

Aug. 13, 1957

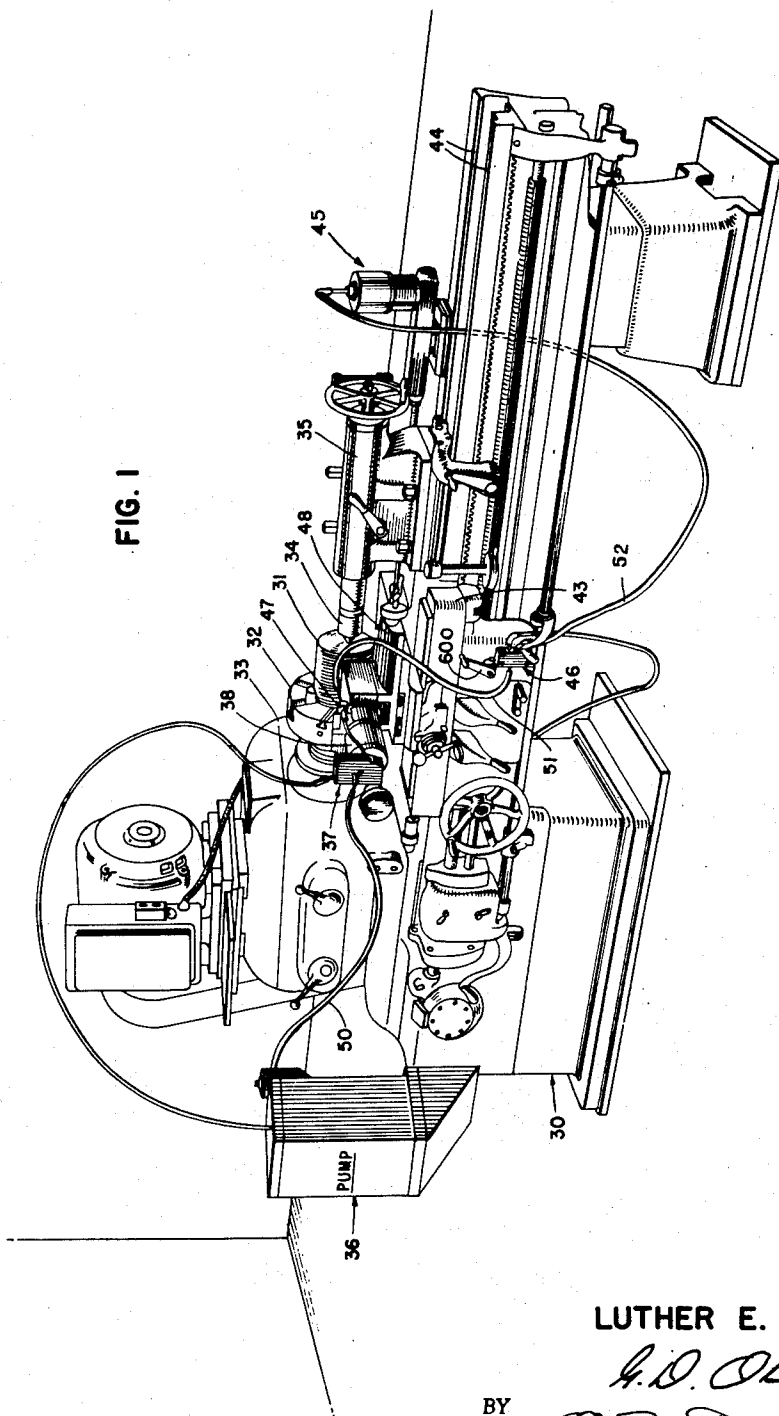
L. E. LEE

2,802,424

PUMP

Original Filed Jan. 20, 1954

8 Sheets-Sheet 1



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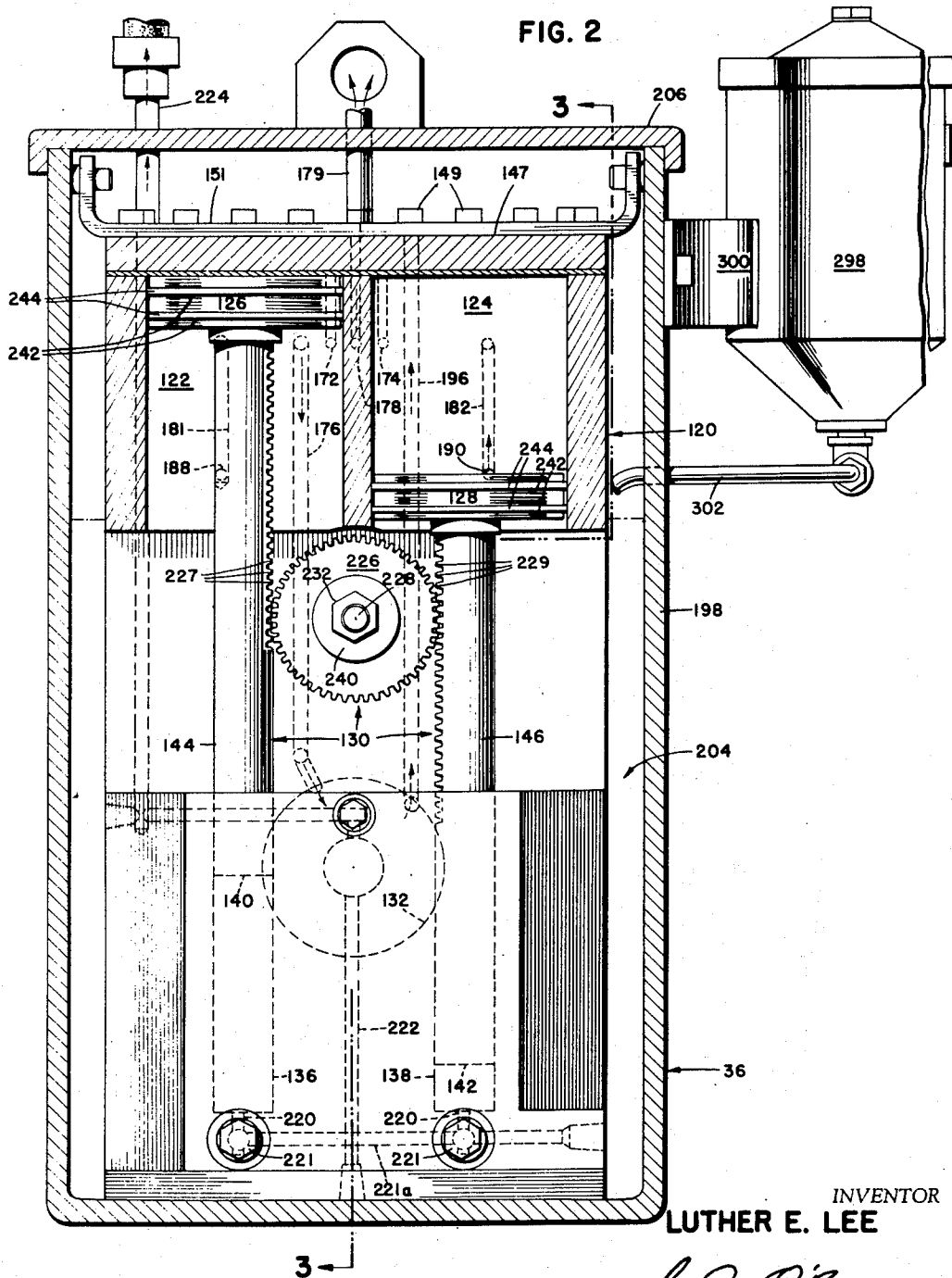
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8 Sheets-Sheet 2



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2,802,424

8 Sheets-Sheet 3

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151

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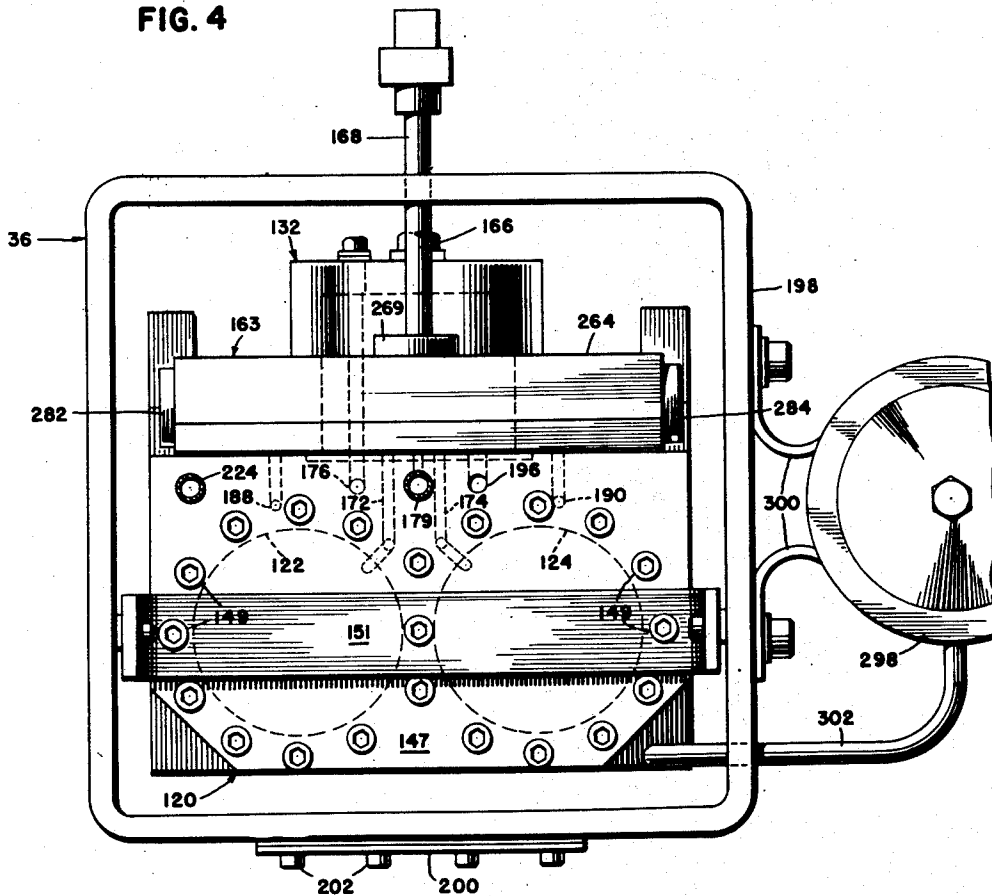
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FIG. 4



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8 Sheets-Sheet 5

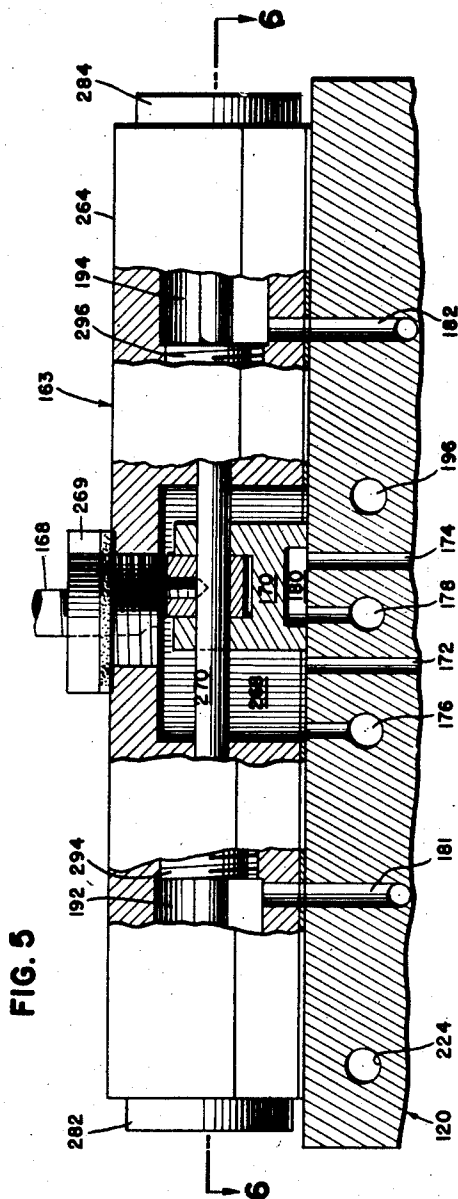
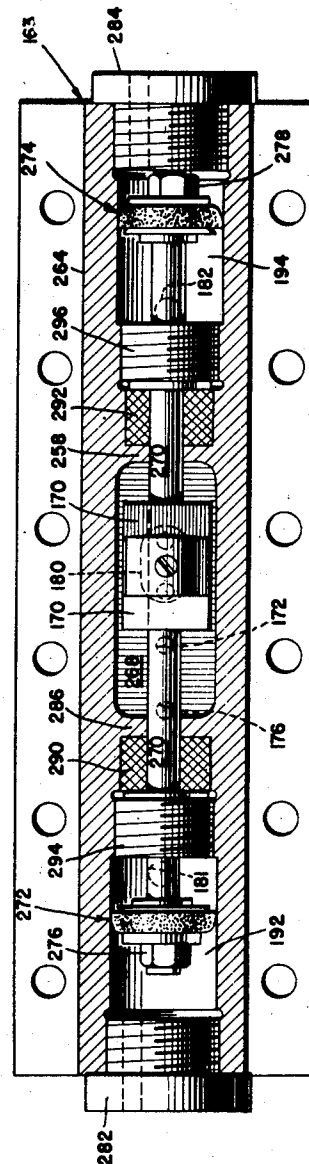


FIG. 6



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8 Sheets-Sheet 7

FIG. 8

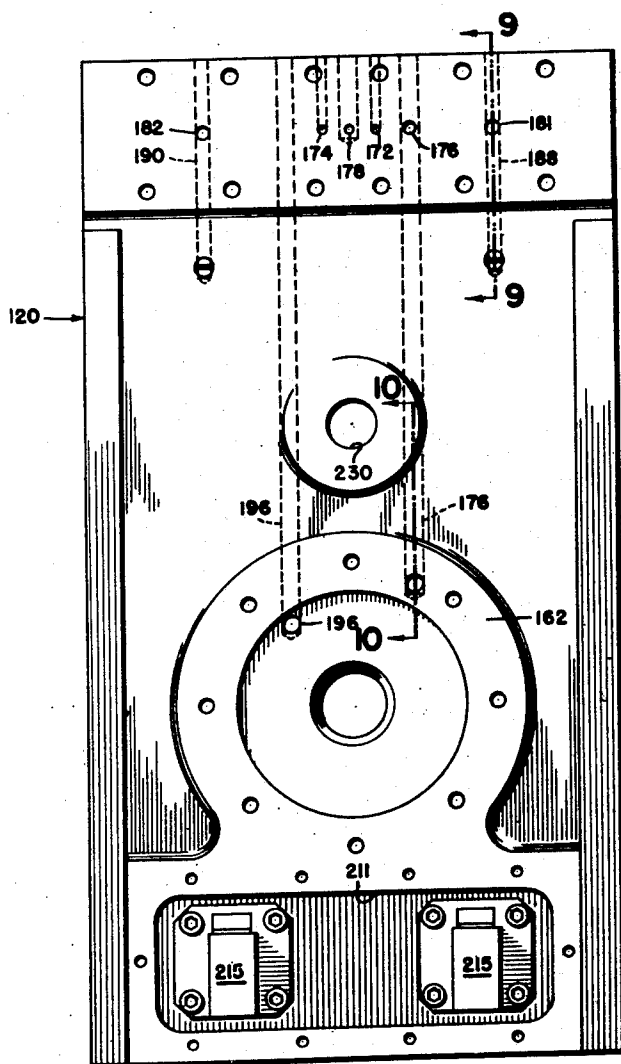


FIG. 9

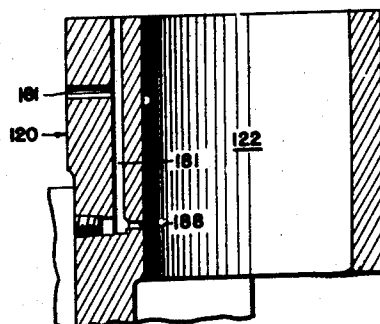
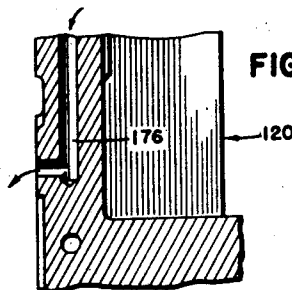


FIG. 10



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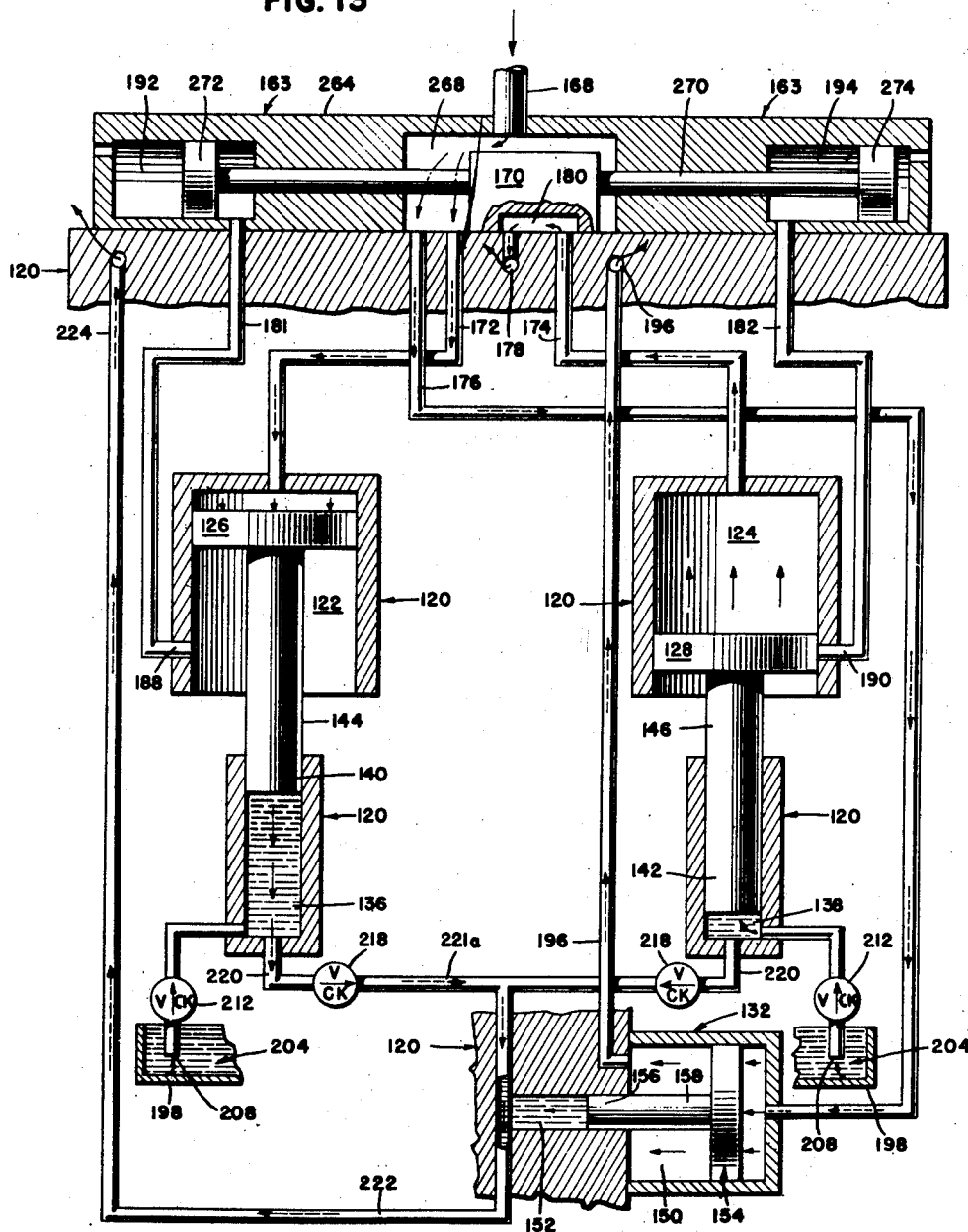
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8 Sheets-Sheet 8

FIG. 13



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2,802,424

PUMP

Luther E. Lee, Takoma Park, Md.

Original application January 20, 1954, Serial No. 405,267.
Divided and this application January 18, 1955, Serial
No. 482,684

11 Claims. (Cl. 103—49)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The instant application is a division of application Serial No. 405,267, filed by Luther E. Lee on January 20, 1954, for Machine Tool.

The present invention relates to pumps and more particularly to pumps particularly well adapted for use with a machine tool for turning and chasing operations and for supplying a concentrated directed stream of high velocity pressure fluid onto a cutting tool or within the proximate vicinity thereof during cutting operations.

Increased production with superior finish and prolonged tool life have long been objectives sought in the machine tool industry. Thus far, however, each of the above factors has been limited by the other factors involved. For example, prolonged tool life normally requires slower operating speeds, and superior finishes necessitates smaller cuts and therefore reduced production is the ultimate result, thus the attainment of one objective can be achieved only by the loss of another objective. Ordinarily the actual manual operating time to perform a metal working function is consumed in making a number of adjustments as the work progresses, returning the working tool for another cutting stroke, and regrinding and resetting the working tool as it wears.

It is contemplated by this invention that by the use of a relatively high pressure directed fluid coolant projected from an appropriately located nozzle to an area immediately proximate the cutting edge of the working tool and the work, appreciably greater tool life and higher rates of metal working will be realized thus contributing to increased production and greater economy.

Therefore, it is an object of this invention to provide a method for cooling the work by directing a cooling fluid under extremely high pressure and at a high velocity to a selected area immediately adjacent to the cutting edge of a tool.

Another object of this invention is to provide a fluid pressure system for projecting a fluid under high pressure to a particular area adjacent the cutting edge to prolong tool life at increased working rates.

Another object of this invention is to provide a fluid pressure system for supplying a group of working machine tool elements with a high pressure fluid as required in the cycle of operation of a suitable machine tool for example.

Another object of this invention is to provide a pumping means actuated by low pressure fluid and operative to supply a fluid at the outlet side thereof at relatively high substantially constant pressure.

Other objects and many of the attendant advantages

2

of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

5 Fig. 1 is a perspective view of an engine lathe embodying the present invention;

Fig. 2 is an enlarged vertical sectional view showing the interior of one form of fluid pump using concepts of the present invention;

10 Fig. 3 is an enlarged vertical sectional view of the pump illustrated in Fig. 2 taken along a line substantially corresponding to line 3—3 of Fig. 2;

Fig. 4 is a top plan view of the pump of Figs. 2 and 3 with the top cover plate removed;

15 Fig. 5 is an enlarged horizontal sectional view of the pump valve taken along a line substantially corresponding to line 5—5 of Fig. 3;

Fig. 6 is a vertical axial section of the valve of Fig. 5 taken along a line substantially corresponding to line 20 6—6 of Fig. 5;

Fig. 7 is an enlarged partial sectional view of the intake and discharge pump valves and the high pressure piston construction of the pump of Figs. 2 through 7;

25 Fig. 8 is a rear elevational view of the pump block with the regulator chamber removed therefrom;

Fig. 9 is an enlarged detailed sectional view taken along a line substantially corresponding to line 9—9 of Fig. 8 and illustrating one of the passages in the block of Fig. 8, extending from the slide valve to a low pressure 30 chamber;

Fig. 10 is a detailed sectional view taken along a line 10—10 of Fig. 8 and illustrating a part of one of the low pressure fluid intake passages leading to the low pressure regulator control cylinder;

35 Fig. 11 is an enlarged sectional view of a cup forming the low pressure side of the regulator chamber taken on a line substantially corresponding to the line 11—11 of Fig. 12;

40 Fig. 12 is an inside end view of the regulator chamber cup illustrated in Fig. 11; and

Fig. 13 is a diagrammatic illustration of the pump system of the present invention.

Referring to the drawings, and particularly to Fig. 1 wherein one embodiment of the present invention is illustrated attached to an engine lathe 30 of any suitable construction in which a workpiece 31 is supported between the chuck 32 mounted on the head stock 33 and the center 34 on the tailstock 35. The lathe may broadly comprise a toolholder and the pump 36 of the present invention designed to develop a relatively high pressure and to deliver a fluid at high pressure through a system of conduits and control valves to a nozzle assembly mounted on the toolholder, the said nozzle assembly being constructed and arranged so as to direct said high pressure fluid adjacent the cutting surfaces of a tool at a high velocity and a pressure in excess of 450 p. s. i. to provide and maintain a cooling effect along the vital tool surfaces by removing the generated heat with sufficient promptness to prevent any appreciable heat effects that might injure either the tool or the work being operated upon by the tool.

By providing a reciprocating pump responsive instantaneously to wide fluctuating demands, a high pressure head may be maintained substantially constant throughout the operations so that fluid operated elements on an associated lathe or other apparatus are supplied with sufficient and uniform fluid pressure under varying loads,

3

The pump 36 has a housing block 120 in which axially displaced cylinders 122, 136 and 124, 138 are formed, and in which differential working pistons 126, 140 and 128, 142 respectively are slidably retained and reciprocated by connection to the gear and rack linkage 130, as shown in Fig. 2, so as to provide for fluid flow during piston reciprocation. A pressure regulator 132 is linked to the discharge sides of the cylinders 136, 138 to maintain the discharge pressure from these cylinders substantially constant by compensating for pressure variation particularly during the dwell periods that occur at the end of each working stroke of the reciprocating pistons. The differential working piston assemblies having intake pistons 126 and 128 and discharge high pressure pistons 140 and 142 are arranged so that the pistons will be slidable parallel to each other when retained in their corresponding cylinders. The low pressure pistons are spaced from the high pressure by elongated piston rods 144 and 146 which are slidably guided within the elongated small high pressure piston cylinders 136 and 138. The piston head surface area of the working pistons 126, 128 and 140, 142 are designed proportionally so as to transmit as by hydraulic ram action the summation of forces acting upon the relatively large piston head surface areas by a relatively low pressure actuating fluid through the elongated piston rods to the relatively small piston head surface areas to act upon a fluid within the elongated small piston cylinders. A housing block head plate 147 is securely mounted as by bolts 149 to seal the upper head end of the low pressure cylinders. Alignment of the block 120 within the jacket 198 is maintained by the U-shaped bracket 151 affixed to the head plate 147 and to the inside walls of the jacket 198.

One effective embodiment of a means for providing for automatic pressure control of the discharge fluid which would normally be delivered in interrupted spurts is to provide a pressure regulator or control 132 in which a differential regulator piston having piston heads 154 and 156, which are proportionally related to the working piston heads, are interconnected by the piston rod 158 that is slidably movable within the pressure regulating cylinder 150. The casing 160 from which the low pressure cylinder 150 of the regulator 132 is formed is securely mounted by appropriate fastening means, such as bolts 164, threaded into the main housing block 120 upon the rear wall 162 and spaced between the piston rods 144 and 146 of the working pistons and outwardly displaced therefrom. A pressure testing tap and plug 166 threadedly engages the end wall of the low pressure chamber casing 160.

A network of passageways drilled in the housing block 120 admit and exhaust the working low pressure fluid to and from the working cylinders 122 and 124 and the pressure regulating cylinder 150, as illustrated in Figs. 2, 3 and 13. A low pressure fluid supply line 168 threadedly retained in the slide valve assembly 163 conducts the low pressure actuating fluid to the slide valve assembly (to be described hereinafter) that selectively controls and transmits the fluid to either of the low pressure cylinder 122 or 124 depending upon the position of the slide valve block 170. In the position illustrated in Figs. 5 and 6, the slide valve block 170, being to the right, will expose the fluid intake passage 172 which will permit the fluid actuating medium to pass directly to cylinder 122. A similar intake passage 174 leading to cylinder 124 is laterally spaced from passage 172. The regulator or control cylinder intake passage 176 is spaced to the left of the intake passage 172 and will remain open to receive low pressure fluid irrespective of slide valve block movement, thus affording free passage of the fluid actuating medium through the passage 176 directly to the pressure regulating cylinder. The cylinders 122 and 124 use a common exhaust passage 178 disposed between the intake passages 172 and 174 that lead to the cylinders 122 and 124 and the exhaust passage 178 will vent the cylinder

4

to which the slide valve block 170 permits communication. For example, Fig. 5 illustrates the slide valve block 170 positioned to the right so that it will cut off the supply of the fluid medium leading to the cylinder 124, and while in this position the valve block 170 will permit a free exhaust between the intake passage 174 of the cylinder 124 and the exhaust passage 178 through the recess 180 in the block 170. The position of the block 170 illustrated in Fig. 5 uncovers the passage 172 to admit a fluid supply to the cylinder 122 while the cylinder 124 is being exhausted. The common exhaust passage 178 connects to the external discharge line 179. Of course, the disposition of the exhausted fluid depends on the fluid medium that is employed, so that, when the actuating fluid is air the exhaust passage 178 and discharge line 179 may be vented to the atmosphere, but, when a liquid medium is used a suitable storage tank may be provided to serve as a reservoir. Spaced laterally from the fluid intake passages 174 and 176 are the valve assembly operating passages 181 and 182 which lead from the valve operating ports 188 and 190 in the lower portion of the cylinder sidewalls to the valve cylinders 192 and 194 respectively to reciprocate the slide valve block 170 in timed sequence with the working pistons 126 and 128. The regulator vent passage 196 which exhausts freely is provided to prevent a fluid cushion effect of the regulator piston during cyclic pressure fluctuations which will occur in pump piston reciprocation.

In the embodiment illustrated, a jacket 198 that surrounds the housing block 120 has a transparent fluid level indicator glass 200 retained in a leakproof manner, as by bolts 202 and suitable gasket material, to an opening 203 in a portion of the jacket sidewall thereby providing a suitable visual indication of the fluid level in the reservoir 204 that is formed between the jacket 198 and the block housing 120. A removable cover plate 206 is secured to the jacket 198 to prevent fluid contamination. Although the jacket illustrated indicates a loose fitting top cover plate for the reservoir it will be used only for stable fluids. However, it is within the contemplation of this invention to utilize a pressurized cover member depending upon the nature of the fluid medium that will be pumped.

Fluid intake or suction passages 208 leading from the reservoir 204 and communicating with the high pressure working piston cylinders 136 and 138 and the high pressure cylinder 152 of the regulator are clearly shown in Fig. 7. Ball checks 212 and flow control valves 213 are mounted in the intake passage lines 208 in the valve body 215 which is secured at the base of the block 120 within the inlet recess 211 that is protectively guarded by filtering screen 214. The inlet mass flow of fluid to each cylinder 136, 138 may be effectively controlled by a flow control valve screw 213 which is threadedly retained in each of the valve bodies 215 in cooperation with a ball check 212 disposed in an inlet passage 208.

Ball check valves 218 urged by compression spring 219, or the equivalent, are placed at the outlet of the high pressure discharge side of the working pistons in the discharge passages 220. The desired discharge pressure may be regulated by varying the spring tension against a ball check 218. The high pressure discharge passages 220 within the block 120 leading from the high pressure discharge side of each of the working pistons 136, 138 and the high pressure side 152 of the regulator control 132 are linked together by line 221a to a common discharge header line 222 that may be coupled to the main outlet line 224 to direct the pumped fluid to the desired application.

Reciprocating movement is imparted to the working pistons through the gear and rack linkage 130, best illustrated in Fig. 2, which linkage is driven by the low pressure fluid medium acting on the working pistons 126 and 128. The differential working pistons have elongated piston rods 144 and 146 disposed intermediate the pistons with rack teeth 227 and 229 thereon to engage the gear

226 which is rotatably mounted on the stub shaft 228 that is supported by the housing block 120. The stub shaft 228 is threaded at both ends and is mounted in the block 120 through the hole 230 and fastened therein by the nut 238. A tapered spacer sleeve 234 on the shaft will orient the gear 226 which may be press fitted on the bearing 236 to the correct position laterally between the piston rod racks 227 and 229, and the nut 232 and washer 240 securely retain the bearing and gear on the shaft 228.

It will be apparent that vertical downward displacement of the right working piston 128 as illustrated in Fig. 2 will cause the gear 226 to rotate clockwise and thereby raise the left working piston 126, and similarly when the left working piston 126 is moved downwardly the right working piston 128 will be raised hence providing for the desired alternate reciprocation of the working pistons.

The relatively large surface areas of working pistons 126 and 128 that receive the low pressure fluid medium are conventional shallow depth pistons with circumferential grooves 242 therein to accommodate split piston rings 244. The piston rods 144 and 146 with the racks 227 and 229 disposed intermediate the rod ends may be secured to the large pistons by a piston pin or by threading the piston and rod for threaded engagement, or any conventional manner. The relatively small pistons 140 and 142 and the regulator control piston 156 on the high pressure side of the pump, as illustrated in Figs. 2, 3 and 7, have circumferential recesses 246 and 248 on the piston rods to accommodate the sealing ring 254 and the fabricated piston head 256. Each of the high pressure piston heads is composed of cup-shaped nonmetallic washers 249 of Teflon, nylon, rubber or other suitable material and centered in position on the end of the rod by the tapered washer 250 and the assemblage is securely mounted as by a bolt 252 threaded into the end of the piston rod.

Slight deviation from the established discharge pressure limits is compensated for by the pressure regulator control 132. The low pressure side of the floating differential piston 154 is similar in construction to the low pressure working pistons 126, 128 but with its low pressure fluid contact surface area relatively proportional to transmit a pressure compensating increment on the high side of the discharge line which is encountered whenever the discharge pressure falls below the established limits. The high pressure side of the differential regulating control piston 156 is designed with respect to the low pressure side to transmit to the pumped fluid the resultant summation of the forces as applied to the low pressure side of the regulator piston 154. Conventional split rings 257 are applied to the regulator piston within grooves 258 on the piston circumferences. The high pressure side of the piston is constructed similar to the high pressure side of the working pistons with the ring washer 254 in the groove 246 and the cup-like washers 249 affixed to the high pressure side of the piston by the bolt 252. Since the relative travel of the regulator control piston is limited during only short periods of pressure fluctuations, the length of the piston rod 158 intermediate the pistons 154, 156 need only be relatively short as compared to the length of the working piston rods 144 and 146. The relative dimensions employed in the one working physical embodiment will be set forth hereinafter.

The slide valve assembly 163 that governs the low pressure intake and exhaust to the working cylinders is housed within the rectangular valve block 264 which is mounted on the housing block 120 as by bolts 266. The ends of the valve block are bored out longitudinally to form cylinders 192 and 194, and the central portion is milled out to provide the rectangular fluid inlet plenum chamber 268 through which the low pressure fluid medium will pass to the inlet passages of the working and regulating cylinders. Axially movable within the valve block 264 is a valve stem 270 having valve pistons 272 and

274 fastened to the ends of the valve stem, as by nuts 276 and 278 or the equivalent, and a throttle or slide valve block 170 having a recess 180 therein to straddle the fluid exhaust passage 178 and a fluid intake passage 172 or 174 to exhaust the actuating fluid medium. The slide valve block 170 is designed so that axial movement in both directions will leave the regulator intake passage 176 open to the inlet supply line 168 and, further, the intermediate position of the exhaust passage 178 will always remain within the recess 180 of the axially movable slide valve block 170, so therefore, only one fluid intake passage will communicate with the exhaust passage 178 during the axial shifting of the slide valve block 170 in either direction. Valve cylinder plugs 282 and 284 are threaded into the valve block to seal the ends of the cylinders 192 and 194, respectively, and at the partition walls 286 and 288, packing glands 290 and 292 and threaded bushings 294 and 296 in each of the cylinders 192 and 194 prevent leakage about the valve stem 270 into the inlet plenum chamber 268. The fluid intake line 168 is connected to the valve assembly 163 through the valve block bushing 269 and the low pressure fluid enters the inlet plenum chamber 268 and passes into the open low pressure inlet passages, one leading to cylinder 122 or 124 and the other leading to the regulator chamber 150. Therefore, it is quite apparent that when one working piston is in its lowermost position, as the working piston 128, illustrated in Fig. 2, the corresponding valve operating port 190 will be uncovered and the low pressure fluid medium will pass through the passage 182 into the valve cylinder 194 to force the piston 274 laterally to the right and thus the entire stem assembly will be shifted to the right. Lateral displacement of the stem assembly will be limited by the right end of the stem 270 striking the inside of the cylinder sealing plug 284 as a stop member thereby exposing the inlet passage 172 to the plenum chamber 268. When in this position the fluid actuating medium in the plenum chamber 268 will then communicate with the passage 172 to admit the fluid to the cylinder 122 thereby depressing piston 126.

To provide for the removal of contaminating impurities a conventional cartridge type filter 298 may be fastened as by a bracket 300 to the outside wall of the jacket 198. The filtered fluid to be pumped is then passed through the feed line 302 into the reservoir 204 preparatory to pumping. By providing a sufficiently large reservoir to enclose the block there is provided a suitable heat transfer medium of sufficient volume to maintain the housing block 120 within desirable operating temperature limits by dissipating the heat generated during pump operation.

Although the operation of the various pump components have been described in detail the general operation of the pump in its entirety, as illustrated diagrammatically in Fig. 13, briefly is as follows: the pump reservoir 204 is filled with a suitable fluid to be pumped and, upon admitting a suitable low pressure fluid medium, such as compressed air, through the inlet line 168 fluid flow will continue through the plenum chamber 268 through the line 172 on into cylinder 122 in which the relatively large working piston 126 is retained and shown positioned in the upward position. In this upward position fluid from the reservoir 204 will be admitted through check valve 212 into the high pressure chamber 136. As the low pressure fluid is admitted into the cylinder 122 piston 126 will be moved downwardly causing the gear 226 which engages the piston rod rack teeth 227 to rotate counterclockwise. Gear 226 is also in engagement with the piston rod rack teeth 229 on the piston rod 146 and upon counterclockwise rotation of the gear 226 the piston 128 will be moved upwardly thereby creating a suction within cylinder 138 which will be sufficient to overcome the spring resistance of check valve 212 in the fluid intake line 208, thus as the high pressure piston continues moving upward the cylinder 138 becomes filled with fluid. Simultaneously with admission of fluid into the cylinder 138, fluid is

being pumped from cylinder 136 previously admitted into cylinder 136. The slide valve assembly 163 having the block and piston assembly therein is shown moved to the right, as in Figs. 5 and 6, with the recess 180 in the slide valve block 170 providing free passage between inlet passage 174 and exhaust line 178 so as to discharge the low pressure fluid from the slide valve piston cylinder 194, after the block 170 is moved to the right, through the valve operating line 182 that leads into the lower portion of the cylinder sidewall into the cylinder 124 which cylinder is then exhausted through line 178 into the recess 180 and then into the discharge passage 178 which is vented to the atmosphere. During pump operation low pressure fluid will pass freely from the plenum chamber 268 through line 176 to the pressure regulator cylinder 150 in which the regulator piston 154 is slidably retained. The piston 156, affixed to the piston 154 through the rod 158, is sensitive to pressure variations in the discharge line 222 and will respond to these variations by a compensating lateral movement. Vent passage 196 taps onto the back of cylinder 150 to prevent a cushioning or locking effect on piston movement. When the piston 126 reaches the end of its downward stroke the low pressure fluid in the cylinder will flow into the slide valve operating passage 181 through port 188 in the sidewall of the cylinder 122. Passage 181 conducts fluid flow to the slide valve piston cylinder 192 so as to shift the valve stem 270 through the piston 272 to the left placing the recess 180 over the inlet passage 172 and exhaust passage 178. In this position of the block 170 the valve piston 192, the line 181 and the cylinder 122 will exhaust to the discharge passage 178. A momentary dwell encountered at the end of piston strokes results in a pressure drop in the discharge line which is then automatically compensated for by the pressure regulating control 132 that is actuated by the low pressure fluid constantly acting upon the relatively large surface area of piston 154 to move the relatively proportional pistons 154 and 156 to the left so that the fluid in the cylinder 152 may be discharged into the common discharge line 222 to compensate for pressure fluctuations. As previously noted when the piston 126 is in its lowermost position and the slide valve block 170 is shifted axially to the left the inlet exhaust line 174 will communicate with plenum chamber 268 and low pressure fluid will be admitted to the cylinder 124 to repeat the cycle described.

It will be apparent that the areas of the pistons 156 and 154 may be so proportioned that the pistons are normally moved to the right during the pressure stroke and will be moved to the left between pressure strokes to maintain a substantially constant outlet or discharge fluid pressure. To do this the area of piston 154 must necessarily be somewhat less than sufficient to oppose the pressure exerted through the area of the piston 156 exposed of the high output pressure. The area of the piston 156 should be sufficient to overcome this high output pressure immediately upon it dropping slightly below the maximum output pressure.

The following piston dimensions represent those for one actual operative pump embodiment:

	Inches
Diameter of working piston, intake.....	3.25
Diameter of working piston, discharge.....	1.00
Diameter of regulator piston, intake.....	3.00
Diameter of regulator piston, discharge.....	1.00

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A fluid operated pump comprising; alternately reciprocating working pistons each having selectively proportioned differential surface areas to impart individual-

ly a ram action on a fluid, a block having cylinders to retain slidably the differential pistons, the interior portions of said block defining a system of fluid passageways therein and inlet and exhaust ports, one of said passageways being a discharge line, a floating piston regulator integral with said block and having a surface area proportionate to the working pistons to compensate for periodic discharge pressure fluctuations encountered during the dwell period of piston reciprocation, and valve means slidably correlated with the position of the working pistons to admit and exhaust the actuating fluid, certain ones of said passageways sequentially functioning as both inlet and exhaust lines in accordance with the position of the working pistons and sequentially connecting the latter to the inlet port and the exhaust port via said valve means, other ones of said passageways connecting said working pistons to said regulator and the discharge line, an additional one of said passageways connecting the inlet port and said regulator, and further ones of said passageways connecting said working pistons to opposite sides of said valve means whereby the latter is positioned in accordance with the position of the working pistons.

2. A fluid operated pump comprising; differential working pistons each having selectively proportionate surface areas to impart individually a ram action on a fluid, a gear and rack linkage interconnecting the working pistons to impart a sliding reciprocating movement thereto, a pressure regulating control to compensate for periodic discharge pressure fluctuations encountered during the dwell period of piston reciprocation, a housing block having cylinders to retain the piston and pressure regulating control and having inlet and exhaust ports, said block having fluid passageways therein, one of said passageways being a discharge line and valve means slidably correlated with the position of the working pistons to admit and discharge the actuating fluid to the cylinders, certain ones of said passageways connecting said working pistons to opposite sides of said valve means to position the latter in accordance with the strokes of the working pistons, further ones of said passageways sequentially functioning as both inlet and exhaust passageways and alternately connecting said working pistons to the inlet and exhaust ports via said valve means in accordance with the position of the working pistons, other ones of said passageways connecting said working pistons to said pressure regulating control and to the discharge line, and an additional one of said passageways connecting the inlet port to the pressure regulating control.

3. A fluid operated reciprocating pump comprising; differential working pistons each having selectively proportioned surface areas, said pistons being operable by a low pressure supply fluid to pump a fluid to increase the discharge pressure, regulator means interconnected and adapted to function with the low pressure supply fluid, said regulator means floating in the system and in fluid communication with the discharge side of said working pistons to compensate for pressure discharge fluctuations encountered during cyclical dwell periods in the reciprocating pump, valve means fluidly actuated in accordance with the position of the working pistons, and a passageway between said valve means and each of the working pistons, said passageway functioning as a common inlet and exhaust line in accordance with the position of the piston individual thereto.

4. A fluid operated reciprocating pump comprising; inlet and exhaust ports, alternately reciprocating working pistons each having relatively proportionate surface areas, a pressure regulator means cooperatively linked with the discharge from said working pistons to compensate for discharge pressure fluctuations, said working pistons and regulator means having a common low pressure fluid supply, and fluidly actuated valve means al-

ternately connecting said inlet and exhaust ports to each of said pistons through a common path for effecting reciprocation of said pistons, said valve means being fluidly actuated in accordance with the position of the pistons.

5. A fluid operated pump comprising; alternately reciprocating working pistons each having relatively proportionate surface areas to produce a hydraulic ram pumping action, a pressure regulator means cooperatively associated with the discharge from said working pistons to compensate for discharge pressure fluctuations, a housing body having cylinders in which the working pistons and the pressure regulator are operatively contained therein, and valve means in fluid driven communication with and slidably correlated with the position of the working pistons to alternately admit and exhaust the actuating low pressure fluid through a common fluid path for each piston.

6. A fluid operated reciprocating pump comprising; reciprocating differential pumping members having relatively proportioned surface areas to produce a resultant ram pumping action, a gear and rack linkage cooperatively engaged with the pumping members to impart reciprocatory movement, a regulator piston interconnected to the discharge side of the pumping members to compensate for discharge pressure fluctuations, said regulator and pumping members being interconnected to receive directly a low pressure actuating fluid from a common supply, and valve means in fluid driven communication with each pumping means to regulate the flow of a low pressure fluid through the valve means and through a single path individual to each of the pumping members.

7. A constant pressure fluid pump comprising; a block having a plurality of laterally spaced and selectively proportioned cylinders therein, fluid actuated reciprocating differential working pistons disposed parallel to each other, each of said working pistons having a relatively large low pressure fluid receiving surface at one end and a relatively small high pressure fluid pumping surface at the other end, a rack disposed between the ends of the working pistons, an idler gear mounted to engage the racks on parallel working pistons to alternately reciprocate said pistons, valve means in fluid driven communication with said pistons to control the sequence of piston reciprocation through the supply and exhaust of the piston actuating fluid via a single fluid path for each piston, a regulator having a pressure compensating differential piston reciprocable within one of said compound cylinders, said regulator piston being proportionally related in area to the working pistons, a supply passageway for the fluid to be pumped interconnecting the high pressure sides of the working piston and the regulator cylinders, a discharge passageway linking the high pressure cylinders, check valves in the supply and discharge passageways to maintain fluid flow in a predetermined path, fluid supply passageways to conduct a relatively low pressure fluid to the relatively large fluid receiving side of the compensating piston of the regulator and to the low pressure side of the working pistons through the valve means, and a jacket surrounding the block to form a reservoir therebetween for a fluid to be pumped.

8. A constant pressure hydraulic pump comprising; a low pressure fluid supply line, a housing block with spaced in-line low pressure cylinders therein, pistons slidably retained for movement in said cylinders, piston rods extending from said pistons, each piston rod having a rack extending longitudinally therealong, a pinion rotatably mounted on the housing between the piston rods for engaging the rack on each piston rod and to impart reciprocatory movement to the pistons, high pressure cylinders proportionally reduced from the low pressure cylinders in said housing, pistons integrally formed with said piston rods slidably retained within the high pressure cylinders, a jacket forming a reservoir surrounding said housing, a low pressure regulator cylinder mounted

on said housing block and proportionately related in area to the low pressure cylinders, said low pressure regulator cylinder being connected in fluid communication with said low pressure fluid supply line, a piston slidably retained in said low pressure regulator cylinder, a piston rod having a piston thereon proportionately related in area to the low pressure regulator piston affixed thereon, a high pressure regulator cylinder fluidly interconnected with said high pressure cylinders, fluid passageways from said reservoir to the high pressure cylinders, check valves in the fluid passageways to direct fluid flow in a predetermined path, slide valve means selectively operable with and fluid actuated through the movement of the alternately reciprocating pistons in the low pressure cylinders, low pressure passageways for admitting low pressure fluid to the low pressure cylinders, and a discharge passageway connected with said high pressure cylinders, said regulator low pressure cylinder being designed to compensate for discharge pressure fluctuations caused during the reversing movement of the reciprocating pistons.

9. A constant pressure fluid pump comprising; a housing block having a plurality of low pressure and high pressure fluid receiving cylinders therein, each high pressure cylinder being in axial alignment with a low pressure cylinder, reciprocating working pistons having proportionate fluid contact areas within said cylinders, piston rods affixed between the working pistons and slidable parallel to each other, rack teeth on the piston rods intermediate the ends, an idler pinion rotatably mounted on the block to engage the rack teeth on the piston rods to effect a gear and rack linkage for the working pistons, a slide valve assembly having pistons mounted to slide in response to the position of low pressure pistons to admit and exhaust an actuating fluid in accordance with the reciprocating sequence of the working pistons in the low pressure cylinders, pressure regulating pistons having fluid contact areas proportional to the working pistons and reciprocable within a low pressure and a high pressure cylinder to compensate for pressure fluctuations occurring during a dwell at the end of the working piston stroke, said high pressure cylinders being in fluid communication with one another, said low pressure cylinders being in fluid communication with one another via said valve assembly, a jacket surrounding the block to form a reservoir retaining the fluid to be pumped, inlet passageways in the block interconnecting the reservoir and the high pressure cylinders, a discharge header interconnecting the high pressure cylinders to receive a high pressure fluid, passageways alternately functioning for sequentially admitting low pressure fluid for actuating the working pistons in the low pressure cylinders and for exhausting the low pressure fluid from the working piston low pressure cylinders to the atmosphere both the admission and exhausting of low pressure fluid occurring through a substantially common path for each low pressure cylinder and via said valve means.

10. A constant pressure fluid pump assembly comprising; a source of low pressure fluid, a reservoir of fluid to be pumped, a discharge header for high pressure fluid, an exhaust vent connected to the pump for venting low pressure fluid, pump means for pumping fluid from said reservoir to said discharge header, valve means in fluid driven communication with said pump means for alternately connecting the latter to said source and said exhaust vent by one fluid path, and a pressure regulator operatively connected to said source and the discharge header for actuation in response to a pressure variation in the high pressure fluid within the discharge header.

11. A constant pressure fluid pump assembly comprising; a source of pump driving and valve driving fluid, a reservoir of fluid to be pumped, a discharge header for pumped fluid, pump means for pumping fluid from said reservoir to said discharge header, an exhaust vent in fluid communication via said pump means with said source for venting said pump driving fluid, valve means

in fluid driven communication with said pump means for alternately connecting the latter to said source and said exhaust vent by one fluid path, and a pressure regulator operatively connected to said source and said discharge header for actuation in response to a pressure variation in the pumped fluid.

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