April 14, 1942. B. F. SCHMIDT 2,279,498

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FIG. 1.

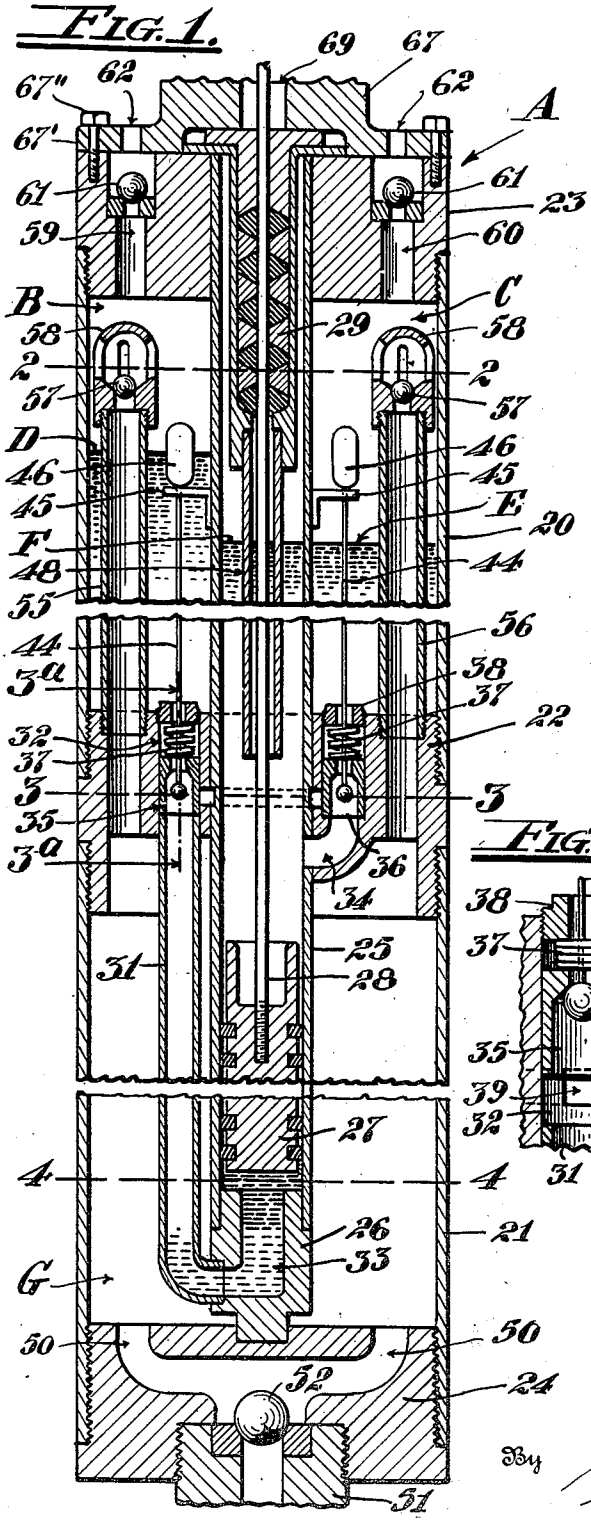


FIG. 2.

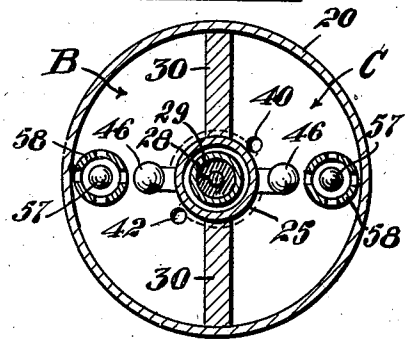


FIG. 3.

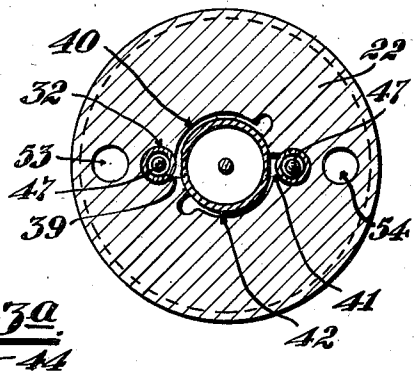
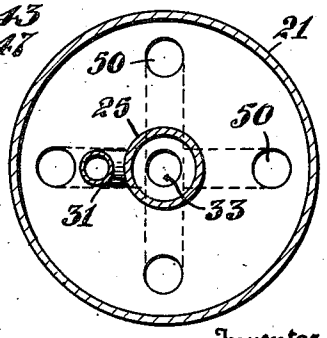


FIG. 3a.

FIG. 4.



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FIG. 5.

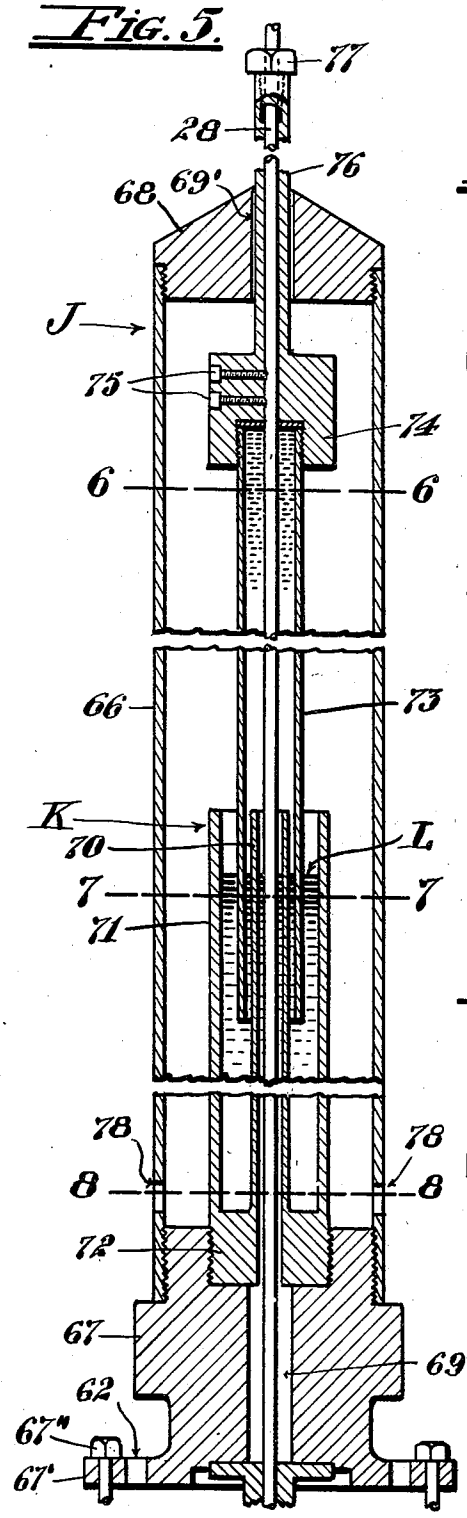


FIG. 6.

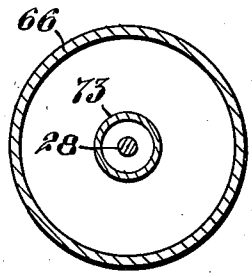


FIG. 7.

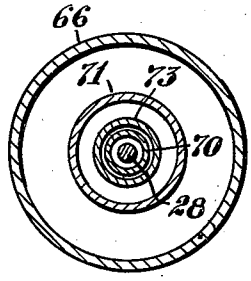


FIG. 8.

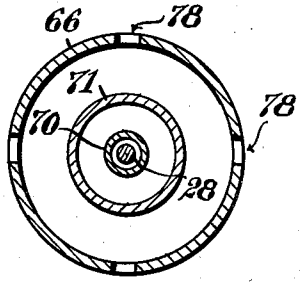
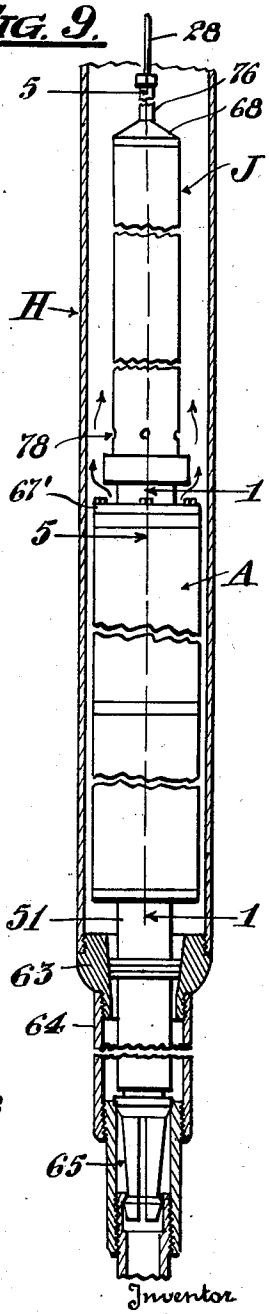


FIG. 9.



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FIG. 10.

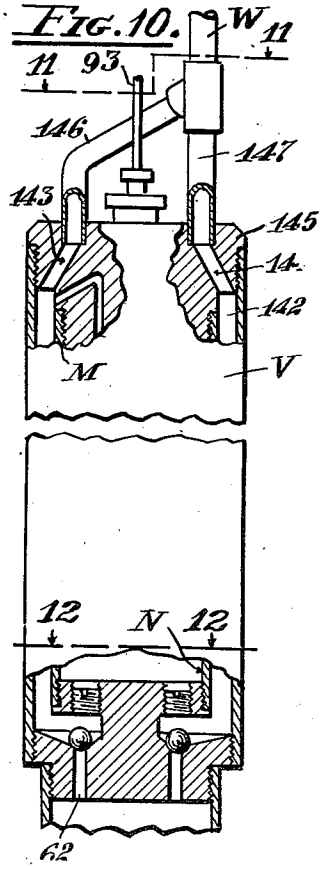


FIG. 11.

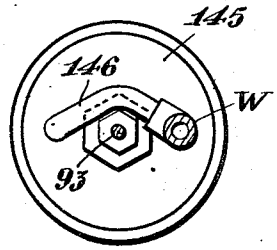
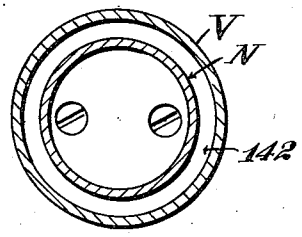


FIG. 12.



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FIG. 13.

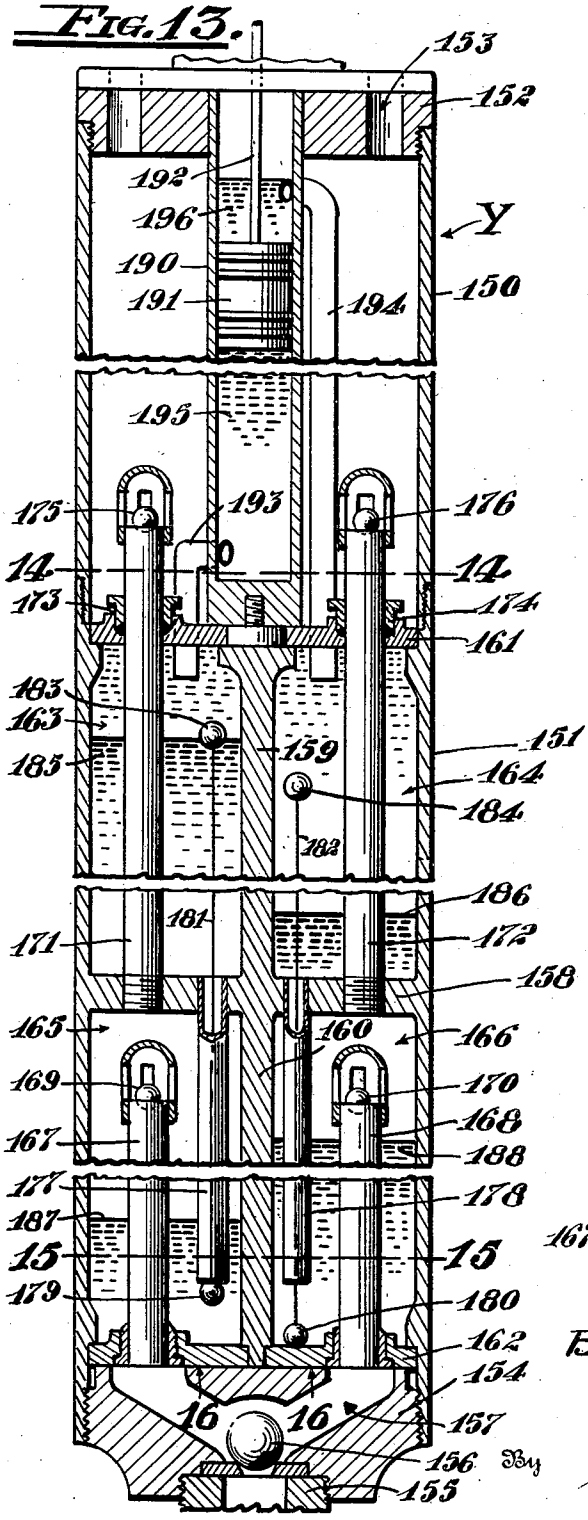


FIG. 14.

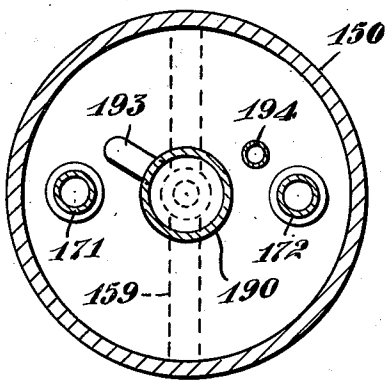


FIG. 15.

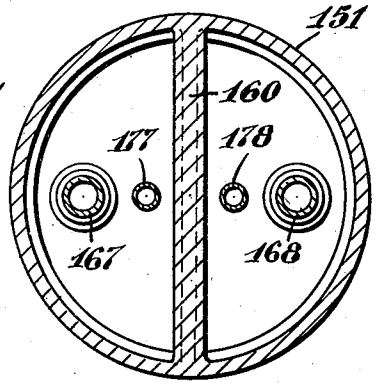
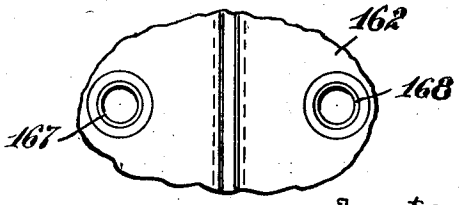


FIG. 16.



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FIG. 17.

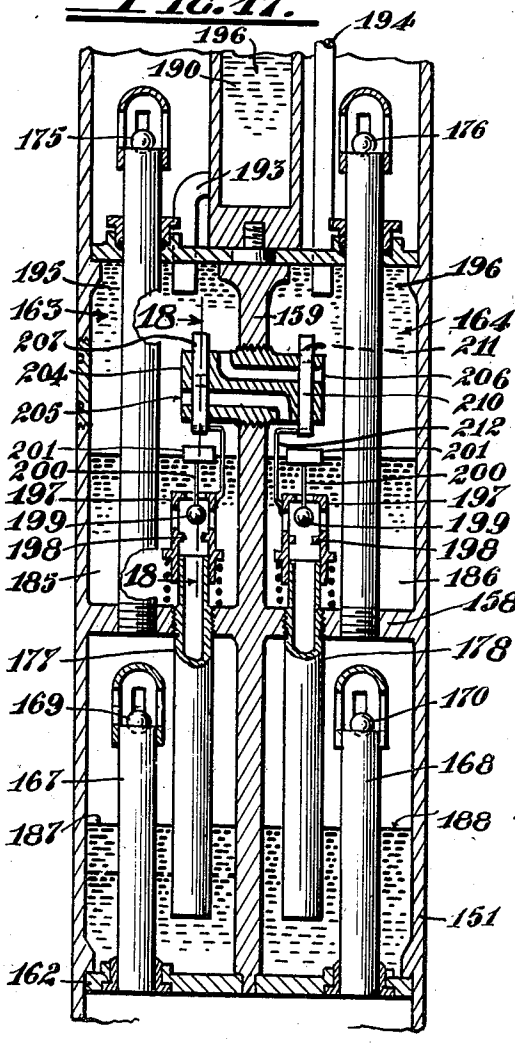


FIG. 18.

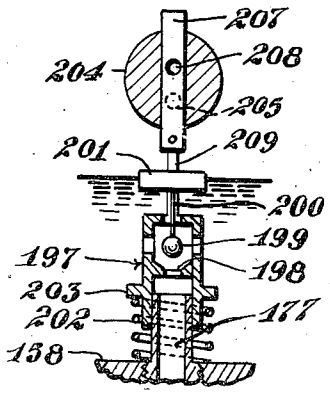


FIG. 19.

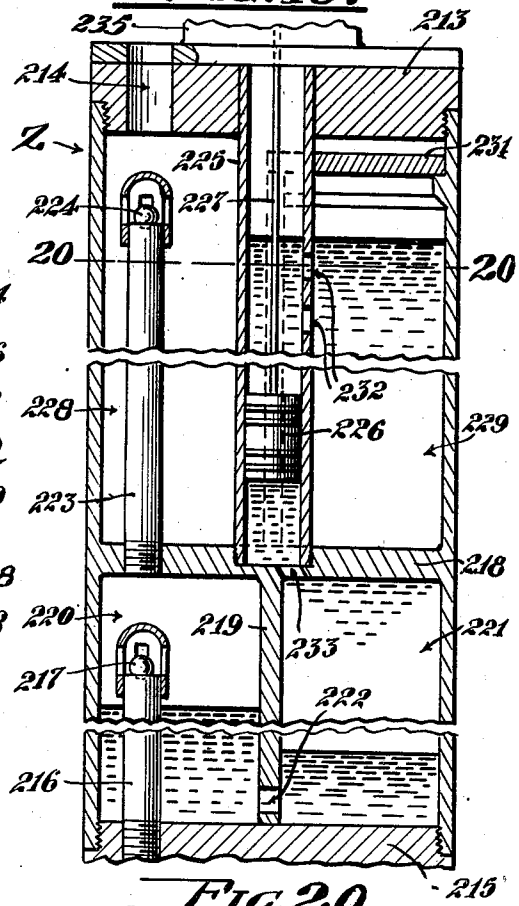
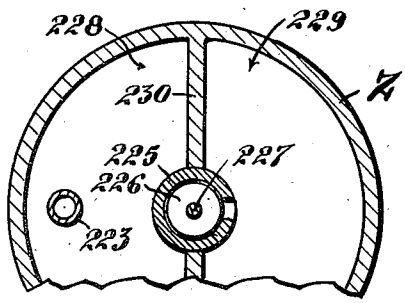


FIG. 20.



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Patented Apr. 14, 1942 2,279,498

UNITED STATES PATENT OFFICE

2,279,498

PUMP

Benjamin F. Schmidt, Los Angeles, Calif.

Application October 22, 1937, Serial No. 170,408

9 Claims. (Cl. 103—165)

This invention relates to a pump and more particularly pertains to a double acting submersible fluid piston pump of the type shown in my co-pending application Ser. No. 166,097 which type of pump is especially applicable for use in pumping liquids from deep wells and particularly in oil well pumping operations.

An object of the invention is to provide a pump embodying a body of fluid of greater specific gravity than the liquid to be pumped, and insoluble therein, herein referred to as "pumping fluid", such fluid being confined within the pump housing in association with a reciprocal piston in such fashion that the level of the fluid will rise and fall on reciprocation of the piston and thereby be caused to effect a pumping action with the aid of the customary valve arrangement to effect intake of liquid to be pumped into the pump on the fall of the fluid level in the pump, and to effect elevation of the liquid within the pump on raising of the fluid level.

While the pumping fluid may comprise any suitable liquid, mercury has been found to be admirably suited for the purpose and it may be used alone or in conjunction with some other fluid having the requisite characteristics.

A particular object of the invention is to provide an effective automatic means for maintaining the working level of the pumping fluid constant irrespective of seepage thereof in either direction past its actuating piston, and whereby the level of the fluid may be maintained at such height within the pump as to prevent the oil or liquid being pumped from coming in contact with the pump piston and piston rod at points where those parts are subject to wear, thus effectively protecting the pump packing and piston rings against excessive wear occasioned by the presence of sand or grit in the liquid being pumped.

Another object is to provide a pump of the above character which is rendered double acting by the employment of a pair of pumping fluid columns arranged to be actuated by a single reciprocal piston in such manner that one of the columns will act to discharge liquid from the pump on the upstroke of the piston while the other column will act to discharge liquid from the pump on the downstroke of the piston.

A further object is to provide a float controlled valve arrangement affording a communication between the pairs of columns of pumping fluid acting to automatically maintain substantially corresponding ranges of travel of the working surfaces of the fluid columns under the displacement action of the reciprocal piston.

While the invention is generally directed to a double acting pump certain features thereof are applicable to single acting fluid system pumps and accordingly the invention is not to be limited to the double acting system.

With the foregoing objects in view, together with such other objects and advantages as may subsequently appear, the invention is carried into effect as illustrated by way of example in the accompanying drawings in which:

Fig. 1 is a view in vertical section taken on the line 1—1 of Fig. 9 showing a portion of the pump containing the pumping mechanism and showing the manner in which the pair of pumping fluid columns are actuated alternately by the reciprocation of a single piston to effect a double acting pumping action;

Fig. 2 is a detail in horizontal section taken on the line 2—2 of Fig. 1;

Fig. 3 is a detail in horizontal section taken on the line 3—3 of Fig. 1;

Fig. 3*a* is a detail in vertical section taken on the line 3*a*—3*a* of Fig. 1 showing the equalizing valve in its open position.

Fig. 4 is a detail in horizontal section taken on the line 4—4 of Fig. 1;

Fig. 5 is a view in vertical section taken on the line 5—5 of Fig. 9 showing a portion of the pump connecting with the upper end of the pump section shown in Fig. 1 and showing the manner of effecting a seal around a vertically reciprocal sucker rod, where such rod is employed in operating the pump piston from a point remote from the pump;

Fig. 6 is a detail in horizontal section taken on the line 6—6 of Fig. 5;

Fig. 7 is a detail in horizontal section taken on the line 7—7 of Fig. 5;

Fig. 8 is a detail in horizontal section taken on the line 8—8 of Fig. 5;

Fig. 9 is a view in elevation with portions broken away of the assembled pump sections shown in Figs. 1 to 5 depicting the manner of mounting the assembly in a well;

Fig. 10 is a view in elevation partly in section of a modified form of the pump structure showing the pump as adapted to effect discharge through a pipe line connecting with the pump housing;

Fig. 11 is a sectional plan view taken on the line 11—11 of Fig. 10;

Fig. 12 is a detail in section as seen on the line 12—12 of Fig. 10;

Fig. 13 is a view in vertical section partly in elevation of a modified form of the pumping mechanism in which the pumping fluid is shown as comprising mercury in association with a liquid insoluble in the liquid being pumped, and in which pumping fluid the pump piston works.

Fig. 14 is a view in cross section taken on the line 14—14 of Fig. 13;

Fig. 15 is a view in cross section taken on the line 15—15 of Fig. 13;

Fig. 16 is a fragmentary inverted plan view as seen on the line 16—16 of Fig. 13;

Fig. 17 is a view in vertical section with parts in elevation of a modified form of the pumping mechanism shown in Fig. 13;

Fig. 18 is a detail in section as seen on the line 18—18 of Fig. 17;

Fig. 19 is a diagram in vertical section depicting a feature of the invention as applied to a single acting fluid piston pump;

Fig. 20 is a detail in horizontal section taken on the line 20—20 of Fig. 19.

Referring to the drawings more specifically A indicates generally a section of the pump embodying the pumping mechanism and which section as particularly shown in Figs. 1 to 4 inclusive, embodies a housing comprising upper and lower lengths of tubing 20 and 21 respectively which are threaded on and project in axial alignment from opposite sides of a septum 22. The upper end of the upper tubing section 20 is fitted with a cap 23, and closing and threaded on the lower end of the lower tubing section 21 is a coupling block 24.

Extending axially through the cap 23 is a cylinder 25 which passes through the septum 22 and connects at its lower end with a tubular shoe 26 which seats on the block 24 and which cylinder 25 is fitted with a piston 27 affixed to a sucker rod 28 leading upwardly through the cylinder and passing through a packing gland 29 carried on the cap 23; the sucker rod being adapted to be reciprocated longitudinally to effect reciprocation of the piston 27.

The space between the septum 22 and the shaft 23 is divided into two longitudinally extending compartments B and C by partitions 30 as particularly shown in Fig. 2, which partitions extend radially between the outer periphery of the cylinder 25 and the inner periphery of the tubing section 20, and extend vertically between the septum 22 and the cap 23. The compartment B is in communication with the lower end of the cylinder 25 through a tube 31 which extends downwardly from a passage 32 leading through the septum 22 from compartment B; the tube 31 connecting with the passage 33 of the tubular shoe which passage 33 opens to the cylinder 25 below the piston 27.

Leading from the cylinder 25 above the piston 27 is a passage 34 formed in and extending upwardly through the septum 22 and opening to the compartment C. Mounted in the passages 33 and 34 for vertical reciprocal movement are tubular slide valves 35 and 36 normally held in their lowermost seated positions by expansion springs 37 bearing between the upper ends of the valves 35 and 36 and apertured plugs 38 screwed in the upper ends of the passages 33 and 34. The valve 35 normally closes a port 39 at one end of a passage 40 formed in the septum 22 and opening upwardly into the compartment C. The valve 36 normally closes a port 41 at one end of a passage 42 formed in the septum and opening to the compartment B.

The valves 35 and 36 are formed at their upper ends with normally open passages 43 through which loosely extend vertical stems 44 slidably supported in guides 45 carried by the cylinder 25. The stems are fitted at their upper ends with floats 46. The lower ends of the stems 44 are fitted with ball valves 47 which are adapted to be moved upwardly under the urge of the floats 46 to effect closing of the passages 43.

The compartments B and C are partly filled with columns D and E of mercury in which the floats 46 are buoyantly supported. The mercury column D in compartment B leads to the lower end of the piston 27 through the valve 35, tube 31 and passage 33. The mercury column E in the compartment C extends into the cylinder 25 above the piston 27 through the valve 36 and passage 34. A mercury column F is formed within the cylinder 25 above the passage 34 into which projects a tube 48 leading downwardly from the packing gland 29 and loosely encircling the sucker rod 28. The surfaces of the parts contacted by the mercury are silvered.

The block 24 at the lower end of the section A is fitted with intake passages 50 connecting with an intake pipe 51 fitted with a foot valve 52; the passages 50 opening to a chamber G extending between the block 24 and the septum 22. Formed in the septum 22 are passages 53 and 54 which lead upwardly therethrough and connect with vertically extending tubes 55 and 56 leading upwardly through the mercury columns D and E in the compartments B and C and terminating above the maximum level of the surfaces of the mercury columns. The upper end of each of the tubes 55 and 56 is fitted with an upwardly opening ball check valve 57 arranged in a cage 58. The passages 53 and 54 and the tubes 55 and 56 afford communications between the chamber G below the septum 22 and the upper portions of the chambers B and C extending above the mercury columns D and E.

The cap 23 at the upper end of section A is formed with a pair of discharge passages 59 and 60 leading from the chambers B and C respectively, each of which passages is fitted with an upwardly opening ball check valve 61. The upper ends of the passages 59 and 60 above the valve 61 may be in open communication through ports 62 with the interior of a tube H in which the housing A is mounted as shown in Fig. 9, and which tube H leads upwardly in a well bore to any suitable point of discharge, or the ports 62 may be connected with a separate pipe line as shown in Fig. 10 as will be later described.

Where the sucker rod 28 is reciprocated from a point remote from the pump housing it is necessary to anchor the latter in the casing H. As here shown in Fig. 9 this is accomplished by extending the intake pipe 51 downwardly through a reduction coupling 63 on the lower end of the casing H and through a reduced length of tubing 64 connected with the coupling 63, and fitting the lower end of the intake tube with a standard pump fitting 65 adapted to be latched into engagement with the reduced end portion of the pump intake in a conventional manner.

Where the sucker rod 28 is to be reciprocated from above and remote from the housing A, means are provided for affording a seal for the sucker rod above the packing gland 29, so as to effectively prevent sand or grit contained in the liquid being pumped from entering the gland. This means as particularly shown in Figs. 5 to 9 inclusive embodies a housing J including a cylindrical jacket 66 fitted at one end with a coupling block 67 having a base flange 67' which flange is formed with the outlet openings 62 and which is detachably connected to the cap 23 of the pump section A by bolts 67''. The other end of the jacket 66 is fitted with a cap 68. The coupling block 67 and cap 68 are formed respectively with axially aligned openings 69 and 69' through which the sucker rod 28 extends and leads up-

wardly to any suitable reciprocating mechanism not necessary to be here shown.

Carried on the coupling block 67 interiorly of the housing J is a mercury trap K embodying a pair of spaced concentric tubes 70 and 71 extending vertically in the jacket 66 axially thereof with the inner tube encircling the sucker rod 28 in spaced relation thereto. The lower ends of the tubes 70 and 71 are connected together by a wall 72 which is screwed into engagement with the coupling block 67. A column L of mercury is arranged in the space between the tubes 70 and 71, and extending into the mercury column L intermediate the tubes 70 and 71 in concentric relation thereto is a tube 73 which is open at its lower end and which extends upwardly around the sucker rod 28 and connects with a collar 74 fastened to the rod as by screws 75; the collar 74 being spaced relative to the upper ends of the tubes 70 and 71 and to the cap 68 to permit the requisite pumping stroke of the sucker rod. The collar 74 is formed with a tubular extension 76 which leads upwardly around the sucker rod in close contact therewith and passes through the opening 69' in spaced relation to the walls of the latter to permit ingress of the liquid being pumped freely into the upper end of the housing J. The upper end of the extension 76 is fitted with a packing gland 77 to effectively seal the joint around the sucker rod.

The jacket 66 is formed adjacent the lower end thereof with a series of openings 78 to permit the escape of sand or other solids settling out of the liquid contained in the jacket 66.

In the construction of the pumping mechanism depicted in Fig. 1 and previously described, the pump piston 27 is set forth as operating directly in a body of mercury. The invention, however, is subject to modification in this respect by a construction and arrangement whereby while utilizing a pair of mercury columns as fluid pistons such columns may be acted on by another liquid insoluble in the liquid being pumped and in which such other liquid the pump piston works. A form of this modified construction is illustrated in Figs. 13 to 16 inclusive in which Y indicates generally the pump housing which embodies upper and lower tubular sections 150 and 151 respectively, which sections are screwed together at their adjacent ends. The upper section 150 is fitted with a cap 152 formed with discharge openings 153 and the lower end of the lower section 151 is fitted with a coupling 154 connecting with an intake pipe 155 and fitted with a foot valve 156 arranged in a passage 157. The lower section 151 is formed intermediate its end with a septum 158 from the opposite sides of which extend diametrical partitions 159 and 160 leading to end walls 161 and 162 closing the upper and lower ends respectively of the section 151; the partition 159 dividing the upper portion of the section 151 into a pair of chambers 163 and 164 and the partition 160 dividing the lower portion of the section 151 into a pair of chambers 165 and 166.

Leading upwardly into the chambers 165 and 166 is a pair of tubes 167 and 168 the lower ends of which open to the passage 157 through the end wall 162 and the upper ends of which open to the upper portions of the chambers 165 and 166 but are normally closed by ball valves 169 and 170.

Leading upwardly from the septum 158 on opposite sides of the partition 159 is a pair of tubes 171 and 172 which open at their lower ends to the chambers 165 and 166 and have their upper ends extending through packing glands 173 and 174 in the end wall 161; the upper ends of the tubes 171 and 172 opening to the interior of the upper section 150 of the pump housing but being normally closed by ball valves 175 and 176.

Leading downwardly from the septum 158 into the chambers 165 and 166 are tubes 177 and 178, the upper ends of which open to the chambers 163 and 164 at the upper face of the septum and the lower ends of which open to the chambers 165 and 166 adjacent to but spaced from the end wall 162. The tubes 177 and 178 are fitted at their lower ends with float controlled valves 179 and 180 which are in the form of balls and are carried on stems 181 and 182 which pass upwardly through the tubes 177 and 178 and are fitted at their upper ends with floats 183 and 184 respectively; the floats being arranged in the chambers 163 and 164 in which chambers are arranged columns 185 and 186 of mercury which connect through the tubes 177 and 178 with mercury columns 187 and 188 in the compartments 165 and 166 and which columns 187 and 188 constitute portions of fluid pistons which contact liquids being pumped.

Arranged in the upper pump section 150 is a cylinder 190 the lower end of which is connected to the end wall 151 and the upper end of which fastens to the cap 152; the cylinder 190 being fitted with a piston 191 carried on a vertically reciprocal sucker rod 192. The lower end of the cylinder 190 communicates with the chamber 163 through a conduit 193 which leads from the lower end portion of the cylinder downwardly through the partition 161 and opens to the chamber 163. The upper portion of the cylinder 190 above the piston 191 is in open communication with the chamber 164 through a conduit 194 which opens at its upper end to the interior of the cylinder 190 and has its lower end extending through the partition 161 and opening to the chamber 164.

Arranged in the space extending between the level of the mercury column 185 through the upper portion of the chamber 163, conduit 193 and lower portion of the cylinder 190 below the piston 191, is a body of liquid 195, and occupying the space above the mercury column 186 in the chamber 164 and extending through the conduit 194 into the upper portion of the cylinder 190 above the piston 191 is a body of liquid 196. The liquid bodies 195 and 196 are composed of liquids of specific gravities exceeding that of the liquids being pumped and also insoluble in the latter. It will be manifest that in the construction just described the piston 191 will work in the liquid bodies 195 and 196 and in effecting displacement thereof will displace the mercury columns 185 and 186 without coming in contact therewith.

In the construction shown in Fig. 17, which constitutes a modified form of the construction shown in Fig. 13, corresponding reference characters designate corresponding parts in the two views. In this instance the upper end portions of the tubes 177 and 178 extend into the chambers 163 and 164 a short distance above the septum 158 and slidably mounted on the protruding end portion of each of the tubes 177 and 178 is a sleeve 197 fitted with a valve seat 198 and a float controlled valve 199 which latter is in the form of a ball and is carried on an upwardly extending stem 200 fitted at its upper end with a float 201 as particularly shown in Fig. 18. The sleeve 197 is normally maintained in an elevated position under the urge of a spring 202 bearing

between the septum 158 and the flange 203 on the sleeve 197.

Mounted in the partition 159 is a valve block 204 the opposed ends of which protrude into the chambers 163 and 164 above the sleeves 197, and formed in the valve block 204 is a pair of passages 205 and 206 opening at their ends to the chambers 163 and 164. Mounted on the block 204 is a vertically reciprocal slide valve 207 controlling the passage 205; the valve 207 having a port 208 arranged to be positioned in and out of register with the passage 205. The lower end of the valve 207 is connected by a rod 209 to the sleeve 197 on the tube 177.

Mounted in the portion of the valve block 204 extending into the chamber 164 is a slide valve 210 for controlling the passage 206; the valve 210 having a port 211 arranged to be moved in and out of register with the passage 206 on vertical reciprocal movement of the valve 210 which latter is connected by a rod 212 with the sleeve 197 carried by the tube 178.

The passages 205 and 206 open to the chambers 163 and 164 above the levels of the mercury columns 185 and 186 in the chambers and serve when opened to afford a communication between the liquid columns 195 and 196 contained in the chambers 163 and 164 above the mercury columns 185 and 186 on opening of either of the valves 207 or 210, so that transfer of liquid from the column 195 may be made to the liquid in the column 196, or vice versa, as may be required in order to maintain an approximate balance of the bodies of such liquids on opposite sides of the piston 191 in compensation of leakage of the liquids past the pistons.

The feature of the invention of operating the piston apart from a body of mercury is applicable to other forms of mercury piston pumps than above described. As an example, the application of this feature to a single acting mercury piston pump is illustrated in Figs. 19 and 20, in which Z indicates a pump cylinder having an upper end wall 213 formed with a discharge outlet 214; the cylinder also having a lower end wall 215 from which upwardly extends an intake tube 216 fitted at its upper end with a ball check valve 217. A septum 218 is provided intermediate the ends of the cylinder Z from the under side of which extends a diametrical partition 219 leading to the end wall 215 and dividing the sleeve below the septum 218 into two chambers 220 and 221 which are in communication with each other through an opening 222 formed in the lower portion of the partition 219. The intake tube 216 extends into the chamber 220 and leading from the upper portion of the latter to the septum 218 is a tube 223 which projects above the septum 218 to adjacent the end wall 213 and is fitted at its upper end with a ball check valve 224. Extending between the end wall 213 and the septum 218 is a cylinder 225 fitted with a vertically reciprocal piston 226 carried on a sucker rod 227. The space above the septum 218 is divided into two chambers 228 and 229 by a partition 230 leading from diametrically opposed portions of the cylinder 225. The upper end of the chamber 229 is closed by a wall 231 and formed in the cylinder 225 are openings 232 which afford a communication between the interior of the cylinder and the chamber 229 above the piston 226. The lower end of the cylinder 225 communicates with the chamber 221 through an opening 233 formed in the septum 218.

In the operation of the invention, as depicted in Figs. 1 to 12 inclusive, to effect a pumping action the sucker rod 28 is reciprocated as by means of a suitable pump operating mechanism. Reciprocation of the sucker rod 28 actuates the piston 27 which on a down stroke operates to elevate the mercury column D and on an up stroke to elevate the mercury column E; the column D moving downwardly on the upstroke of the piston and the column E moving downwardly on downstroke thereof. On each down stroke of a mercury column, liquid to be pumped flows into the chamber G through the check valve 52, and flows through the tubes 55 and 56 into the upper portions of the chambers B and C and from which chambers the liquid is discharged upon upstroke of the mercury columns through the outlets 62.

In event the volume of the mercury in either of the columns D and E be excessively increased such as to raise the level thereof to an appreciable extent, the float 46 in such increased column will move upwardly and effect closing of the passage 43 in the sleeve valve 35 or 36 by the valve 47, as shown in Fig. 3a. When this occurs upward movement of the body of mercury below the then closed sleeve valve 35 or 36 under influence of the piston 27 will cause such sleeve valve to move upwardly and thereby uncover its associated port 39 or 41 such as to direct a portion of the mercury then in the space below the slide valve through the passage 40 or 42 into the chamber B or C and into the diminished column of mercury therein. The succeeding stroke of the piston 27 will occasion a reduction of pressure below the then elevated sleeve valve and will effect a consequent opening of the ball valve in opposition to the float 46, whereupon mercury in the amplified column thereof will flow back through the sleeve valve into the space therebeneath until a balance of pressures on opposite sides of the sleeve valve will be reached, thus reducing the volume of mercury in the column of excessive height.

As before described the sucker rod 28 where reciprocated from a point remote from the submerged pump is passed through a protective housing J as shown in Fig. 5 for preventing the ingress of sand or grit to the pump packing gland 29 and the operation of which is apparent.

In the operation of the pump structure as illustrated in Fig. 13, down stroke of the piston 191 forces the body of heavy fluid 195 therebeneath downwardly through the tube 193 into the chamber 163 thereby forcing the mercury column 185 downwardly through the tube 177 causing the valve 179 to open and thereby effecting delivery of a portion of the mercury column 185 into the mercury column 187 in the chamber 165, thus elevating the level of the mercury column 187 so as to elevate pumped liquid previously trapped in the chamber 165. The liquid thus elevated will be delivered through the tube 171 past the valve 175 and through the upper portion of pump cylinder Y to discharge through the outlets 153. During this down stroke of the piston 191 the valves 176, 170 and 156 will open while the valves 169 will close either under the urge of well pressure or the suction induced by the piston 191. This latter action effects downward displacement of the liquid body 196 acting to elevate the liquid body 196 in the chamber 164 thus causing the then lowered level of the mercury column 186 to move upwardly in the chamber 164; mercury from the column 188 in the chamber 166 then flowing through the tube

178 past the then open valve 180 to replenish the column 186. The ascending level of the column 186 on reaching the float 184 elevates the latter so as to effect closing of the valve 180 thereby inhibiting further flow of mercury from the column 188 to the column 186. This closure of the valve 180 is timed to occur at the moment the piston 191 reaches its lowermost position. Lowering of the mercury column 188 effects intake of liquid being pumped through the valve 170 and tube 168 and through passage 167 past valve 156.

Manifestly upstroke of the piston 191 will effect reversal of the operation just described and in which operation the valve 179 is closed under the action of the float 183 at the moment the piston 191 reaches its uppermost position.

In order to effect operation of the valves 179 and 180 the floats 183 and 184 are constructed so as to be buoyant in the mercury columns and not be influenced by the lighter bodies of fluid superimposed on the mercury columns. This operation of the valves 179 and 180 serves to maintain the maximum levels of the mercury columns uniform, and prevents excessive pumping of the bodies of liquid 195 and 196 past the piston 191 and whereby the piston 191 is maintained submerged in the pumping fluid.

The parts are shown as positioned in Fig. 6 with the piston 191 as at the termination of its upstroke and about to descend on the downstroke thereof.

In the operation of the structure depicted in Fig. 17, which constitutes a modified form of the structure shown in Fig. 13, movement of the pump piston effects displacement of the mercury columns 185 and 186, and the intake and discharge of the pump liquid in the manner described in connection with Fig. 13. In this instance, however, instead of transferring mercury to maintain the uniform level of the mercury columns as effected in the construction of Fig. 13 such level is maintained uniform in the structure shown in Fig. 17 by transferring of pumping fluid superimposed on the mercury column from one side of the pump piston to the other in compensating for leakage past the piston.

In the arrangement shown in Fig. 17 the parts are shown as disposed in the position occupied when the piston is in its intermediate position, in which position the valves 199 are maintained open by the float 201 so that mercury is free to flow downward through either tube 177 or 178 into the lower chambers 165 or 166 and also flow upwardly from either of the lower chambers to the upper chambers 163 or 164 according to the direction of movement of the pump piston. Assuming that the piston is moving downwardly, the action will then be as follows: The pumping fluid advancing beneath the piston will force fluid in the chamber 163 downwardly thereby lowering the level of the mercury column 185 in the latter to a point where the float 201 in the chamber 163 will advance the valve 199 connected thereto to a seated position on the sleeve 197, which action is timed to occur at the moment the piston reaches its lowermost position. In event there has been a leakage of pumping fluid to the underside of the piston such as to create an excess of the fluid below the piston, such increased downward movement of the mercury column 185 will be effected as to cause the sleeve 197 to move downward and thereby move the slide valve 207 downward therewith. When such movement of the valve 207 is sufficient to open the port 208 to the passage 205 a delivery of a portion of the fluid in chamber 163 to the chamber 164 will take place, thus equalizing the fluid on opposite sides of the piston. On the succeeding upstroke of the pump piston the level of the mercury column 185 will reach normal.

Manifestly, in event of excess pumping fluid being delivered to the upper side of the pump piston, the float 201 in the chamber 164 will act to control the delivery of pumping liquid from the chamber 164 to the chamber 163 through the passage 206 in a manner like that just described.

It will be seen from the foregoing that I have produced a sucker rod operated submersible double action displacement pump embodying a pair of mercury columns constituting fluid pistons which are actuated by a single reciprocating pump piston, and in which the pump mechanism and the associated parts are so formed and arranged as to effectively prevent fluids being pumped from contacting the polished surfaces of the sucker rod or of the pump piston and its encompassing cylinder in which the surfaces of the chamber containing the fluid piston may be silvered so as to prevent gritty or sticky substances from clinging to the walls of such chamber, and in which the pumped liquid as well as the liquid in the well is excluded from packing glands and other wearing parts of the pump, whereby on the pump being set in operation in a well the wearing parts will endure for a prolonged period of time thereby obviating frequent shut-downs for repairs with a consequent loss of production as is common in ordinary well pumps.

In the operation of the structure shown in Fig. 19, downstroke of the piston 226 will act to displace downwardly the pumping fluid beneath the piston through the port 233 and thereby cause mercury to pass from chamber 229 into chamber 228 and thereby elevate the level of the mercury column in the latter to effect discharge of the liquid being pumped through the tube 223 past the valve 224 and through the outlet 214. On upstroke of the piston the pumping fluid thereabove, which is confined between the piston and a packing gland 235 thereabove, will be directed in part through the passages 232 and will act to build up pressure in the chamber 229 due to a volume of air being trapped in the upper end portion of the chamber 229 above the liquid therein, and which pressure will act to assist in the following working downstroke of the piston. The upstroke of the piston also effects intake of the fluid being pumped, through the tube 216 past valve 217 into the chamber 228 to charge the latter in readiness for action thereon on the piston downstroke.

It is manifest that in the constructions shown in Figs. 13, 17 and 19, the pump piston will be encompassed in a fluid body superimposed on the mercury column so that the piston may be maintained out of contact with the mercury.

By finishing the surfaces of the pump contacted by the mercury with a coating of silver, gritty or sticky substances will be prevented from clinging thereto. This coating may be applied in any desired manner, but it is desirable that the inner faces of the mercury containing chambers be lined with thin sheet copper carrying a silver plating on the exposed surface thereof.

While I have shown and described specific embodiments of my invention I do not limit myself to the exact details of construction shown

but may make such changes in the parts and their arrangement as occasion may require coming within the meaning and scope of the appended claims.

I claim:

1. In a submersible pump, a pump housing having a pair of adjacent compartments, a mercury column in each of said compartments, a reciprocal piston in said housing, a passage affording a communication between one of said mercury columns and the lower end of said piston, a passage affording a communication between the other of said mercury columns and the upper end of said piston, means for reciprocating said piston, said housing having a fluid inlet below said mercury columns and a fluid outlet leading from above each of said mercury columns, and means for delivering liquid from the inlet to spaces in said housing above each of said mercury columns, said last named means including tubes leading through said mercury columns, and check valves confining the direction of flow of the liquid through said tubes to an upward direction.

2. In a submersible pump, a pump housing, a pair of mercury columns therein, means for reciprocating said columns, means for delivery of liquid being pumped above said columns, means for discharging the liquid from above said columns, and means for maintaining a balanced relation between said columns.

3. In a submersible pump, a pump housing, a pair of mercury columns therein, means for reciprocating said columns, means for delivery of liquid being pumped above said columns, means for discharging the liquid from above said columns, a pair of passages communicating said columns, normally closed valves controlling said passages, and float operated means controlling opening of said valves to effect transfer of mercury from one of said columns to the other.

4. In a submersible pump, a pump housing, a pair of mercury columns therein, means for reciprocating said columns, means for delivery of liquid being pumped above said columns, means for discharging the liquid from above said columns, a pair of passages communicating said columns, normally closed valves controlling said passages, said valves having normally open valves therein, floats in said mercury columns connected to said last named valves for closing the latter on the mercury level of either of said columns becoming excessive.

5. In a submersible pump, a pump housing, a reciprocal sucker rod extending into said housing from the upper end thereof, a piston on said sucker rod, a cylinder encompassing said piston, a pair of mercury columns in said housing, one of which extends into said cylinder above said piston and the other of which extends into said cylinder below said piston, a pair of passages connecting said columns, normally closed valves controlling said passages, floats in said columns, means connecting said floats to said valves for conditioning said valves to open said passages under the influence of said piston, and a liquid pump actuated by said mercury columns.

6. In a submersible pump, a pump housing, a cylinder in said housing, a piston in said cylinder, a sucker rod connected to said piston extending upwardly through said cylinder and above said housing, a packing gland encompassing said sucker rod, a column of mercury in said cylinder above said piston, a pair of mercury columns in said housing one of which connects with the mercury column in said cylinder and the other of which connects with said cylinder below said piston, means for directing liquid being pumped into spaces in said housing above said pair of mercury columns, means for delivering liquid from said spaces, and means for preventing well liquid and liquid being pumped from entering the packing gland around said sucker rod.

7. In a fluid piston pumping unit arranged to be lowered in a well, a plurality of chambers provided to receive the liquid to be pumped, a valved inlet and outlet in each of said chambers, a fluid insoluble in the liquid to be pumped in said chambers acting as a liquid piston, a reciprocating means for said fluid, a liquid provided to act on said fluid, passageways connecting the liquid and fluid, and passageways connecting the liquid to the reciprocating means which causes said fluid to flow in and out of said liquid chambers upon operation of the reciprocating means for said fluid; means for operating said reciprocating means, means regulating the amount of liquid transferred upon each reciprocation of said reciprocating means, and a means for replacing the liquid acting on the fluid from one chamber to another to its original amount, and a finished surface within the liquid chambers co-operating with the fluid piston to prevent gritty or sticky substances from clinging to the walls of said chambers; means for setting said pumping mechanism in an oil well and means for the operation of same.

8. In a submersible pump, a pump housing having a pair of adjacent compartments, a mercury column in each of said compartments, a reciprocal piston in said housing, a passage affording a communication between one of said mercury columns and one end of said piston, a passage affording a communication between the other of said mercury columns and the other end of said piston, means for reciprocating said piston, said housing having a fluid inlet below said mercury columns and a fluid outlet leading from above each of said mercury columns, means for delivering liquid from the inlet to spaces in said housing above each of said mercury columns, and means for maintaining the mercury columns at substantially constant relative volumes.

9. In a submersible pump, a pump housing having a pair of adjacent compartments, a mercury column in each of said compartments, a reciprocal piston in said housing, a passage affording a communication between one of said mercury columns and one end of said piston, a passage affording a communication between the other of said mercury columns and the other end of said piston, means for reciprocating said piston, said housing having a fluid inlet below said mercury columns and a fluid outlet leading from above each of said mercury columns, means for delivering liquid from the inlet to spaces in said housing above each of said mercury columns, and float controlled means for maintaining the mercury columns at substantially constant relative volumes.

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