 154 having an annular wall 156 that is screw-threaded into the bottom end of the cylinder passage 110 of the casing 98. The exhaust oil flows from the tube 152 into the chamber 158 under the cover plate and thence into an exhaust connection 162 screw-threaded in a plug 163 threaded into the bottom of the passage 110. A flexible pipe 164 connects the exhaust connection 106 with the aforesaid junction box 90 from whence the oil flows through a pipe 166 to the tank 96.

The bushing or valve cylinder 122 is held against axial displacement in the passage 110 by being seated upon the upper end of the side wall 156 of the bottom cover plate 154 and at the upper end by being seated against an annular ring 168 which bears against an internal shoulder of the passage 110 and also upon an upper closure plate 170 which is screw-threaded into the upper end of the passage.

Spring mechanism is provided to maintain the valve piston 134 yieldingly in a normal or mid position thereof where both cylinder ports are closed and the table is locked against movement by reason of confinement of oil in both ends of the operating cylinder; and also to tend to return the valve member to said position when displaced therefrom under control of the operative.

Said spring mechanism includes an upper spring carrying disc or plate 172 which bears upon the top or end wall 174 of the valve piston within the spacer ring 168 and is larger in diameter than the valve member and extends outwardly therebeyond and also bears upon the top end face of the bushing 122. Said disc 172 has a plurality of recesses in its top face in which the lower ends of axially short compression springs 176 are located. The closure plate 170 is provided with similar recesses in which the upper ends of the springs are located. Thus upward movement of the valve member is opposed by the springs 176. A spring carrying disc or plate 178, similar to the disc 172, has recesses containing the upper ends of a plurality of compression springs 180 the lower ends of which are

received in recesses of the closure member 154. The disc 178 bears against the lower face of the valve member and radially outstands said face and also bears against the lower face of the sleeve 122.

With this arrangement the valve piston is normally held in mid or unoperated position as illustrated and movement of the valve in either direction causes the compression of one or another set of springs which tend to return the valve to its initial position. The springs are under substantial initial stress so that their initial pressure has to be overcome to move the valve piston in either direction. The springs are of short axial extent so that their resistance to compression increases rapidly with a shortening of their lengths. The valve piston and cylinder are substantially coextensive in length so that there is no harmful lost motion of the valve piston in shifting its application of pressure from one to the other set of springs under manual operation.

The lower ring 178 is held against relative rotation with respect to the closure member 154 by means of a pin 182, see Fig. 11, carried by the closure member and upstanding loosely within a passage 184 of the ring. The upper disc 172 is similarly held against relative rotation with respect to the cover member 170.

The space between the lower end of the valve member 134 and the interior of the closure member 154 is adapted to form a dash pot chamber containing oil to steady the movements of the valve piston, or the relative movement between the valve and the casing 98 so that the action of the table will be smooth. To this end the exhaust tube 152 extends upwardly within the lower end of the tubular passage in the valve member and is provided with reasonably oil tight sliding engagement therewith preferably by a piston ring 186 bearing against the inner sidewall of the valve member and held against axial movement by the outstanding shoulder 188 of the tube 152 and also by the bottom wall 190 of the closure member 154.

The valve member or piston is moved vertically by a vertical valve rod 192 screw-threaded at its lower end into the end wall 174 of the valve member and having a head 194 which is seated against the inner face of the end wall. A check nut 196 is screw-threaded on the valve stem and bears against the outer face of the end wall. Passages 198 through the stem and nut 196 allow exhaust oil, which is under a slight pressure, to flow into the spring space above the valve member to lubricate the parts and also to dampen the action of the valve.

The valve stem passes movably through a packing gland 200 of the top cover plate 170 and has a connection with an operating arm 202, the connection being such that the arm and stem move up and down together without undue lost motion while permitting changes in the radial length of the arm due to changes in its angular position.

The arm 202 is integral with a hub 204. Said hub on the opposite side of said arm is provided with a pair of arms 206 terminated in a boss 208 journalled by anti-friction rolls 210 to a stud 212 fixed in the end wall of the enclosing casing 98. Thus vertical movements of the lever structure, including the arm 202, the hub 204, and the arms 206, correspondingly move the valve.

The lever structure is moved about the stud 212 by a shaft 214 which extends through and is journalled in the hub 204 by anti-friction rolls 216. The shaft at its outer end passes loosely through the cover plate 218 and has clamped thereon an arm 220. Said arm has an operating handle 222 fixed thereto which extends forwardly under the table 32 to a position in front of the table where it can be readily grasped and operated by an operative. The arm 220 extends on the side of the shaft 214 opposite the handle and is sufficiently weighted to counter-balance the handle so that the handle preferably will stay in any position in which it is placed without movement away from such position.

The other end of the shaft 214 has fixed thereto a gear sector 224 which meshes with the teeth of a vertical rack 226 vertically movable through a boss 228 of the casing 98 or more accurately, the casing 98 is movable vertically over the rack. The rack at its lower end passes into a housing 230, see Figs. 1 and 2, fixed to and upstanding from the base 22 of the machine. The housing is vertically split in a well known manner and can be contracted about the rack 220 by means of the clamping handle 232 so as to hold the rack stationary. So far as the present invention is concerned the rack is held stationary at all times.

The manner of operation is essentially as follows:

If the table is to be moved upwardly the handle is raised upwardly. This causes the gear sector 224 to rotate on the rack 226, the gear sector and the rack constituting a movable pivot for the handle. The upward movement of the handle raises the lever structure about its pivot 212 and consequently raises the valve 134 so that high pressure oil flows from the intermediate high pressure oil channel 114 into the upper channel 112 of the operating cylinder and thence to the top of the cylinder above the stationary piston and consequently forces the table upwardly. At the same time the lower end of the cylinder is placed in communication with the exhaust through the channel 116. Hence the table is caused to be moved upwardly at a rate depending upon the extent of displacement of the valve member, which determines the rate of flow of oil into the upper end of the cylinder and the rate of escape of oil from the lower end of the cylinder.

Since, however, the casing 98 is fixed to the operating cylinder and hence moves upwardly with the table the pivot 210 acts on the lever structure to cause it to fulcrum in a counterclockwise direction about the shaft 214 or in a direction to close the valve 134. Thus if the operating handle were only moved upwardly a slight extent and held in this displaced position the table would move upwardly only until the upward movement of the pivot 212 had caused the valve to reclose. Thus the table tends constantly to close the valve. Hence to effect continuous upward movement of the table the handle must be elevated in a continuous manner. The same action takes place upon downward movement of the table.

Release of the handle causes the instant stoppage of the table due to the resetting of the valve by the table movement and one or another of the sets of springs 176 and 180. The rate of movement of the table is controlled by the rate of movement of the handle since the rate of movement of the table is dependent upon the extent of displacement of the valve member and also since the table tends to close the valve. For any

selected rate of movement of the handle the table movement is such that a selected opening of the valve ports is maintained, the proportions and adjustments of the parts being such that the valve piston and the valve cylinder move at the same speed, one by the handle and the other by the table, to maintain the port opening until the handle speed is changed. Thus the handle for any desired speed of movement of the table must be moved continuously at a rate sufficient to maintain a required displacement of the valve member.

The springs 176 and 180 are intentionally made short so that their resistance to compression increases rapidly as they are compressed. Thus additional effort is required to be exerted on the handle to obtain additional displacement of the valve in either direction. This corresponds to the increased pressure required to be applied to the handle of a mechanical sensitive drill to obtain an increased rate of drilling.

In the actual machine there is no perceptible lost motion, or time interval, between movement of the handle and corresponding movement of the table. The table goes up and down smoothly and instantly with corresponding movements of the handle and stops instantly when the handle movement is stopped. Increased pressure is required to be exerted on the handle to provide increased movement of the table. Increased resistance to table movement by the drills causes increased pressure to be applied to the handle since the table tends to slow down due to the increased resistance of drilling and hence causes the upper set of springs 176 to be compressed further to maintain the speed of the handle and to increase the displacement of the valve member. The compression of the springs also places additional force on the operating handle in a direction to oppose its movement.

The handle is provided with an adjustable stop to limit the upward position of the table. Said stop comprises a sleeve 234, see Fig. 13, on a bolt 236 movable in an arcuate T-groove 238, see also Fig. 2, and screw-threaded into a nut 240 slidable along the base portion of the groove. The stop can be shifted along the groove by backing off the bolt and moving it into the desired position and re-tightening it.

I claim:

1. In a hydraulic drilling machine, a tool holder, a work support, hydraulic mechanism for effecting movement of one of the aforesaid elements relatively to the other, valve mechanism for controlling said hydraulic mechanism, an operating handle for said valve mechanism movable in opposite directions for effecting said relative movement in opposite directions, and control means associated with said valve mechanism, movable element and handle and responsive to movements of said element and handle whereby said movable element is caused to respond hydraulically in direction and speed to the direction and speed of movement of said handle.

2. In a hydraulic drilling machine, a tool holder, a work support, hydraulic means for effecting movement of one of the aforesaid elements relatively to the other element, an operating handle, and control means associated with said handle and with said hydraulic means and movable independently by said handle and said movable element for effecting movement of said movable element at a rate corresponding to the rate of movement of said operating handle and for controlling the forward and rearward movements of said movable element and the stop position thereof as determined by the forward and rearward movement and the stop position of said handle.

3. In a manually-controlled, hydraulically-operated drilling machine, the combination of a tool holder, a work support movable toward and away from said holder, hydraulic means for reciprocating said work support, and an operating handle movable in opposite directions different amounts at different rates of speed and into different positions under the will of the operator for controlling said table, means controlled by said handle for controlling said hydraulic means to effect corresponding action and position of said work support, and means controlled by movement of said work support when said handle is stationary for moving said handle controlled means into position to arrest movement of said work support.

4. In a hydraulic drilling machine, a tool holder, a reciprocable work support, a hydraulic piston and cylinder for reciprocating said support, valve means including a movable element controlling the inlet and outlet of fluid to and from opposite ends of said cylinder, an operating handle controlling said movable element and movable in different directions and different amounts to condition said valve means to effect movement of said table in different directions and different amounts, means associated with said handle and valve means for effecting movement of said work support in a direction corresponding to any selected direction of movement of said handle and at a rate of speed corresponding to the rate of speed of movement of said handle, and means responsive to movement of said work support and responsive to a stationary position of said handle for moving said movable element into a position to arrest movement of said work support.

5. In a hydraulic drilling machine, a tool holder, a work support, hydraulic means for effecting movement of one of the aforesaid elements relatively to the other, valve means controlling the operation of said hydraulic means having a valve member movable with the movable element and a cooperating second valve member, an operating handle movable to move said second valve member in a selected direction, and means responsive to movement of said movable element acting in a direction to move said second valve member in the opposite direction.

6. In a hydraulic drilling machine, a tool holder, a work support, hydraulic means effecting movement of one of the aforesaid elements relatively to the other element, an operating handle, and valve means for said hydraulic means having a movable member provided with connections with said handle and said movable element for movement in opposite directions by said handle and element.

7. In a hydraulic drilling machine, the combination of a tool holder, a work support, hydraulic means for effecting movement of one of the aforesaid elements with respect to the other element, an operating handle, and valve means for controlling said hydraulic means comprising a valve cylinder movable with said movable element and a valve piston movable with said handle, said handle having a shiftable pivotal support which changes its position with change in position of the handle.

8. In a hydraulic drilling machine, a drill holder, a movable work support, hydraulic means

for reciprocating said support toward and away from said tool holder, a fixed member, an operating handle having pivotal engagement with said fixed member, and a cylinder valve controlling said hydraulic means, the cylinder of said valve being connected and movable with said support and the piston of said valve having means connecting the valve piston for movement by said handle and also by said support, said valve having hydraulic connections with said hydraulic means by which movement of said handle effects a movement of said support in the corresponding direction and movement of said valve cylinder in a direction to close the valve, and said valve piston having connections with said movable support tending constantly to effect closing of said valve in response to movements of said support.

9. In a hydraulic drilling machine, a tool holder, a movable work support, hydraulic means for reciprocating said support toward and away from said tool holder, a fixed support, an operating handle having a shiftable pivotal engagement with said fixed support, valve means controlling said hydraulic means including a valve cylinder carried by and movable with said movable work support, a valve piston in said cylinder, a lever operatively connected at one end with said piston and having a pivotal connection at its other end with said movable work support and an intermediate pivotal connection with said handle.

10. In a hydraulic drilling machine, a tool holder, a movable work support, hydraulic means for reciprocating said support toward and away from said tool holder, a fixed support, an operating handle having a shiftable pivotal engagement with said fixed support, valve means controlling said hydraulic means including a valve cylinder carried by and movable with said movable work support, a valve piston in said cylinder, a lever operatively connected at one end with said piston and having a pivotal connection at its other end with said movable work support and an intermediate pivotal connection with said handle, and hydraulic ducts connecting said valve means and hydraulic means by which movement of said operating handle moves said lever and valve piston to open said valve and effects the movement of said movable work support and valve cylinder and lever in a direction tending to close the valve.

11. In a hydraulic drilling machine, a tool holder, a movable work support, hydraulic means for reciprocating said support toward and away from said tool holder, valve means controlling said hydraulic means including a valve cylinder carried by and movable with said support, ducts connecting said valve cylinder and hydraulic means, a piston valve in said cylinder, a fixed support, an operating handle having a shiftable pivotal connection with said fixed support, and a lever having a pivotal connection with said movable support and with said operating handle and an operative connection with said valve piston to move the valve piston in one direction by movement of said handle and in the opposite direction by movement of the movable support.

12. In a hydraulic machine, a tool holder, a movable work support, hydraulic means for reciprocating said support toward and away from said tool holder, valve means having a movable control member controlling said hydraulic means, an operating handle, and connections between said control member and said operating handle and said work support operative to hold said work support stationary in any position of said work support within its range corresponding to any stationary position of said handle within its range of movement.

13. In a hydraulic drilling machine, a tool holder, a movable work support, hydraulic means for reciprocating said support toward and away from said tool holder, valve mechanism controlling said hydraulic means including a movable valve member having a connection with said handle and movable with said handle tending to admit fluid to said hydraulic means in a direction to move said support in opposite directions an amount corresponding to the direction and amount of movement of said handle and having a connection with said support and movable with said support in a direction tending to arrest the flow of hydraulic fluid.

14. In a hydraulic drilling machine, a tool holder, a vertically movable work support, hydraulic means for reciprocating said support toward and away from said tool holder, a fixed vertical rack, an operating handle having gear teeth meshing with said rack and valve mechanism controlling said hydraulic means including a valve cylinder carried by said work support and a piston valve, and a lever having an operative connection with said valve piston and pivotal connections with said handle and with said work support.

15. In a hydraulic drilling machine, a tool holder, a vertically movable work support, hydraulic means for reciprocating said work support toward and away from said tool holder, valve mechanism controlling the operation of said hydraulic means including a valve cylinder carried by said work support, a valve piston movable in said cylinder, a lever having an operative connection at one end with said valve piston and at its other end having a pivotal connection with said work support, a fixed vertical rack, and an operating handle having a pivotal connection with said lever, and gear teeth meshing with said rack.

16. In a hydraulic drilling machine, a tool holder, a work support, hydraulic means for moving one of the aforesaid elements relatively to the other element, valve mechanism controlling said hydraulic means including a valve cylinder carried by and movable with said movable element, a valve piston movable in said cylinder, an operating handle, connections between said handle and piston responsive to movement of said handle to secure opening movement of said piston, and connections between said piston and movable element responsive to movement of said movable element to secure closing movement of said piston.

17. In a hydraulic drilling machine, a tool holder, a work support, hydraulic means for moving one of the aforesaid elements relatively to the other element, control means for said hydraulic means including an operating handle movable in opposite directions the position of which determines the position of said movable element and the rate of movement of which in both of its opposite directions of movement determines the rate of movement of said movable element in the corresponding directions, and means yieldingly opposing the movement of said handle with increased effort for increased rate of movement of said handle in any direction.

18. In a hydraulic drilling machine, a tool holder, a work support, hydraulic means for

moving one of the aforesaid elements relatively to the other element, control means for said hydraulic means including an operating handle movable in opposite directions the position of which determines the position of said movable element and the rate of movement of which in both of its opposite directions of movement determines the rate of movement of said movable element in the corresponding directions, and means yieldingly opposing the movement of said handle with increased effort for increased rate of movement of said handle, said last named means including oppositely disposed springs yieldingly opposing movement of the handle in opposite directions, said springs being of short axial length and acting with increased effort on said handle for increased change of length of the springs.

19. In a hydraulic drilling machine, a tool holder, a work support, hydraulic means for moving one of the aforesaid elements relatively to the other element, a fixed support, an operating handle pivoted on said fixed support, valve mechanism controlling said hydraulic means including a valve cylinder carried by said movable element, a valve piston in said cylinder connected with said handle and also with said movable element for movement by both, and oppositely acting springs acting on said valve piston tending to hold it in a predetermined position against displacement in opposite directions.

20. In a hydraulic drilling machine, a tool holder, a work support, hydraulic means for moving one of the aforesaid elements relatively to the other element in opposite directions, an operating handle movable in opposite directions, valve mechanism controlling said hydraulic means including a valve cylinder, a valve piston in said cylinder connected with said handle for movement in opposite directions thereby, and springs acting on opposite sides of said piston to maintain it yieldingly in a predetermined position against displacement in opposite directions.

21. In a hydraulic drilling machine, a tool holder, a work support, hydraulic means including a cylinder and piston for moving one of the aforesaid elements relatively to the other element in opposite directions, a fixed support, an operating handle movable in opposite directions having pivotal engagement with said fixed support, valve mechanism controlling said hydraulic means including a valve cylinder movable with said movable element and having ports controlling the flow of fluid to and from opposite ends of said hydraulic cylinder, a valve piston in said cylinder having a connection with said handle for movement in opposite directions thereby, and spring means acting in opposite directions on said valve piston to yieldingly maintain said valve piston in a port closing position against displacement in opposite directions.

22. In a hydraulic drilling machine, a tool holder, a work support, hydraulic means including a piston and cylinder for moving one of the aforesaid elements relatively to the other element in opposite directions, a fixed support, an operating handle movable in opposite directions having a pivotal connection with said fixed support, and valve mechanism controlling said hydraulic means including a valve cylinder movable with said movable element and having ports communicating with opposite ends of said hydraulic cylinder, a pressure fluid inlet port and an exhaust port, a piston valve in said cylinder arranged to control both hydraulic cylinder ports simultaneously, said valve piston having an operative connection with said handle for movement in opposite directions thereby, a plate at each end of said piston and cylinder abutted against the ends of both, and spring means acting on said plates and operative to maintain said plates yieldingly in the aforesaid position to maintain said valve piston yieldingly in cylinder port closing position against displacement therefrom in opposite directions.

23. In a hydraulic drilling machine, a tool holder, a work support, hydraulic means including a cylinder and piston for moving one of the aforesaid elements relatively to the other element, a pivoted operating handle, and valve mechanism controlling said hydraulic means including cooperating valve elements controlling the flow of fluid to and from said hydraulic cylinder, means for moving one of said valve elements both by said handle and by said movable element, and means for moving the other valve element by said movable element alone.

24. In a hydraulic drilling machine, a tool holder, a work support, hydraulic means for moving one of the aforesaid elements relatively to the other element, a pivoted operating handle, valve mechanism controlled by operation of said hydraulic means including a cooperating valve cylinder and valve piston, one being movable by said handle and the other by said movable element, and means cooperating with the ends of said valve cylinder and piston forming dash pots controlling the movements of said valve cylinder and piston.

25. In a hydraulic drilling machine, a tool holder, a vertically movable work support, a hydraulic cylinder fixed to said work support, a stationary piston in said cylinder, a control housing carried by said work support and cylinder having a valve cylinder therein provided with ports communicating respectively with the upper and lower ends of said hydraulic cylinder, a valve piston in said valve cylinder, a lever having a connection with said valve piston and a pivotal connection with said housing, a fixed vertical rack, an operating handle having a pivotal connection with said lever and a gear tooth connection with said rack, and spring means opposing displacement of said lever and valve piston in opposite directions.

26. In a hydraulic drilling machine, a tool holder, a work support, means including a hydraulic cylinder and piston for effecting movement of one of the aforesaid elements relatively to the other element, a hydraulic circulatory system associated with said cylinder and piston for admitting fluid into and out of opposite ends of the cylinder for moving said movable element in opposite directions, an operating handle, valve means including a movable valve member having a connection with and movable under control of said handle operative to admit fluid into a selected end of said cylinder and the escape of fluid from the opposite end of the cylinder to effect movement of said movable element in a selected direction, said movable valve member also having a connection with and movable under control of said movable element in a direction tending to oppose such admission and escape of fluid.

27. In a hydraulic drilling machine, a tool holder, a movable work support, a hydraulic motor for moving said work support toward and away from said tool holder, an actuating mem-

ber arranged for different amounts of movement away from a neutral position to effect corresponding amounts of movement of said work support, a valve controlling operation of said motor and having a movable valve member displaceable from a neutral position to secure operation of said motor, means responsive to the movement of said actuating member for maintaining said valve member in displaced motor-operating position, and means responsive to the cessation of movement of said actuating member for moving said movable valve member to neutral motor-unoperative position.

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