June 3, 1930. J. ROBSON 1,760,915

FLUID CONTROLLED MECHANISM

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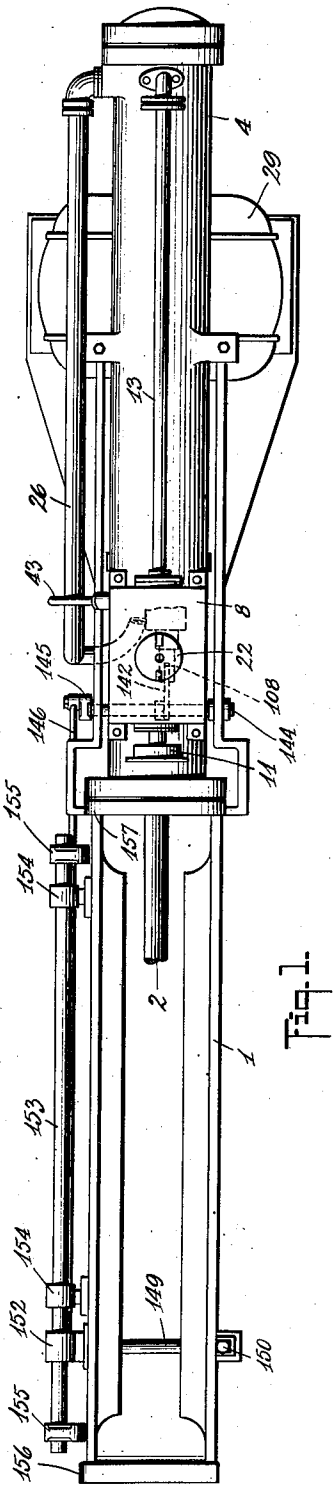


Fig. 1.

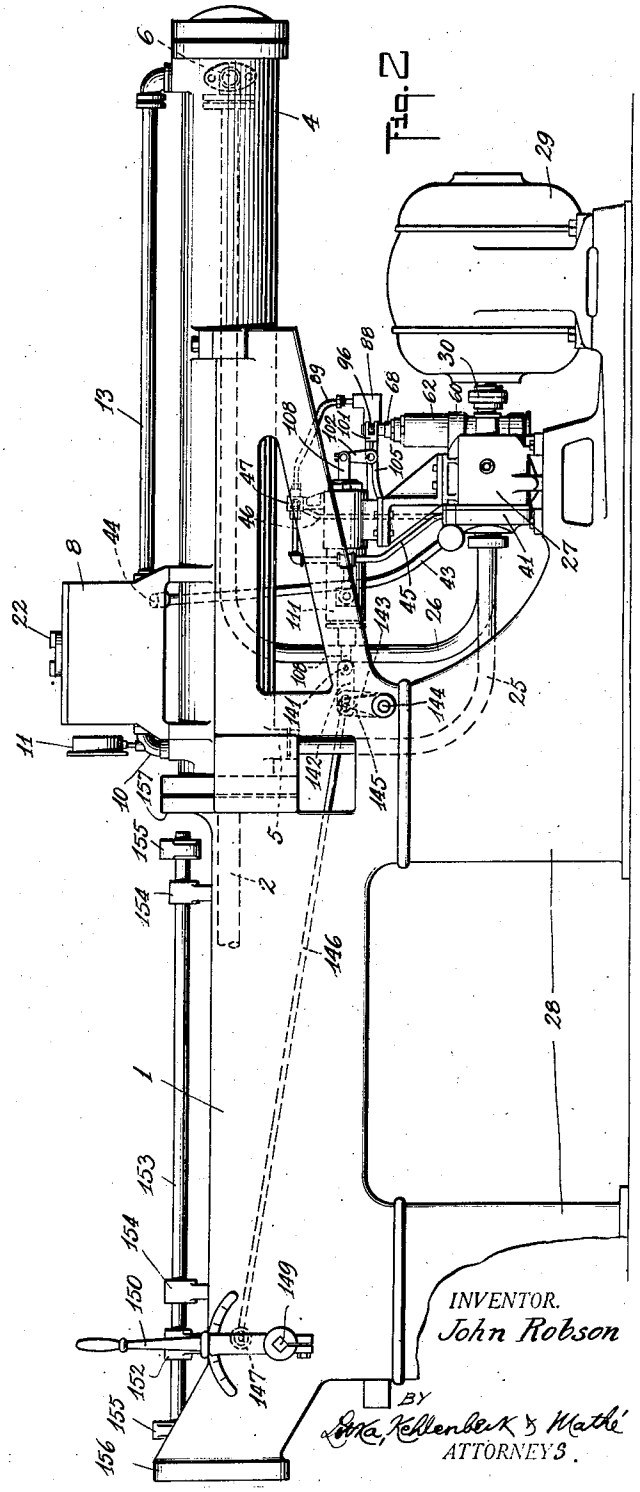


Fig. 2.

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FLUID CONTROLLED MECHANISM

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Fig. 3.

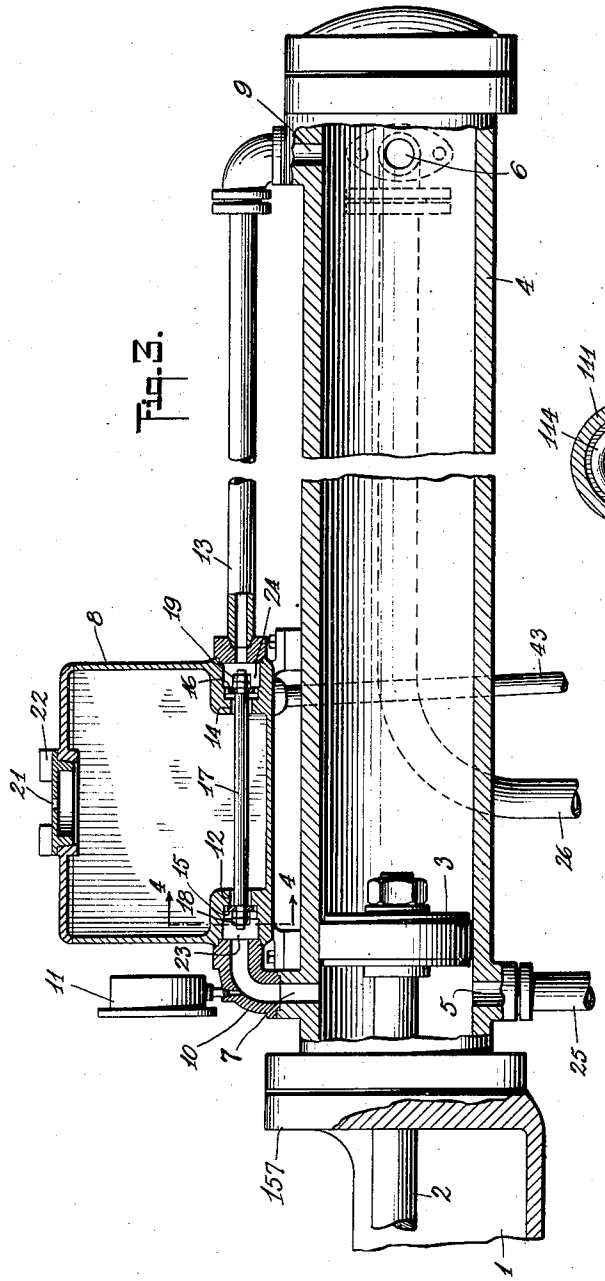


Fig. 15.

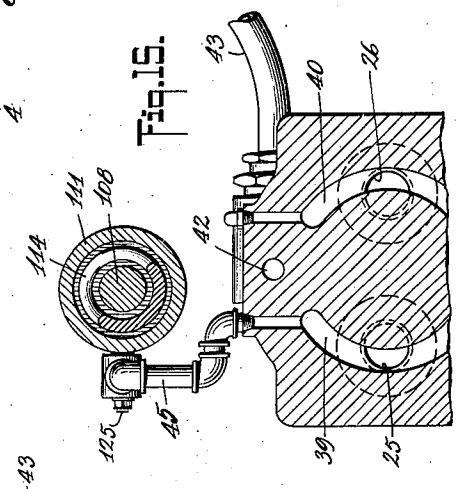
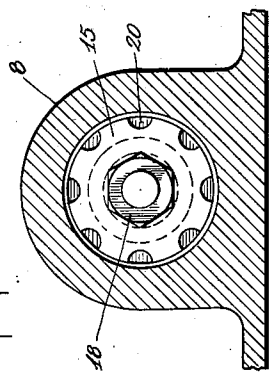


Fig. 4.



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FLUID CONTROLLED MECHANISM

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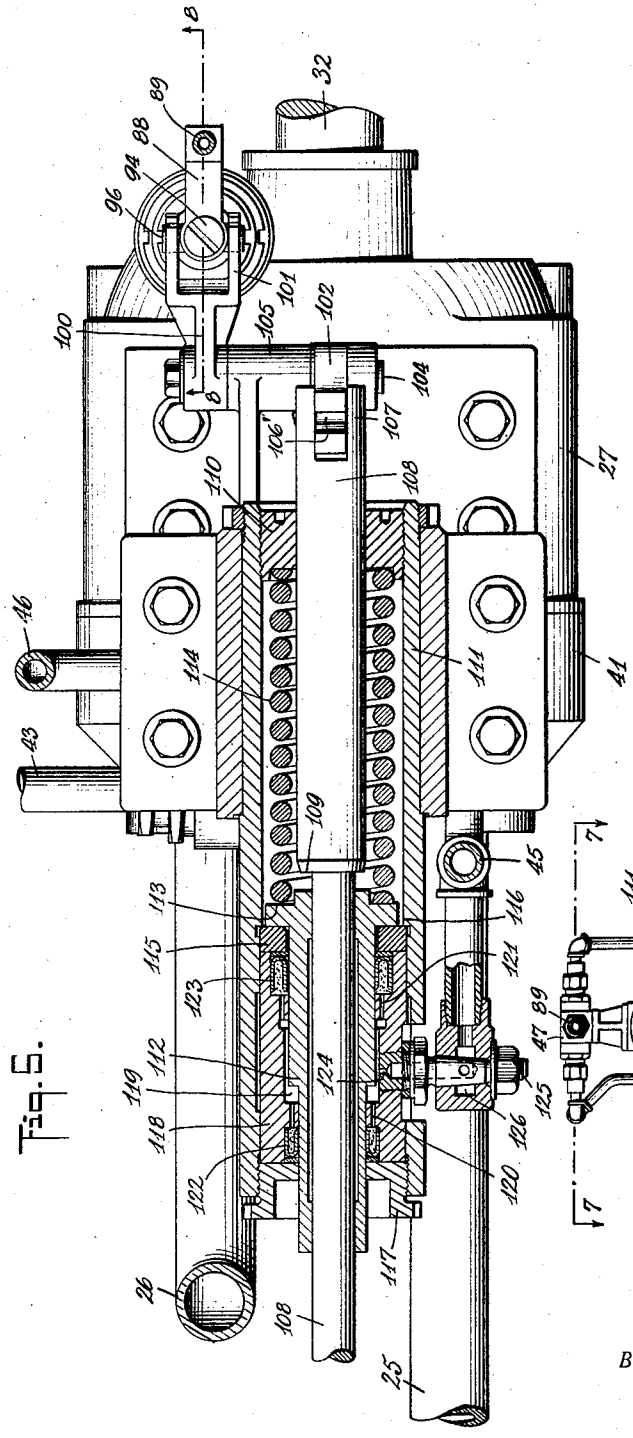


Fig. 5.

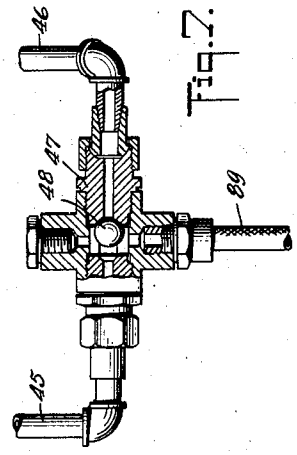


Fig. 7.

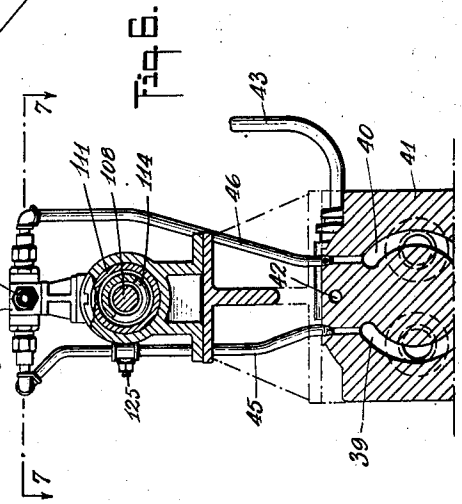


Fig. 6.

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Fig. 9.

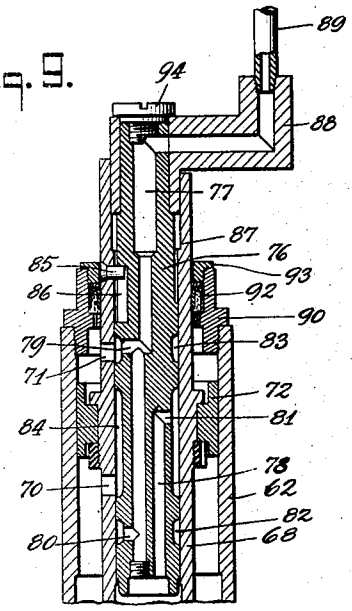


Fig. 8.

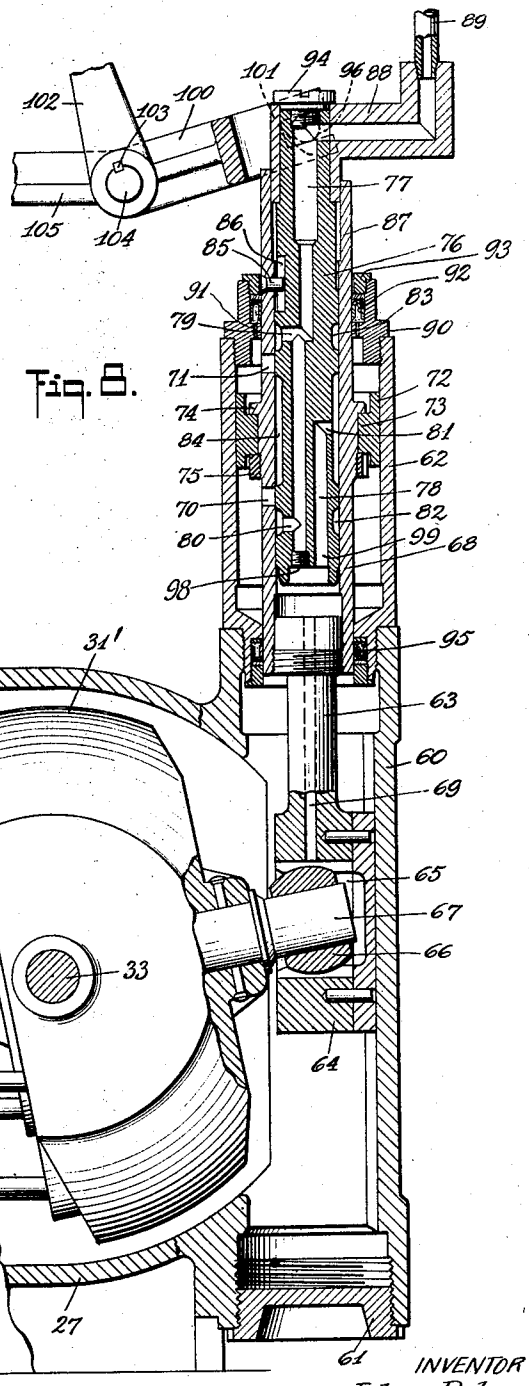
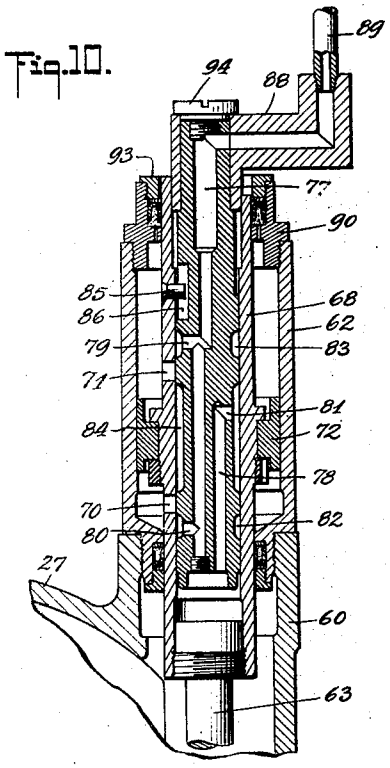


Fig. 10.



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FLUID CONTROLLED MECHANISM

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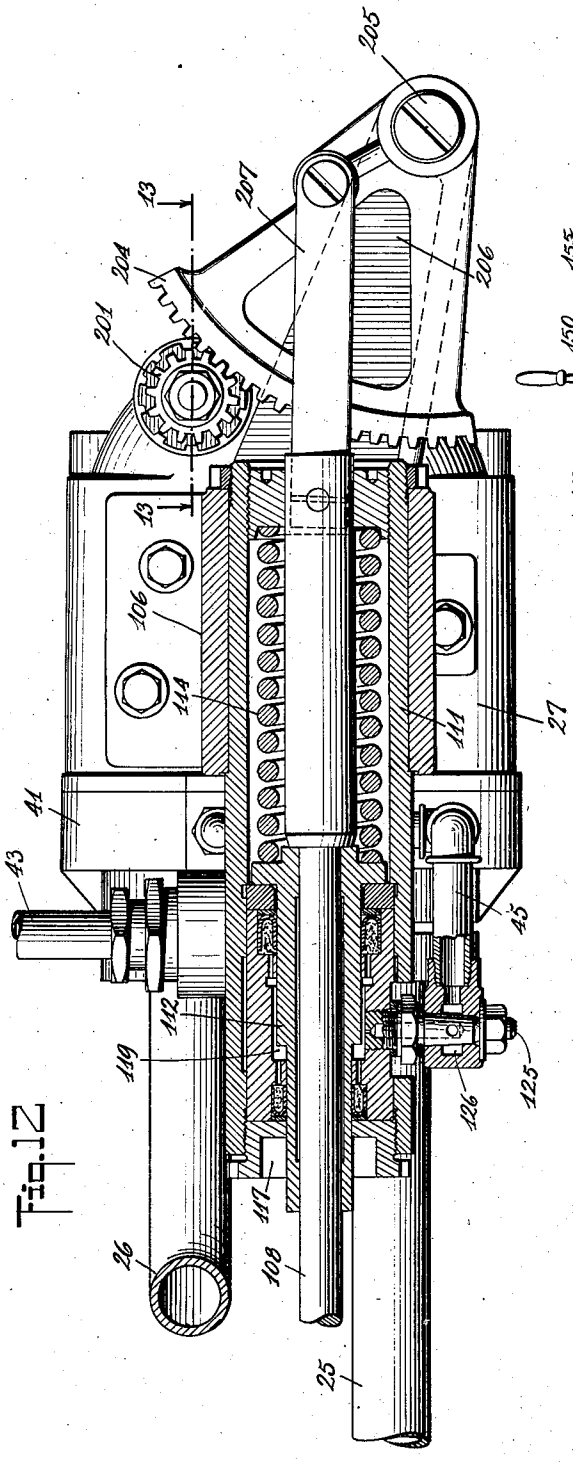


Fig. 12.

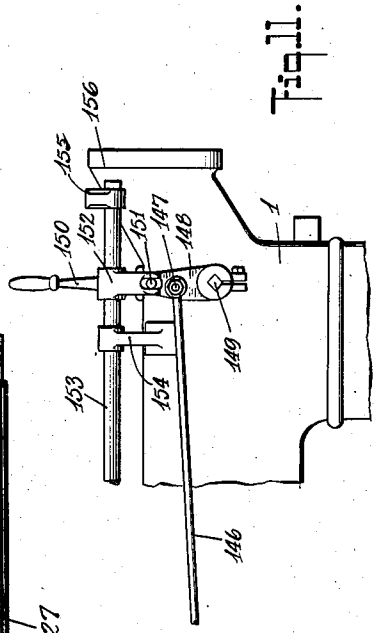


Fig. 11.

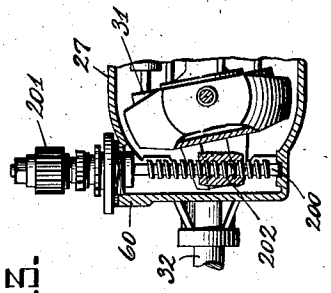


Fig. 13.

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FLUID CONTROLLED MECHANISM

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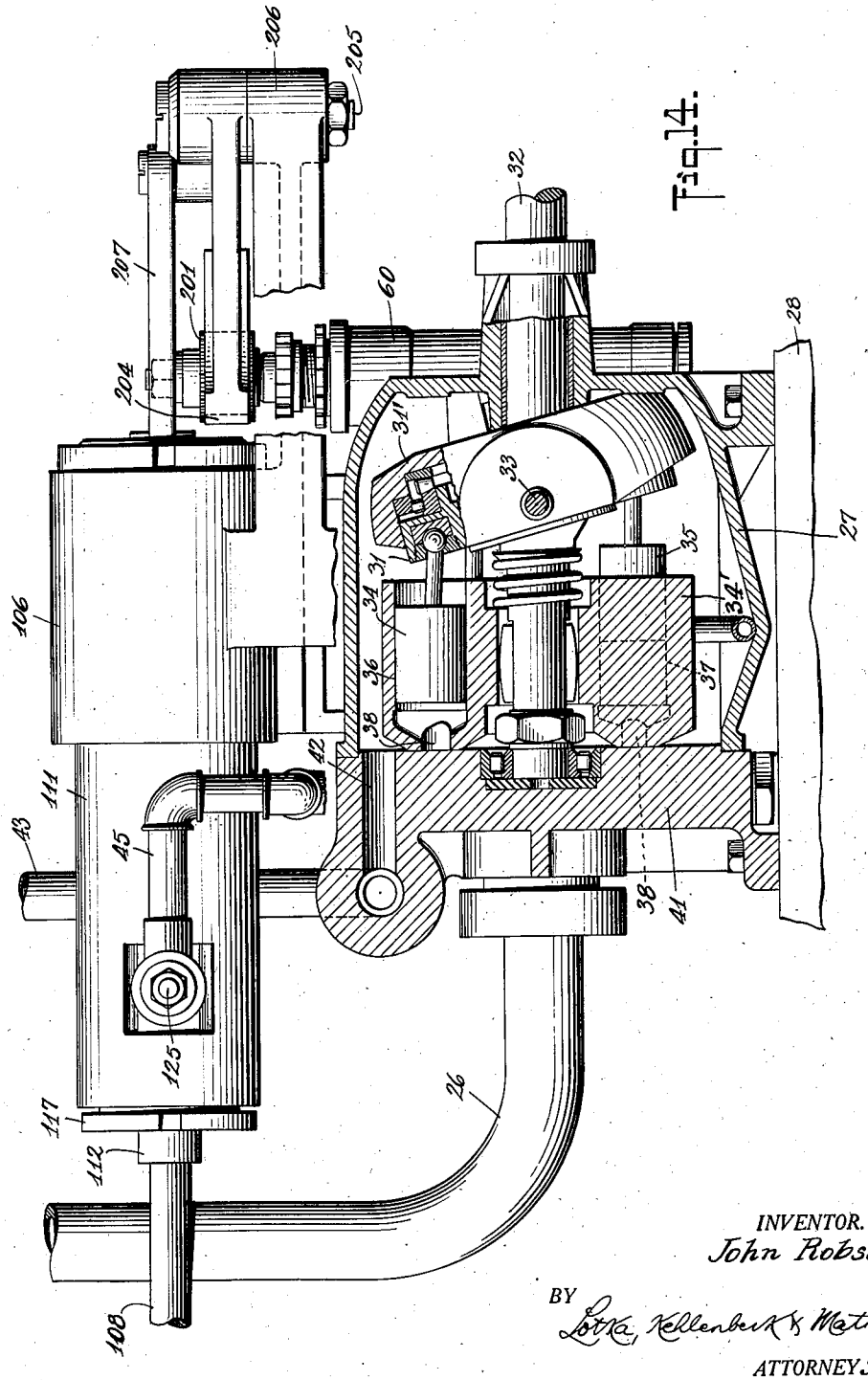


Fig. 14.

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Patented June 3, 1930 1,760,915

UNITED STATES PATENT OFFICE

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FLUID-CONTROLLED MECHANISM

Application filed April 28, 1923. Serial No. 635,319.

This invention relates to fluid controlled mechanism, and more particularly to improvements in the motor or pump control of such mechanisms.

It is the object of the present invention to provide a simple and efficient structure in which the desired operation can be carried on at a high rate of speed and without danger of breakage or other damage.

With this object in view, I provide automatic means for responding to excessive pressures in the liquid supply system. This automatic means is directly responsive to a predetermined maximum liquid pressure and causes the reduction of the liquid flow whereupon it becomes again inactive.

According to another feature of the invention, the stroke or timing of a liquid pump may be varied either in response to said automatic means or in response to manually operated means.

Still another feature of the invention has to do with the provision of a liquid operated means for varying the stroke or timing of the liquid pump.

Further features of the invention relate to the arrangement and distribution of the liquid supply system, the coordination of various parts of these mechanisms formed into a unitary structure, the application of various features to a broaching machine, and to other combinations which will be specifically set forth in the appended claims.

The various features of the invention are disclosed as applied to a broaching machine. However it will be obvious to those skilled in the art that such disclosure is merely illustrative, and that the features may be singly or in various combinations applied to the widest variety of devices.

While in the present preferred embodiment of the invention I disclose a combination including a liquid pump of substantially the same type as the one disclosed in Patents Nos. 924,787 and 1,020,285 to R. Janney, other liquid pumps may be used in conjunction with some of the features of my invention without departing from the spirit thereof.

In the drawings, Figs. 1 and 2 represent a plan view and an elevation, respectively, of a broaching machine and its associated operating and controlling mechanism; Fig. 3 is an enlarged side elevation, with parts broken away, of the broaching cylinder; Fig. 4 is a sectional view along line 4—4 of Fig. 3 showing an end view of the valve controlling the ports of the oil reservoir; Fig. 5 is an enlarged horizontal cross section of the automatic pressure control mechanism; Fig. 6 is a vertical cross section showing the oil pipe connections from the delivery pump to the pressure control mechanism; Fig. 7 is a sectional view taken along line 7—7 of Fig. 6 showing a ball check valve in the oil supply of the hydraulic pump control mechanism; Fig. 8 is an enlarged vertical cross section of the hydraulic control mechanism for the oil pump and Figs. 9 and 10 are similar views showing said mechanism in its different actuated positions; Fig. 11 is a side elevation of the manual broach controlling mechanism, and

Figs. 12 to 15 illustrate various details of a modified type of broaching machine, Fig. 12 being a view corresponding to Fig. 5; Fig. 13 an elevation with parts broken away of the pump control mechanism, the view being along line 13—13 of Fig. 12; Fig. 14 a side elevation of the pump and pressure control mechanism, parts of the pump being broken away; and Fig. 15 a view corresponding to Fig. 6.

In operating the machine, the work is held upon the work table or bed 1 (Figs. 1 and 2) of the broaching machine, the broaching tool (not shown) being mounted in the well known manner on a piston rod 2 projecting from a piston 3 provided in a broaching cylinder 4 (Fig. 3). By forcing oil into the cylinder 4 through the port 5 and withdrawing oil through a port 6, the piston 3 will be caused to move in the right hand direction, and by introducing oil into the cylinder through port 6 and withdrawing oil through port 5, the piston 3 will be caused to move in a left hand direction. The piston 3 will be caused to move from left to right during the broaching operation, and in the opposite direction for returning the tool to its normal position. The space that may be occupied by the oil in cylinder 4 to the right of piston 3 is larger in

cross section than the annular space to the left of this piston, because about one-sixteenth of the space to the left of 3 is occupied by the piston rod 2. For the purpose of making possible the uniform operation of the oil pump (to be hereinafter described more in detail), when oil is being withdrawn through port 5 from the chamber to the left of piston 3, this chamber is connected through a port 7 with an oil reservoir 8 mounted on top of the cylinder 4; when oil is introduced through port 5 then the chamber to the right of the piston 3 is connected through a port 9 with the reservoir 8. The connection between port 7 and the reservoir 8 is effected through a pipe 10, in which a pressure gauge 11 is provided and then through a port 12. The port 9 is connected with the reservoir through a pipe 13, and a port 14 in the reservoir. The oil in reservoir 8 is always under atmospheric pressure, an aperture 21 being provided in the closing cap 22. The ports 12 and 14 of the reservoir 8 are controlled by valves 15 and 16 mounted on a common operating rod 17 by means of nuts 18 and 19. The valves 15 and 16 are located in suitable recessed valve chambers 23 and 24 of the reservoir 8, and the rod 17 traverses the reservoir. The valves 15 and 16 are frictionally held around their circumference by the side walls of the corresponding recessed chambers 23 and 24, each valve being suitably perforated at 20 (see Fig. 4) around its periphery to permit the passage of oil. The distance between the valves is such that when one is closed the other is open. It will be seen, therefore, that when oil under pressure is introduced through port 5 then oil will be forced through port 7, and pipe 10 into chamber 23, forcing rod 17 to the right, thus causing valve 15 to close and valve 16 to open. When oil under pressure is introduced through port 6, then valve 16 will close and valve 15 open.

Oil is forced into or withdrawn from the cylinder 4 through pipes 25 and 26 connected at one end with ports 5 and 6, respectively, and at the other end with a delivery pump 27. The delivery pump 27 is suitably mounted on the stand or base 28 of the machine and is driven in any suitable manner, as by an ordinary belt drive, or, for example, by means of an electric motor 29 which is of the non-reversing type and is adjusted to operate at a constant speed. This motor also is mounted on the stand 28 and is connected with the pump 27 or rather with the pump shaft by a suitable coupling 30. The general construction of such pumps is well-known and only a few of the important elements of the pump, shown in connection with the second form of my invention, Fig. 14, will be described herein.

The oil delivery pump or circulating pump 27 includes a swashplate 31 which may be rotated from the power-driven shaft 32 through an intermediate connection of the universal joint character (not shown) as set forth in the Janney patents above referred to. The swashplate 31 rotates in an inclined plane determined by the inclination of the box 31′ adapted to be tilted about a transverse axis 33. A barrel 34′ is held to rotate with the shaft 32, said barrel being provided with a number of cylinders extending lengthwise of the shaft, and containing reciprocating pistons. Two of these pistons are indicated at 34 and 35, and the corresponding cylinders at 36 and 37. Each of the cylinders of the barrel 34′ is provided with a reduced port, such as shown at 38 for each of the cylinders 36 and 37, and these cylinder ports are adapted to register alternately, during the rotation of the barrel, with elongated arcuate ports 39 and 40 (Fig. 6) in the end plate 41 of the pump 27. Port 39 is connected by the pipe 25 with port 5 of cylinder 4, and port 40 is connected by the pipe 26 with the port 6. According to the direction in which the shaft 32 rotates, and according to the inclination of the swashplate 31, the port 39 will be either the suction port or the delivery port of the pump, the other port, 40, being accordingly the delivery port or the suction port of the pump, respectively. The reservoir 8 is connected with the interior of the pump casing through a port 42 in the end plate 41, a pipe 43, and a port 44 (Fig. 2) in the lower part of the reservoir. The broaching cylinder and therefore these various oil connections are the same in both constructions of my invention disclosed herein.

The ports 39 and 40 are also connected, by pipes 45 and 46 respectively, with a valve casing 47 (Figs. 6 and 7) containing a ball valve 48. When oil is under pressure in 45 and under suction in 46, the ball valve 48 will become seated toward the right, as shown in Fig. 7, thus closing off pipe 46 from the casing, and vice versa. The interior of the casing 47, and its outlet (connected with a hose 89, as mentioned below) will therefore always communicate with that pump port 39 or 40 which at the time is the pressure port or delivery port.

As described in detail in the prior patents above referred to, the rotation of the swashplate 31 when inclined will cause the pistons to reciprocate in the barrel cylinders, oil from those cylinders in which the pistons are moving toward the end plate 41, being forced out through the corresponding port of the end plate, for instance port 39, while oil will be sucked through the other port (40) into those cylinders in which the pistons are moving away from the end plate 41. If, with the swashplate 31 in the position shown in Fig. 14, the shaft 32 rotates in such a direction that 39 is the delivery port and 40 the suction port, then, with the shaft 32 rotating in the same direction, but with the tilting box

31′ and the swashplate inclined in the opposite direction to that shown in Fig. 14, oil will be forced out through port 40 and sucked in through port 39. It will be further obvious from Fig. 14 that the rate at which oil is delivered by the pump depends on the length of the piston stroke which in turn is controlled by the angular displacement of the swashplate 31 from the vertical, no oil being pumped or circulated when the said swashplate is in the vertical or neutral position.

In accordance with one embodiment disclosed herein, the rocking of the tilting box 31′, for the purpose of varying the output of the pump, or the direction in which it propels the liquid, is accomplished by a combination of mechanical and hydraulically-operated means illustrated by Figs. 8, 9, and 10. This arrangement is as follows:

The pump casing 27 opens at one side into a cylindrical chamber 60 which is closed at its lower end by means of a screw cap 61, and into the upper end of which a cylinder 62 is screwed. A plunger 63 projects within the chamber 60 and terminates in a block 64 one face of which is in contact with the inner surface of the side wall of said chamber 60. The block 64 is hollowed out at 65, providing a socket for a rocking head 66 in which is fitted slidably an arm 67 fastened to the tilting box 31′.

The upper end of the plunger 63 is screwed into the lower end of a cylindrical sleeve or casing 68. The plunger 63 is perforated at 69 throughout its length. The cylindrical sleeve 68 is provided with two ports 70 and 71 communicating with the cylinder 62 surrounding said sleeve 68. An annular piston 72 provided in cylinder 62 surrounds the sleeve 68, and an inwardly-projecting rim 73 of this piston is held between an annular rib 74 and a nut 75 provided on the sleeve 68, whereby the said sleeve 68 will be compelled to move lengthwise in unison with the piston 72.

A barrel 76 is arranged within the cylinder or sleeve 68, to slide therein. This barrel is provided with a longitudinal duct 77, which for about the upper half of the barrel is co-axial therewith, this half of the duct being composed of two portions of different widths. The lower portion or half of the duct is eccentric, that is to say, is located to one side of the barrel axis, so as to provide room for a short longitudinal duct 78 which extends upwardly from the base of the barrel. The lower end of duct 77 is closed by a plug 98, while the lower end of duct 78 communicates with the interior of sleeve 68 through a port 99 provided at the lower end of the barrel. At different points of its length, duct 77 has ports 80, 79, and the duct 78 has a port 81. The ports 80, 79 open into annular grooves 82, 83 respectively, and the port 81 opens into a relatively wide annular groove 84 on the barrel 76. The three grooves 82, 83, and 84 are so spaced that sufficient surface of the barrel will contact with the cylinder or sleeve 68 to close or free ports 70 and 71 at the same time. The free vertical movement of barrel 76 is limited by a stop 85 projecting from sleeve 68 into a longitudinal groove 86 of the barrel. By means of this stop or pin 85, the barrel 76 and sleeve 68 will be compelled to move together after a predetermined relative displacement.

The upper part of sleeve 68 is widened interiorly at 87 sufficiently to permit the vertical movement therein, of the lower end of a pipe or sleeve 88 surrounding the reduced upper end of the barrel 76. This pipe 88 serves for conveying to the duct 77, liquid supplied through the flexible hose 89 one end of which is connected with the upper end of the pipe 88 (Fig. 8), while the other end of said hose 89 is connected, as shown in Fig. 7, with the outlet of casing 47, to receive liquid under pressure from either the pipe 45 or the pipe 46, as explained above.

The upper end of cylinder 62 is closed by means of a ring 90 having oil ducts 91. An annular projection of ring 90 and packing ring 93 enclose a packing chamber 92 surrounding cylinder 68, the lower end of said cylinder being surrounded with packing at 95. The upper end of barrel 76 has an aperture into which the duct 77 opens but this aperture is normally closed by a screw threaded plug 94, which also secures the pipe 88 to barrel 76.

The vertical displacement of barrel 76 and sleeve 88 is controlled by a lever 100 (Figs. 5 and 8) a forked end 101 of which engages a pair of trunnions 96 projecting from the bent down portion of sleeve 88. The required oscillation of lever 100 is caused in turn by an arm 102 keyed at 103 to one end of a rock shaft 104 carrying at its other end the lever 100. The shaft 104 is journaled in a bearing 105 (Figs. 2 and 5) provided on the casing of a pressure control device 106 (Figs. 12 and 14). The upper end of arm 102 is engaged by a pin 106′ (Fig. 5) projecting through the forked end 107 of a plunger 108. The left-hand end of this plunger is reduced in diameter to form a shoulder 109 and said plunger 108 passes through a screw cap 110 into and through a bushing 111. The reduced end of the plunger is surrounded within the bushing 111 by a piston 112 movable relatively to said plunger and adapted with its right hand end to engage the annular shoulder 109 of rod 108. A shoulder 113 formed near the right hand end of piston 112 serves as a seat for one end of a coiled spring mounted within the bushing 111 and surrounding the larger end of plunger 108, the other end of the spring resting in a recess of cap 110. The movement of piston 112 in a left hand direction is limited by the shoulder 113 engaging a ring 115 which is seated

against a shoulder formed by a narrowed portion 116 of the bushing 111, and cooperates with a screw cap 117, to securely hold a sleeve 118 in position. This sleeve forms a cylinder in which the piston 112 is slidably mounted, and is cut away in such a manner as to form a chamber 119 surrounding a portion of the piston 112 and communicating, by way of perforations 120 and 121, with packing compartments 122 and 123, respectively. The left-hand end of piston 112 protrudes through an opening in cap 117.

The chamber 119 surrounding the piston 112 communicates with a reduced port 124 at the inner end of an axial duct provided in a threaded bolt-like member 125 screwed into a suitable opening of the sleeve 118. The other end of said duct has a radial port which opens into a chamber 126 communicating with pipe 45. Through this channel oil under pressure will be delivered from port 39 and into the chamber 119 for the purpose of actuating the piston 112 against the resistance of the coiled spring 114. Obviously, instead of the coiled spring, other elastic means of suitable character may be provided for thus opposing the actuation of plunger 108 by piston 112 in the manner and for the purpose to be hereinafter set forth more in detail.

The left-hand end of plunger 108 (Figs. 1 and 2) is pivotally connected at 141 with a link 142 having a like connection with an arm 143 mounted rigidly on a shaft 144 having fixed thereto another arm 145. This latter arm is linked with a rod 146 (see also Fig. 11) which is pivotally connected at 147 with an arm 148 secured rigidly to one end of a shaft 149 traversing the body 1 of the broaching machine. A hand lever 150 is fastened to the other end of the shaft 149 on the opposite side of the broaching machine. The free end of arm 148 has a pin 151 projecting therefrom and held in a jaw formed at the end of a guide 152 securely mounted on a rod 153 which is in turn slidably mounted on the body 1 in bearings 154. The rod 153 may be shifted horizontally in response to the rocking of the lever 150 and arm 148, and the extent of its movement and therefore that of the lever's movement may be varied by means of stops 155 engaging projections 156 and 157 provided on the body 1 of the machine, such stops being normally rigid with the rod 153, but adjustable lengthwise thereof. By means of the links described above, the rocking movement of lever 150 is transmitted to the plunger 108.

Having thus described the more important elements of the structure disclosed in Figs. 1 to 11, I will now explain the operation in detail:

Assuming that the tool is at the end of its return stroke, the piston 3 will be in its extreme left-hand position, as shown in Fig. 3. When in the position for the return stroke, the swashplate 31 is inclined in the direction opposite to that shown in Fig. 8, assuming that port 39 is the pressure port or delivery port during the broaching operation. The position of the parts 68 and 76 during the return stroke is as in Fig. 10, and the lever 150 is in its extreme right-hand position, (Fig. 2) in which stop 155 engages projection 157. When it is desired to perform a new broaching stroke, the operator moves the lever 150 to the left, such motion being transmitted, through rod 146, lever 145, shaft 144, lever 143, and link 142, to the plunger 108, which is thus also moved toward the left (Figs. 2 and 5). Arm 102 will thereby be swung in a contra-clockwise direction. Through the agency of shaft 104, the arm 100 also is swung in a contra-clockwise direction, and the trunnions 96 on the forked end 101 will be caused to lift the pipe or sleeve 88 and the barrel 76. After a short upward movement of the barrel 76, the shoulder at the lower end of groove 86 will engage the pin 85. At the same time port 70 will register with annular groove 82, and port 71 with annular groove 84. Oil under pressure will flow from pipe or hose 89 through duct 77, port 80, annular groove 82, port 70, into the chamber below piston 72. This oil will lift the piston 72 together with the sleeve 68, thereby assisting the effort which the operator exerts on handle 150. Through the agency of plunger 63, the tilting box 31′ is rocked or swung in a contra-clockwise direction. When the handle 150 has reached the extreme left-hand position, determined by the engagement of stop 155 with projection 156, the barrel 76 is arrested in its upward motion, in about the position shown in Fig. 8. Owing to the engagement of the lower shoulder of groove 86 with pin 85 and also to the admission of pressure oil into the chamber below piston 72, the sleeve 68 has moved upward together with the barrel 76, while the oil from the chamber above the piston 72 has been expelled through port 71, annular groove 84, port 81, duct 78 and duct 69 into the casing 27 of the pump. When the upward movement of the barrel 76 caused by the manual operation of the lever 150 stops, sleeve 68 continues to move upwardly, owing to the oil pressure below the piston 72, until the port 70 is shut off from the annular groove 82. The sleeve 68 and barrel 76 are then in the position shown in Fig. 8, which is the position for the broaching operation. At the end of this operation, that is, after the piston 3 has moved in cylinder 4 from its extreme left-hand position to its extreme right-hand position, the operator throws the lever 150 in a clockwise direction, thereby forcing barrel 76 downwardly, in which movement it will carry along the sleeve 68, in the same manner as during the upward movement. Fig. 9 illustrates the position at the moment

that barrel 76 and sleeve 68 begin to move downwardly in unison after barrel 76 has moved from the position Fig. 8 to the position Fig. 9. It will be seen that pressure oil from hose 89 will now be admitted to the chamber above piston 72, forcing the latter down. As will be seen clearly from Figs. 8 to 10, sleeve 68 will follow the movement of the barrel 76, and when the latter is stopped, the sleeve 68 will always assume the same position relatively thereto, as shown in Figs. 8 and 10, in which position pin 85 is in the center of groove 86, and ports 70 and 71 are out of communication with the annular grooves 82, 83, and 84.

It will also be apparent that the manual effort exerted by the operator on the lever 150 need only be great enough to move the barrel 76 alone, while the pressure oil, admitted from hose 89, will move the sleeve 68, plunger 63, and tilting box 31', swinging the latter on its axis. The pin 85 merely prevents the barrel 76 from moving faster than the sleeve 68, thereby insuring the proper registry of the ports 71 and 70 with the annular grooves 83 and 84 respectively when the parts are moving downwardly, and the registry of the ports 70 and 71 with the grooves 82 and 84 respectively when the parts are moving in an upward direction.

When the barrel 76 and the sleeve 68 pass through the position which corresponds to the vertical or neutral position of the swashplate 31, the oil from pipe or hose 89 will, for a moment, cease to be under pressure, since at that time the pump is neither sucking nor delivering oil; thus, if oil pressure alone were relied upon to move the piston 72, the movement of said piston and of the sleeve 68 would cease under the special circumstances just referred to. However, as pin 85 is in engagement with either the upper or the lower shoulder of groove 86, depending on the direction in which the parts are moving, the sleeve 68 and piston 72 are carried along past this "dead point" by the manual operation of the lever 150, and pressure oil will again be forced through the hose 89, since the tilting of the swashplate from the neutral position will cause the pump to resume its liquid-propelling action. Oil coming prom the pressure port 39 of the pump will pass through pipe 45 and casing 47 (Fig. 7) into hose 89. The oil pressure will force the ball valve 48 away from the opening at the end of pipe 45 into the casing 47, and against the corresponding opening or seat at the end of pipe 46.

As a further result of such operation of the oil pump, oil under pressure will flow from the delivery port 39 through pipe 25 and port 5 into the annular chamber within the cylinder 4, and to the left of piston 3, thereby causing the piston to move toward the right. From said annular chamber, oil is forced through port 7 and pipe 10 into the recess 23, thereby pushing the valve 15 to the closed or seated position, and the valve 16 to the open position. The gauge 11 in pipe 10 serves for permitting the operator to ascertain the oil pressure at which the piston is being forced to the right.

During the same time, due to the suction exerted at 40, oil is sucked out from the right-hand chamber of cylinder 4, port 6 and pipe 26. This chamber being evacuated of oil, the piston 3 is permitted to move from left to right. Due to the fact that the left-hand annular chamber in cylinder 4 has a smaller cross section than the right hand chamber and the pump operates uniformly, i. e. passes the same quantity of oil through 39 as it takes in through 40, space must be found for the oil that cannot be sucked out of the right hand chamber at the rate required by the advance of piston 3. Such excess oil that cannot be evacuated in time through port 6 will flow through port 9, pipe 13, recess 24, past valve 16, and through port 14 into the reservoir 8.

Sufficient oil is stored in the reservoir 8 to insure that during the operation of the machine all chambers and other spaces be filled with oil. To insure this, a permanently open connection is provided between the reservoir and the pump casing 27 through pipe 43.

The rod 2 will move the broaching tool in a right-hand direction whereby the desired operation will be performed. While the broaching or other operation is thus being performed, oil under pressure delivered through port 39 into pipe 45 will find a branch outlet through chamber 126 (Figs. 5 and 6), perforated member 125, port 124 and into the substantially annular chamber 119. The tension of coiled spring 114 is so adjusted that, in case the hydraulic pressure exerted by the oil in chamber 119 on piston 112 is below a predetermined maximum, such pressure cannot overcome that exerted in the opposite direction by the spring, and the piston will be held in the position illustrated in Fig. 5, leaving the operation of the machine unaffected.

If, however, due to an obstacle encountered by the tool, or to the speeding up of the pump, or to any other cause, oil at a pressure above a predetermined maximum should be delivered through port 39, then the resistance of spring 114 will be overcome, and the oil in chamber 119 will force the piston 112 from left to right. By engaging the annular shoulder 109, the piston will force the plunger 108 to the right, and this will result in a reduction of the flow of oil, in the following manner:

The plunger 108, when moved to the right, will cause the arm 102, shaft 104, and arm 101 to move in a clockwise direction. Through the agency of the trunnions 96, the forked lever 101 will cause pipe 88 and barrel 76 to slide downward within the sleeve 68. After a slight movement of the barrel, the

annular groove 83 will be in registry with the port 71, whereby oil under pressure will be delivered from hose 89, through duct 77, port 79, groove 83, port 71, and into the annular chamber above the ring-shaped piston 72. Under the influence of the pressure of the oil in this chamber, the piston 72 will move downward, the oil in the annular chamber below this piston being forced out through the port 70 which at that time registers with the groove 84, and then through port 81, duct 78, port 99, and channel 69 into the pump casing 27. The piston 72 in its downward movement will take along the sleeve 68 and plunger 63, causing the tilting box 31′ to swing on the axis 33 in a clockwise direction, which, as stated above, will result in reducing the pump output. that is, in reducing the flow of oil.

The downward movement of the barrel 76 with respect to the casing 68 may continue until the stop 85 engages the upper periphery of the groove 86 (Fig. 9) in which position the ports 70 and 71 are entirely exposed to the grooves 84 and 83, respectively. From this point on, if the pressure continues to be exerted on the barrel 76, the latter will continue its downward movement, but the relative positions of the barrel and casing 68 will remain the same as illustrated in Fig. 9. This may continue until the swashplate reaches its vertical position whereupon the pump will cease to circulate oil.

Due to the reduction of the flow in the oil supply system caused by the tilting of plate 31, i. e. the varying of the piston stroke, the pressure in chamber 119 will be overcome by the resistance of spring 114 and the latter will return the piston 112 to its normal position. The operator may learn of the existence of an excessive pressure by reading the gauge and also from the swinging of handle 150 in a counter clockwise direction caused by the rod 108.

As soon as the reading of the gauge and other conditions warrant it, the operator returns the handle 150 into its extreme left hand position causing, in the above described manner, the lifting of barrel 76. When the relative positions of the barrel and casing 68 are such that the port 70 communicates with the groove 82 then oil under pressure will be delivered from pipe 89, through duct 77, port 80, groove 82, port 70, and into the chamber below piston 72. This will cause the upward movement of the piston, the oil in the upper chamber being forced out through port 71, groove 84, port 81, duct 78, port 99, and duct 69 into the casing 27. The piston 72 will move the casing 68 and plunger 63 in an upward direction, whereupon the tilting box 31′ will be returned towards the position illustrated in the drawing. The relative displacement in the upward direction of barrel 76 and casing 68 is again limited by the stop 85 which, by engaging the lower periphery of groove 86 will insure the proper circulation of oil to cause the upward movement of piston 72. When the barrel 76 reaches the limit of its upward movement, the casing 68 will continue its movement under the control of piston 72 until the port 70 is closed and the parts assume the positions shown in Fig. 8. The broaching operation may now continue in the above described manner.

When, upon the completion of the broaching operation, the operator desires to reset the machine, he moves the handle 150 in a clockwise direction until the stop 155 engages the projection 157. Through the agency of rod 108, the barrel 76 will be pressed downward in the above described manner until the pump control mechanism assumes the position shown in Fig. 10. The swash plate 31 is now in the other extreme position than the one illustrated in the drawings, and the pump will draw in at 39 and force oil through 40. Oil will therefore flow from the said pump, through port 40, pipe 26, port 6 and into the chamber to the right of piston 3. This will force the piston from right to left. Furthermore, oil will be pumped through pipe 13 against valve 16 causing the closing of the latter and the opening of the valve 15. Oil will be sucked out of the chamber to the left of piston 3, through port 5, pipe 25, and port 39 into the pump cylinders. Inasmuch as the oil will be evacuated from this chamber at an excessive rate as compared with the advancing of piston 3, oil is continuously supplied to the chamber from reservoir 8 past the open valve 15. Notwithstanding the difference in cross section between the chambers to the left and right of the piston, no vacuum will be created in the former during the right to left movement of the piston.

During this time the pump control mechanism remains in the position shown in Fig. 10. When the operator is ready for the next broaching operation he will again throw the handle 150 to its extreme left hand position. This will result in the lifting of the barrel 76 sufficiently to permit the introduction of oil under pressure through groove 82 and port 70 into the chamber below piston 72, whereupon the mechanism will be returned into the position shown in Fig. 8 in the above described manner. The pistons of the pump will now again be adjusted to control the performing of a broaching operation.

Many other arrangements may be adopted for varying the piston stroke of the delivery pump. A particularly advantageous arrangement is disclosed in the modified structure illustrated in Figs. 12–15. In describing the mechanism and the operation of this modified structure, the same reference numerals will be used as in the previously described case wherever the elements remain the same. Parts that differ from those of the

previous structure will be designated by numerals beginning with 200.

The mechanism through which the tilting box may be rocked is shown in Fig. 13 and is substantially like the one disclosed in said Patent No. 1,020,285 in which a screw 200 may be rotated by means of a gear wheel 201 for vertically displacing a screw block 202 suitably held in a forked extension 203 of the swash plate 31. By rotating the gear wheel 201 in the right hand or left hand direction, the screw block 202 will be caused to move upward or downward and tilt the swash plate 31 in a right hand or left hand direction with the same results as in the previously described structure. The gear wheel 201 is rotated by means of a toothed sector 204 which may be rotated around a shaft 205 mounted on an extension 206 of the casing 106 of the pressure control mechanism. The sector is rotated in one or the opposite direction depending on the direction in which the rod 108 is operated, the movement of the latter being transmitted through a link 207.

It will be seen therefore, that the only difference between the two structures is that whereas in the first case the movement of rod 108 is transmitted to the pump by mechanical and hydraulic means, in the second case such movement is transmitted by purely mechanical means. Of course, the structure illustrated in Fig. 12 responds to excessive oil pressure in the same manner as the one shown in Fig. 5.

It will be apparent from Fig. 15, that the ports 39 and 40 of the pump are, in the present case, connected only with the broaching cylinder, and port 39 through pipe 45 with the chamber 119 (Fig. 12). The ball valve mechanism shown in Fig. 7 is not used.

It will be obvious to those skilled in the art that the mechanism herein disclosed may be adapted to a wide variety of uses, and that the details thereof may be varied within wide limits without departing from the spirit of the invention as defined in the appended claims.

What I claim is:

1. In combination, a pump having variable inlet and outlet ports, a cylinder, a piston in said cylinder, a piston rod projecting in one direction from said piston through said cylinder, two ports in said cylinder connected with the ports of the pump, means to cause said pump to deliver fluid to either one of said two ports and to withdraw fluid from the other port for moving said piston in one or the opposite direction, a reservoir open to the atmosphere, a communicating channel between said reservoir and either end of said cylinder, means for closing the channel to one end of the cylinder when the piston is moved in one direction, means for closing the channel to the other end of the cylinder when the piston is moving in the opposite direction, and a permanently open connection between the reservoir and the pump casing, said two last named means operating automatically in response to fluid pressure conditions in their respective channels.

2. The combination with a machine tool having an operating member movable in one direction to perform a working or cutting stroke and in an opposite direction to perform an inactive or return stroke, of a fluid pressure actuated device connected to said member for actuating it, a reversible fluid pressure pump for delivering fluid under pressure to said device, adjustable means for reversing said pump or varying the output thereof, a combined mechanical and fluid operated control for actuating said adjustable means, a manually operable rod for governing said control and a fluid actuated means directly associated with said rod and receiving fluid from said pump for automatically actuating said adjustable means through said control to reduce the output of said pump when the pressure of the fluid pumped thereby tends to exceed a predetermined maximum.

3. A combination as set forth in claim 2 in which the combined mechanical and fluid pressure control includes a pair of co-operating sleeve valves one connected with the manually adjustable rod, and the other having a fluid pressure cylinder and piston actuated by fluid from said pump associated therewith, said valves being opened by a movement of said rod in either direction from a neutral position, to connect said cylinder and piston with said pump and being automatically closed by a limited continued movement of said piston after the movement of said rod is stopped.

4. The combination with a machine tool having an operating member movable in one direction to perform a working or cutting stroke and in an opposite direction to perform an inactive or return stroke, of a fluid pressure actuated device connected to said member for actuating it, a reversible fluid pressure pump for delivering fluid under pressure to said device, adjustable means for reversing said pump or varying the output thereof, a manually operable lever movable in either direction from a central or neutral position, a longitudinally movable rod operatively associated with said lever and said adjustable means, fluid pressure actuated means operatively associated with said rod and said pump for effecting a movement of said rod and adjustable means in a direction to reduce the output of said pump when the pressure of the fluid pumped thereby tends to exceed a predetermined maximum, said last named means being constructed and arranged to be operative only when said lever and rod have been moved from said central or neutral position in the direction which causes the oper-

ating member of said machine tool to perform a working stroke.

5. The combination with a machine tool having an operating member movable in one direction to perform a working stroke and in an opposite direction to perform a return or inactive stroke, of a fluid pressure actuated device connected to said member for operating it, a reversible fluid pressure pump having an adjustable control for varying the output of said pump or the direction of flow thereof, means for actuating said control including a manually operable rod movable longitudinally in either direction from a central or neutral position, and fluid pressure operated means for automatically preventing excess pressure in said device comprising a cylinder communicating with said pump surrounding a portion of said rod, an annular piston in said cylinder also surrounding said rod and adapted to move said rod towards its neutral position only when the latter has been moved to cause said operating member to perform a working stroke.

6. A combination as set forth in claim 5 in which resilient means are provided for normally holding said piston out of operative engagement with said rod.

7. A combination as set forth in claim 2 in which the manually operable rod is movable in either direction from a central position, and the fluid actuated means associated with said rod includes a cylinder and annular piston surrounding a portion of said rod and being operative to actuate said rod automatically only when said rod has been moved in the direction to cause the operating member of the machine tool to perform a working stroke.

In testimony whereof I have signed this specification.

JOHN ROBSON.