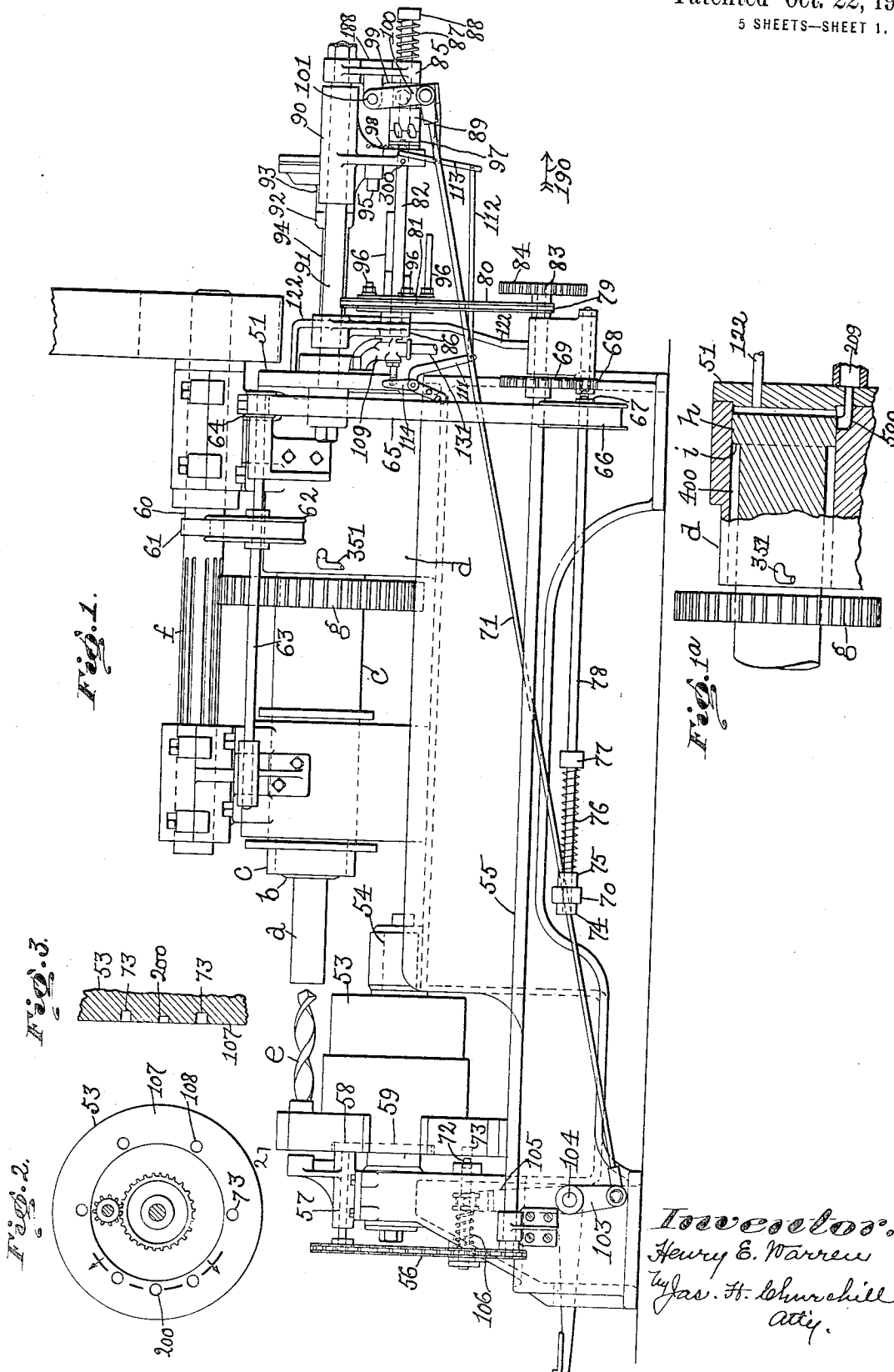


1,282,152.

Patented Oct. 22, 1918.
 5 SHEETS—SHEET 1.



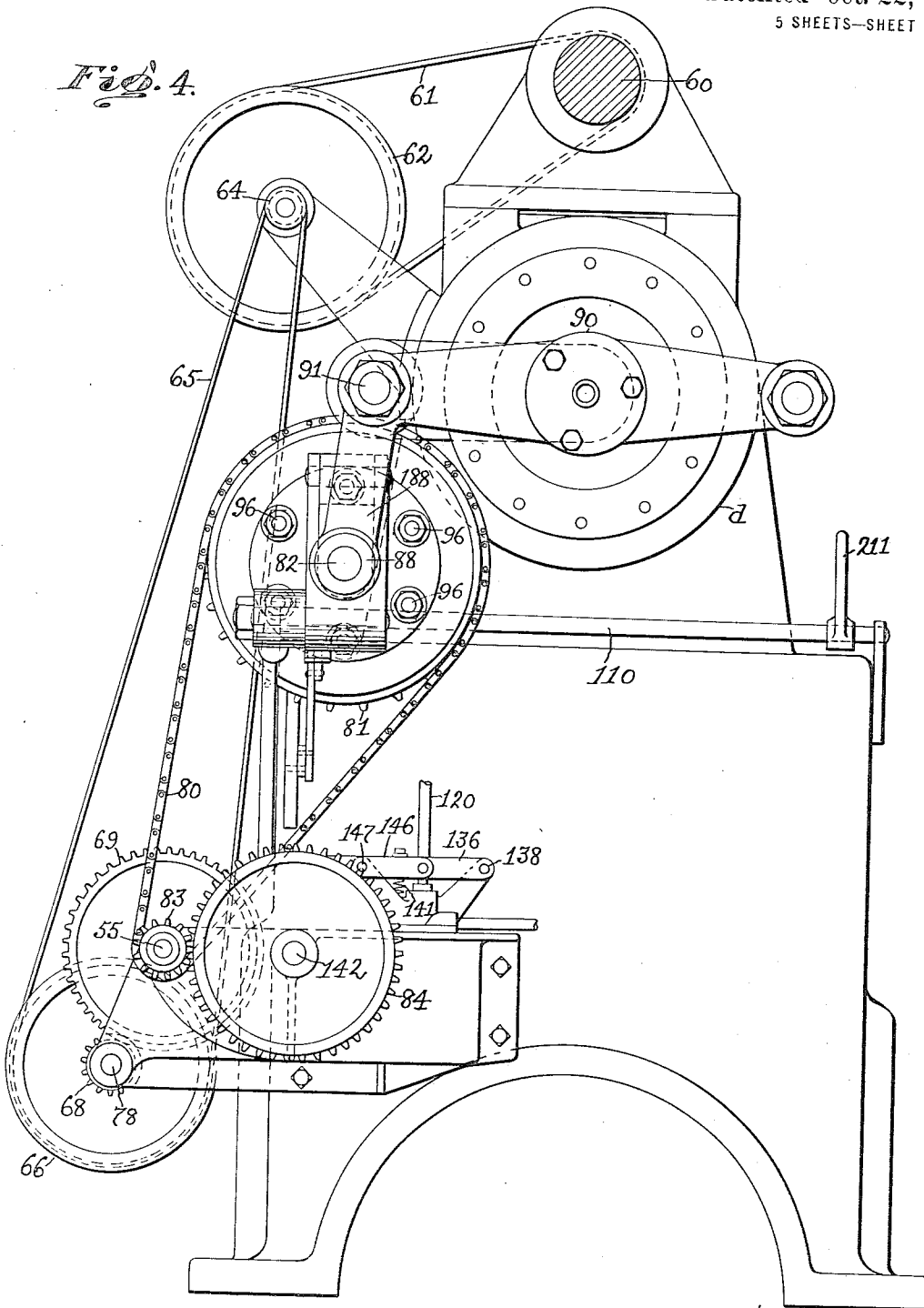
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 Atty.

H. E. WARREN.
 FLUID OPERATED LATHE.
 APPLICATION FILED JAN. 26, 1916.

1,282,152.

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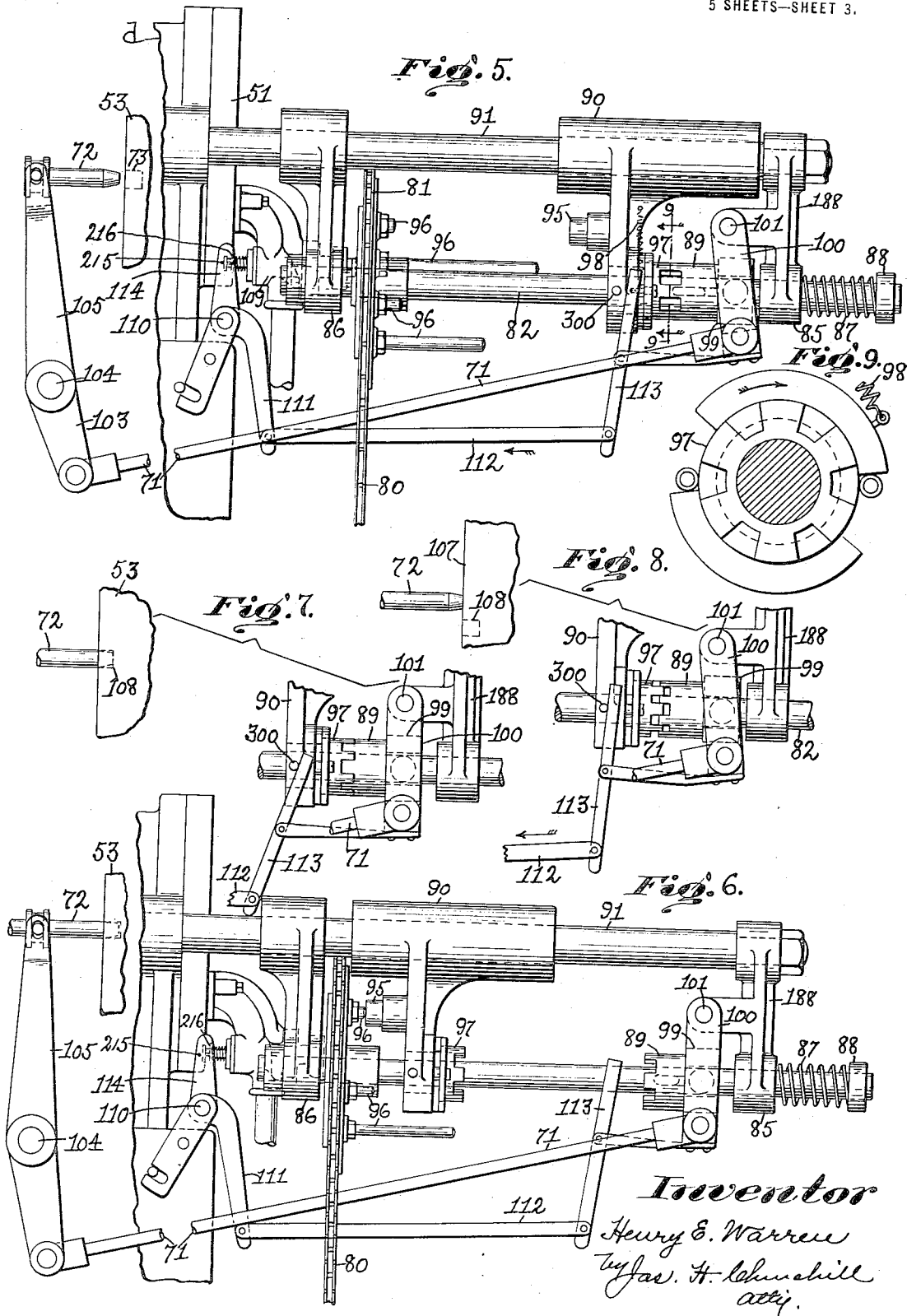
Fig. 4.



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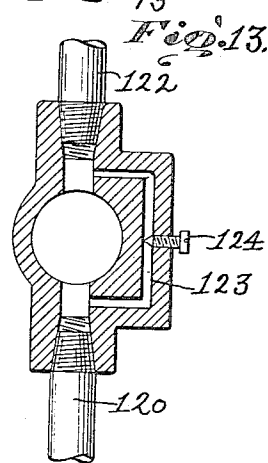
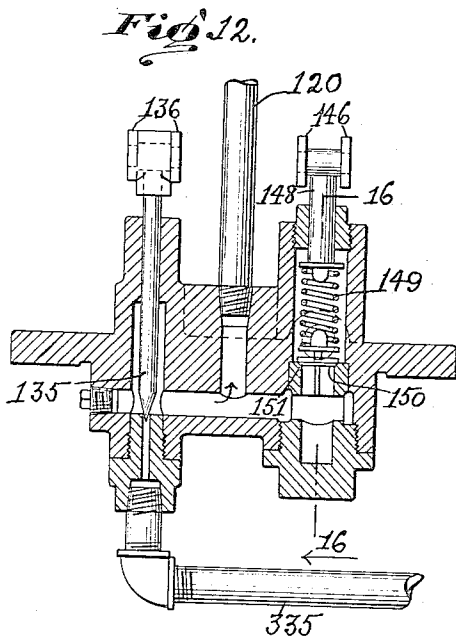
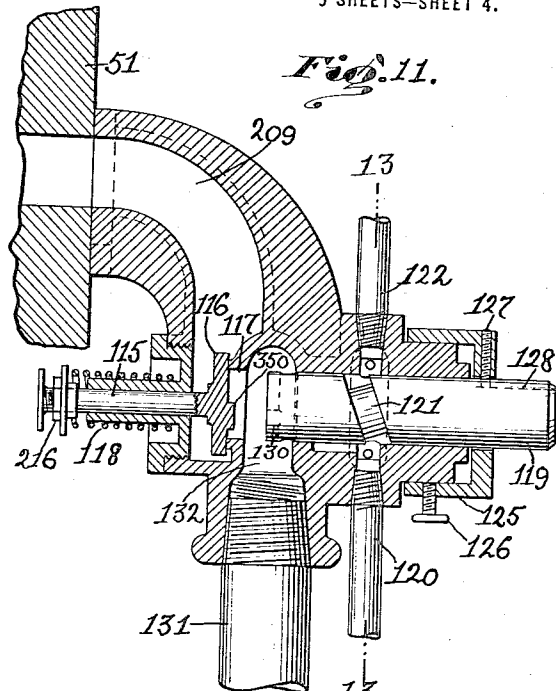
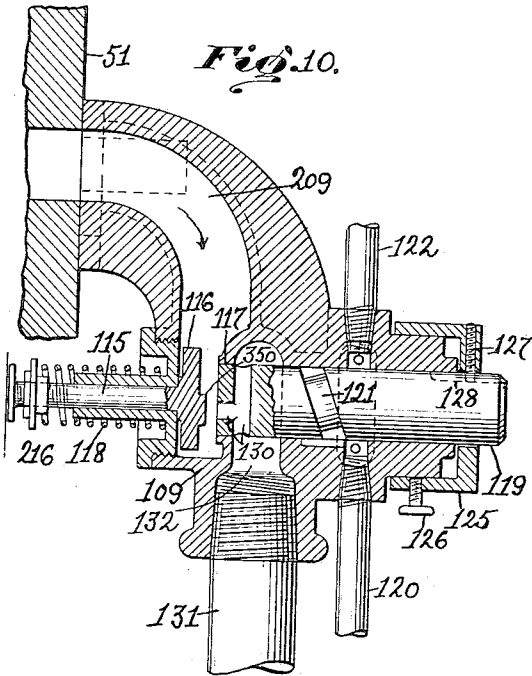
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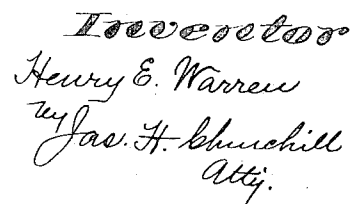
Patented Oct. 22, 1918.
 5 SHEETS—SHEET 4.



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1,282,152.

5 SHEETS—SHEET 5.



UNITED STATES PATENT OFFICE.

HENRY E. WARREN, OF ASHLAND, MASSACHUSETTS, ASSIGNOR TO THE LOMBARD GOVERNOR COMPANY, OF ASHLAND, MASSACHUSETTS, A CORPORATION OF NEW JERSEY.

FLUID-OPERATED LATHE.

1,282,152.

Specification of Letters Patent.

Patented Oct. 22, 1918.

Application filed January 26, 1916. Serial No. 74,498.

To all whom it may concern:

Be it known that I, HENRY E. WARREN, a citizen of the United States, and a resident of Ashland, in the county of Middlesex and State of Massachusetts, have invented an Improvement in Fluid-Operated Lathes, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

This invention is an improvement upon fluid operated lathes of the character shown and described in another application Se. No. 58,680 filed by me October 29, 1915, and has for its object to provide means as will be described whereby the action of the lathe is made automatic with a minimum number of moving parts.

The particular features of the invention will be pointed out in the claims at the end of this specification.

Figure 1 is a side elevation of one form of lathe embodying the invention.

Fig. 1^a a detail of a portion of the cylinder and spindle shown in Fig. 1.

Figs. 2 and 3 details of the turret to be referred to, Fig. 2 being a section taken on the line 2, Fig. 1.

Fig. 4 an end elevation looking toward the left in Fig. 1.

Figs. 5, 6, 7 and 8, enlarged details of the right hand portion of the lathe shown in Fig. 1.

Fig. 9 a detail in section on the line 9—9, Fig. 5.

Figs. 10 and 11 details in section and on an enlarged scale of the automatic reversing valve.

Fig. 12 an enlarged sectional detail showing the needle and relief valves.

Fig. 13 an enlarged detail in section on the line 13—13 Fig. 11.

Figs. 14 and 15, enlarged details to show adjusting devices for the needle and relief valves shown in Fig. 12, and

Fig. 16, a detail in section through the relief valve on the line 16—16, Fig. 12.

The main parts of the lathe are and may be the same as shown and described in detail in my application Se. No. 58,680 and need not be described in detail, it being sufficient for a proper understanding of the present invention to state that the work *a* is secured by a hydraulically operated chuck *b* to a spindle *c*, which is moved axially in

its cylinder *d* toward an operating tool *e*, carried by a rotatable turret 53 which carries a plurality of different tools, each of which is designed to be brought into operative relation to the work by rotation of the turret. The spindle *c* is provided at its rear end with an enlargement *h*, see Fig. 1^a, to form a piston whose rear face is of the full area of the inner circumference of the cylinder *d* and whose front area *i* is materially smaller, and is at all times subjected to fluid pressure admitted into the cylinder in front of the piston, which pressure is utilized to move the spindle and work away from the tool. The spindle *c* while it is moved axially, is also rotated by the long pinion *f* on shaft 60 and the gear *g* on the spindle.

The present invention has for one of its objects to provide for automatically controlling the rotation of the turret 53 by the spindle *c*. In the present instance, rotation of the turret 53 and its shaft 54 is effected from a horizontal shaft 55, through a chain drive 56, counter shaft 57 and gears 58, 59, see Fig. 1.

The shaft 55 receives its motion from the main driving shaft 60 of the lathe, through a belt 61, pulley 62, countershaft 63, pulley 64, belt 65, pulley 66, clutch 67, pinion 68 and gear 69. The clutch 67 is actuated by a projecting arm 70 on a pull rod 71 for the locking pin 72 for the turret, the arrangement being such that when the pin 72 enters one of the holes 73 of the turret, the clutch 67 is released and disengages the pulley 66 from the pinion 68, which is effected by the arm 70 pushing against a collar 74 fast on the shaft 78, which carries the pulley 66 and clutch 67. The locking pin 72 is forced into the hole 73 by a spring 106, and is withdrawn from said hole by movement of the pull rod 71 toward the right, viewing Fig. 1, the pull rod 71 on such movement causing the arm 70 to press against the loose collar 75, which by pressure of the spring 76 against the fixed collar 77, will move the shaft 78 and with it the clutch 67, and thereby couple the pulley 66 with the pinion 68, so as to transmit motion from the belt 65 and pulley 66 through the shaft 55 to the turret 53, causing the latter to rotate. The connection between the arm 70, collar 74 and collar 75 is sufficiently loose to enable the rod 71 to move the shaft 78 to properly operate the

clutch 67. On the right hand end of the shaft 55 is a sprocket wheel 79, which through chain 80 drives the sprocket gear 81, which is fast on a shaft 82. The shaft 55 also drives a pinion 83 and gear 84, whose function will be hereinafter described.

The shaft 82 is free to revolve and also to move axially in bearings 85 and 86. The shaft 82 has mounted on it a clutch member 89, which is splined to the shaft to revolve therewith and to slide thereon. The clutch member 89 coöperates with a clutch member 97, which is carried by a traveling member 90, hereinafter referred to as the traveler, which slides on the guide rod 91 and receives motion from and parallel to the spindle *c*, by being engaged with the extension 94 of the spindle between a collar 92 and the hub of the casting 93 fast on said extension. The traveler 90, therefore, moves accurately in a longitudinal direction with the spindle. The traveler 90 carries an abutment 95, which is designed to make contact at times, as will be described, with one of a series of adjustable stop bars 96, and when this contact takes place, the gear 81 and shaft 82 are moved bodily with the spindle *c* against the resistance of a spring 87, encircling the shaft 82 between a collar 88 and an arm 188 on the guide rod 91. The axial movement of the gear 81 and shaft 82 is so slight as not to interfere with the rotation of the gear by the flexible drive chain 80.

The traveler 90 also carries the clutch member 97, which is concentric with the shaft 82 and is free to swivel about 60° about its axis, although provided with a spring 98, see Fig. 9, which tends to hold it in one position. When the traveler 90 moves back on the return stroke of the spindle *c* in the direction of arrow 190 Fig. 1, the clutch member 89 will be forced back in the direction of the arrow 190, if the teeth of both clutch members are opposite, as shown in Fig. 1. As the clutch member 89 is thus moved, it carries with it a collar 99 loose on the shaft 82, and a lever 100 connected with said collar and pivoted at one end at 101 to the arm 188 and at its other end to the pull rod 71. The pull rod 71 is thus moved in the direction of arrow 190 and through the lever 103, rock shaft 104, and lever 105, will pull the locking pin 72 out of its socket 73 against the opposition of the spring 106, thus unlocking the turret 53. At the same time the turret 53 is unlocked, the clutch 67 is engaged with the pinion 68, and the turret is rotated, as above described. Motion will be simultaneously transmitted through the chain 80 and sprocket wheel 81 to the shaft 82, which, by rotating the clutch member 89, will bring the teeth of the latter opposite the spaces between the teeth of the clutch member 97, which allows the clutch members to be par-

tially interlocked and release the strain on the pull rod 71. This condition of the clutch members is illustrated in Fig. 8, and results in the locking pin 72 being forced by its spring 106 against the face 107, see Fig. 2, of the revolving turret. As the shaft 82 continues to revolve, the clutch member 97 revolves therewith against the opposition of the spring 98, and when the locking pin 72 comes opposite the next hole in the turret face 107, marked 108 in Fig. 2, the said pin will be forced into said hole and the turret will be instantly locked and the shaft 82 stopped rotating. At the same time the clutch 67 is disengaged from the pinion 68 and loss of energy by slipping of belt 65 is avoided. When the rotation of the shaft 82 is stopped as described, the spring 98 remains under tension ready to turn the clutch member 97 in the reverse direction, so as to bring the teeth on said member in line with or opposite the teeth on the clutch member 89, which it is permitted to do at the beginning of the next forward stroke of the spindle *c*.

From the above description it will thus be seen that the rotation of the tool carrying turret is automatically controlled by movement of the spindle *c* on the return or back stroke of the latter, and after the work *a* has been removed from engagement with the operating tool *e*.

Another feature of the present invention consists in providing for automatically controlling the fluid pressure upon the piston or rear end *h* of the spindle. To this end, provision is made for automatically controlling a valve, which governs the rate of flow of fluid into the cylinder behind the piston or rear end of the spindle, and also for automatically controlling a valve, which governs the exhaust or outflow of fluid from the cylinder behind the piston or rear end of the spindle, both of said valves being under the influence of the movable spindle *c*, as will be described.

For the purpose of controlling the rate of feed when the spindle *c* is traveling forward, I provide a needle valve 135, see Fig. 12, which is automatically controlled as will be described.

For the purpose of reversing the travel of the spindle I provide a reversing valve 109, which is preferably of novel construction and which is automatically operated as will be described. The numeral 109 indicates the valve as a whole, which has its inlet passage 209, see Fig. 10, connected with the cylinder head 51 and has its outlet pipe 131 connected with a suitable discharge tank, not herein shown. The automatic reversing valve preferred by me is shown separately in Figs. 10, and 11 and consists of disk valve 116, which is designed to close a port 117 connecting the inlet passage 209

with the outlet port 132 leading to the outlet pipe 131. The valve 116 is acted upon by a spring 118, which tends to move the valve away from its seat and hold it in its open position. The valve 116 is moved to its seat against the action of the spring 118, when the spindle *c* and the follower 90 approach the end of their return stroke and the clutch member 97 reaches the position show in Fig. 8. When the clutch member 97 has been moved so that its teeth partially interlock with the clutch member 89, a pin or stud 300 on the follower 90 engages the upper end of a lever 113, and on further backward movement of the spindle *c* and follower 90, the lever 113 is turned, and through the link 112 and lever 111, see Fig. 5, rocks a shaft 110 and causes a lever 114 to force the valve stem 115 firmly toward the right and holds the valve to its seat as shown in Fig. 11, while the pressure accumulating on top of or behind the valve and in the cylinder behind the spindle *c* starts the spindle *c* in motion toward the left in Fig. 1.

The pressure accumulated in the passage 209 of the valve 109, holds the valve 116 firmly to its seat against the action of the spring 118, which latter is constantly tending to pull the valve away from its seat.

The lever 114 may be connected with the valve stem 115 by providing the lever with pins 215 which straddle a flange on the valve stem, the latter having a nut 216 which is adjustable on a threaded portion of the valve stem. The valve 116 remains closed by the fluid pressure behind it while the spindle *c* is being moved, and said spindle will continue its motion toward the turret 53, all of the parts described being in stable equilibrium, until an abutment 95 on the follower 90 strikes the adjustable stop 96 in line with it, see Fig. 6. When this occurs, the left hand face of the sprocket wheel 81 will be moved against a plunger 119, which is supported by the reversing valve 109 and is arranged opposite or in line with the valve 116. The plunger 119 not only acts to move the reversing valve 116 from its seat, but also acts as a valve to control the flow of fluid under pressure into the cylinder behind the spindle. To this end, the plunger is provided with a spiral channel or groove 121 on its circumference, which normally registers with the pipes 120, 122, the latter being connected with the cylinder head 51. When the plunger 119 is moved by the abutment 95, the spiral channel 121 is moved out of line with the pipes 120, 122, and the main flow of fluid under pressure into the cylinder behind the spindle *c* is interrupted. Provision is made for a restricted flow of fluid into the cylinder behind the spindle when the main flow is interrupted as described. This is permitted by means of a by-pass 123, see Fig. 13, which connects the pipes 120, 122 and the rate of

flow of the fluid may be governed by the adjusting screw 124 in said by-pass.

By the means just described, the rate of travel of the spindle *c*, as it approaches the end of its working or forward stroke, is greatly reduced. The distance over which this reduced speed will take place, may be adjusted by rotating the plunger 119, by means of the sleeve 125, which has a key 127 fitted loosely in a spline 128 in the plunger, and said sleeve may be secured in its adjusted position by the clamping screw 126. The rotation of the plunger 119 obviously varies the point in its travel toward the valve 116, where the edge of the inclined or helical groove or channel 121 will cut off the main supply of fluid to the cylinder. As the spindle *c* still continues its left hand motion or working stroke at a slow rate, the plunger 119 will eventually be forced against the front face of the valve 116, making contact with an eccentrically projecting portion 350 of smaller area than the port 117. Consequently the valve 116, will be moved from its seat in spite of the fluid pressure acting to hold it to its seat, but just as soon as the valve has been opened a thousandth of an inch, fluid will begin to flow in under its outer edge, which having no escape, will almost instantly equalize the fluid pressure acting on the other face of the valve, thus leaving the latter free to be snapped open by the spring 118, which should be strong enough to handle the valve promptly under these conditions, but not strong enough to remove the valve from its seat under the minimum pressure which may occur behind the spindle while the latter is being moved on its working stroke. This minimum pressure which is determined by the ratio between the annular space 400, see Fig. 1^a, around the spindle in front of the piston and the latter, will be in the neighborhood of $\frac{1}{4}$ or $\frac{1}{8}$ of the full operating pressure in pounds per square inch, therefore, if the area of the outside diameter of the valve seat is one square inch, the spring 118 may safely exert a pull equal to about 18 lbs. and I have found that the spring 118 may be considerably weaker than this and still operate perfectly.

Just as soon as the spring 118 has pulled the valve 116 wide open, fluid will be discharged through the port 130 in the plunger 119 into the discharge pipe 131, and the spindle *c* will instantly reverse its motion, due to the fluid pressure within the annular space 400 acting on the front face of the enlarged portion or piston *h* of the spindle. It will be understood, that this front face of the piston is constantly under fluid pressure which is supplied as herein shown through an inlet 351 to the cylinder. As soon as the spindle *c* has moved a short distance on its return stroke, the plunger 119, which moves with it under the influence of

the pressure in the passage 209, will clear the port 117 and the latter is opened to the exhaust pipe 131, consequently fluid will discharge with great rapidity from the cylinder, so that the return stroke of the spindle *c* will take place at a high rate of speed. When the spindle *c* reaches substantially the end of its return stroke, the clutch member 97 will contact with the clutch member 89, and the action as previously described will be repeated for a new position of the turret. Provision is made for preventing the reversal of the spindle when the latter is at the end of its forward stroke, so as to enable the tools to be properly set and also for non-automatic operation when or if desired, and for this purpose, the projecting portion 350 of the valve 116 is made eccentric. The axial portion of the port 130 is made eccentric with relation to the plunger 119, and is of such area that it can be closed by the projecting portion 350 of the valve 116 under normal conditions of use, but which can be uncovered more or less by rotating the valve stem 115, so as to bring the projection 350 more or less out of line with the axial portion of the port 130, and when this is done, the pressure between the valve 116 and its seat will not be equal to the pressure on the opposite or rear face of said valve, and the latter will not be opened by its spring 118, but will remain closed except as to such opening as is provided for the leakage or escape of fluid through the port 130. To close the port 130 it is only necessary to rotate the valve 116 about 180°, and the machine will again be made automatic. For the purpose of controlling the rate of feed when the spindle *c* is traveling forward, I provide an automatically controlled needle valve 135, which is shown in Fig. 12, and its operating mechanism in Figs. 14 and 15. The needle valve 135 controls the flow of fluid from the supply pipe 335 to the pipe 120, and the stem of the needle valve is connected with a lever 136, see Figs. 14 and 15, which is pivoted at 138 and has its outer end provided with a roller 139, which is shown as resting upon one of a series of button-headed screws 140. The lever 136 is held down by a tension spring 141, which tends to close the needle valve. The amount the needle valve is opened is determined by the radial distance of the button-headed screw 140 from the axis or shaft 142. These screws are adjustable radially in the edge of a disk 242 mounted on the shaft 142, and said screws are locked in any desired position by check nuts 143. The shaft 142 and the disk 242 are rotated from the shaft 55 by the pinion 83 and gear 84, whereby the shaft 142 revolves synchronously with the turret; so that for every turret position a different button-headed screw similar to 140 will be beneath the

roller 139, and consequently the needle valve 135 may have a different opening for every turret position.

Since the supply of fluid passing back of the spindle *c* goes through the needle valve 135, it is evident that the feed of the spindle is automatically adjusted for each turret position. The shaft 142 has mounted upon it another disk 342, see Fig. 14, which is provided with adjustable button-headed screws 144, with which coöperates a roller 145, carried by a lever 146, pivoted at 147 and connected at its rear end with a plunger 148. This plunger 148 presses down upon a spring 149, which holds a relief valve 150 against its seat 151, see Figs. 12 and 16. The amount of pressure of the plunger 148 against the spring 149 is determined by the radial distance of the button-headed screws 144, and these are adjustable in the same manner as screws 140.

The function of the relief valve 150 is to limit the possible maximum fluid pressure against the spindle *c* for each operation. This is of service, especially when it is desired to feed the spindle forward gently at a comparatively rapid rate, as in tapping work, for example.

It will be observed that this improved fluid operated lathe is free from cams and other non-adjustable parts, so that it may be easily set up or altered for any series of operations. The length of stroke of the spindle can be adjusted within a thousandth of an inch by the threaded stop bars 96, thus limiting the penetration of the drill or reamer, or definitely locating a shoulder on the work.

The normal rate of feed for each operation is very easily adjusted by rotating the screws 140. The maximum pressure exerted against the tool is controlled by the screws 144. The rate and duration of the slow feed at the end of the forward stroke of the spindle is determined by a slight rotation of the sleeve 125, and no other adjustments of the machine are necessary for ordinary purposes.

If hand manipulation is desired, the rocker shaft 110 with its handle 211 may be utilized at any time to feed the spindle either back or forward and this action will not interfere in any way with the automatic devices which have been provided.

The passage 209 of the reversing valve 109 communicates with the cylinder through a port 500, which preferably opens into the cylinder a sufficient distance away from the cylinder head 51, to enable the said port to be closed by the spindle *c* at the end of its rear stroke as shown in Fig. 1^a.

One of the holes in the turret face 107 which is marked 200 Figs. 2 and 3, is made of less depth than the holes 73, so that, the locking pin 72 can enter the same and ar-

rest rotation of the turret at the end of the complete rotation of the turret.

I have herein shown one construction of lathe embodying this invention but it is not desired to limit the invention to the particular construction shown.

Claims—

1. In a machine of the character described, a cylinder, a spindle rotatable and movable axially in said cylinder, means for rotating said spindle while it is moving axially, a fluid inlet pipe connected to one end of said cylinder to admit fluid under pressure behind the spindle, a fluid outlet pipe connected with the same end of the cylinder to exhaust the fluid from behind said spindle, and a valve in said exhaust pipe normally closed while said spindle is making its forward stroke and automatically opened under the influence of said spindle when the latter reaches a predetermined point in its forward stroke.

2. In a machine of the character described, a cylinder, a spindle rotatable and movable axially in said cylinder, a fluid inlet pipe connected to one end of said cylinder to admit fluid under pressure behind the spindle, a fluid outlet pipe connected with the same end of the cylinder to exhaust the fluid from behind said spindle, a valve in said exhaust pipe, means for normally holding said valve open, and means under the influence of said spindle for closing said valve on the return stroke of said spindle.

3. In a machine of the character described, a cylinder, a spindle rotatable and movable axially in said cylinder, a fluid inlet pipe connected to one end of said cylinder to admit fluid under pressure behind the spindle, a fluid outlet pipe connected with the same end of the cylinder to exhaust the fluid from behind said spindle, a valve in said exhaust pipe, means for opening said valve, said valve being held to its seat by the fluid pressure in said cylinder, and a device rendered effective by said spindle on the forward stroke of the latter to move said valve away from its seat sufficiently to permit the pressure in the cylinder to act on both sides of the valve and permit the latter to be moved into its opened position and thus allow the movement of the spindle to be reversed.

4. In a machine of the character described, a cylinder, a spindle rotatable and movable axially in said cylinder, a fluid inlet pipe connected to one end of said cylinder to admit fluid under pressure behind the spindle, a fluid outlet pipe connected with the same end of the cylinder to exhaust the fluid from behind said spindle, a valve in said exhaust pipe, said valve being held to its seat by the fluid pressure in said cylinder, means for opening said valve normally rendered ineffective by said fluid pressure, a plunger movable under the influence of said spindle

on the forward stroke of the latter to act on said valve and move it away from its seat.

5. In a machine of the character described, a cylinder, a spindle rotatable and movable axially in said cylinder, a fluid inlet pipe connected to one end of said cylinder to admit fluid under pressure behind the spindle, a fluid outlet pipe connected with the same end of the cylinder to exhaust the fluid from behind said spindle, a valve in said exhaust pipe, said valve being held to its seat by the fluid pressure in said cylinder, means for opening said valve normally rendered ineffective by said fluid pressure, a plunger movable under the influence of said spindle on the forward stroke of the latter to act on said valve and move it away from its seat, said plunger controlling the flow of fluid pressure into said cylinder.

6. In a machine of the character described, a cylinder, a spindle rotatable and movable axially in said cylinder, a fluid inlet pipe connected to one end of said cylinder to admit fluid under pressure behind the spindle, a fluid outlet pipe connected with the same end of the cylinder to exhaust the fluid from behind said spindle, a valve in said exhaust pipe, said valve being held to its seat by the fluid pressure in said cylinder, means for opening said valve normally rendered ineffective by said fluid pressure, a plunger movable under the influence of said spindle on the forward stroke of the latter to act on said valve and move it away from its seat, said plunger cooperating with said valve to permit leakage of fluid pressure by the valve to arrest forward movement of the spindle without reversing the latter.

7. In a machine of the character described, a cylinder, a spindle rotatable and movable axially in said cylinder, a fluid inlet pipe connected to one end of said cylinder to admit fluid under pressure behind the spindle, a fluid outlet pipe connected with the same end of the cylinder to exhaust the fluid from behind said spindle, a valve in said fluid inlet pipe movable under the influence of said spindle on the forward stroke of the latter to interrupt the flow of fluid pressure into said cylinder.

8. In a machine of the character described, a cylinder, a spindle rotatable and movable axially in said cylinder, a fluid inlet pipe connected to one end of said cylinder to admit fluid under pressure behind the spindle, a fluid outlet pipe connected with the same end of the cylinder to exhaust the fluid from behind said spindle, a valve in said fluid inlet pipe movable under the influence of said spindle on the forward stroke of the latter to interrupt the flow of fluid pressure into said cylinder, and means for by-passing a restricted flow of fluid pressure around said valve when the direct flow of fluid

pressure to the cylinder is interrupted by said valve.

9. In a machine of the character described, a cylinder, a spindle rotatable and movable axially in said cylinder, a fluid inlet pipe connected to one end of said cylinder to admit fluid under pressure behind the spindle, a fluid outlet pipe connected with the same end of the cylinder to exhaust the fluid from behind said spindle, a valve in said exhaust pipe, said valve being held to its seat by fluid pressure in said cylinder, and means cooperating with said valve for permitting leakage of fluid pressure by said valve to arrest forward movement of the spindle without reversing the latter.

10. In a machine of the character described, a cylinder, a spindle rotatable and

axially movable in said cylinder, a rotatable turret, power operated means for rotating said turret into different positions, a fluid inlet pipe connected with said cylinder to admit fluid pressure into said cylinder behind the said spindle, a valve controlling the flow of fluid under pressure through said inlet pipe, rotatable means actuated by said power operated means for controlling the opening of said fluid inlet valve according to the position of said turret, a relief valve for said fluid inlet pipe, and rotatable means actuated by said power operated means and governing the operation of said relief valve.

In testimony whereof, I have signed my name to the specification.

HENRY E. WARREN.