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J. S. BERNARD

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MULTIPLE DELIVERY PUMP APPARATUS

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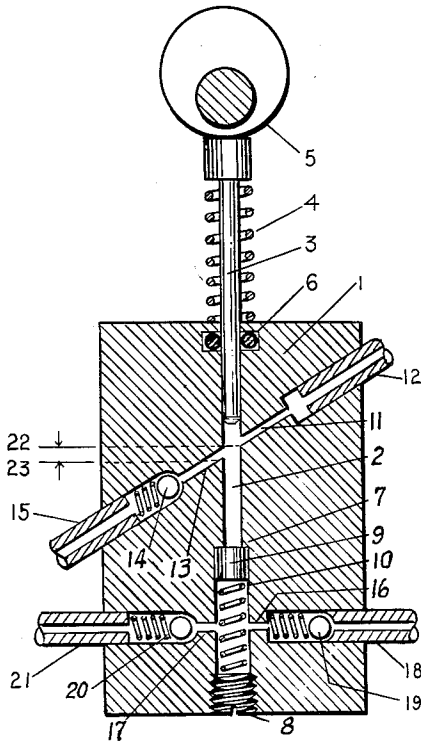


Fig. 1

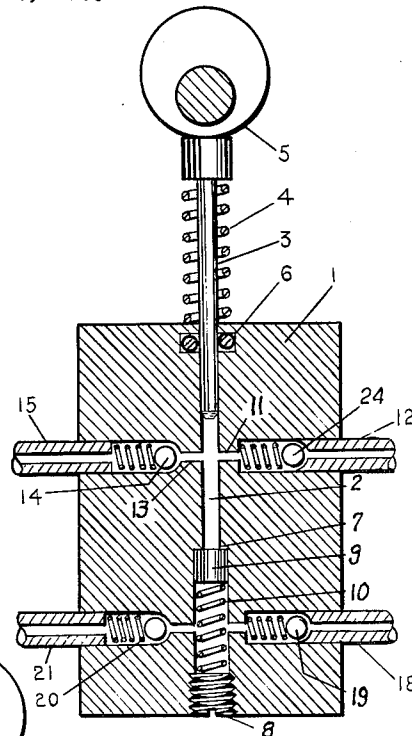


Fig. 2

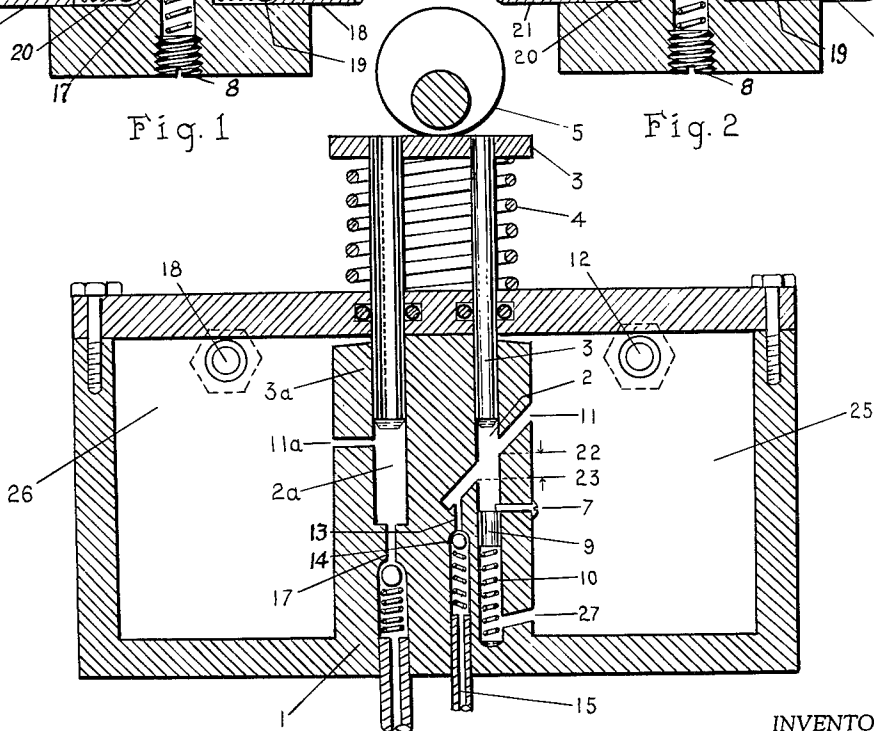


Fig. 3

INVENTOR.

John S. Bernard

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MULTIPLE DELIVERY PUMP APPARATUS
John Springer Bernard, 2060 East 4800 South St.,
Salt Lake City, Utah

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This invention relates to pumping apparatus which pump and deliver liquids by means of a reciprocating piston or plunger, and particularly to those pumps of this class which are employed to meter and deliver specific amounts of liquid, as for example, the fuel-injection pump apparatus employed to deliver liquid fuels into the combustion spaces of an internal combustion engine.

The primary objective of this invention is to provide a pump apparatus having the capability of metering and delivering a plurality of liquids from each of the apparatus cylinder bores during a stroke cycle of the apparatus reciprocating piston or plunger member.

The invention may be usefully employed in the delivery of two different grades of liquid fuels to a main cylinder or other combustion space of an internal combustion engine. One of the fuels being a high test gasoline for ignition with an ignition device and the second fuel being a low test fuel, such as stove oil or diesel, which would be ignited by the first fuel and would furnish the engine's power output.

The principles involved in this invention may also serve to pump two or more liquids of any nature whenever constant or variable amounts of such liquids are desired to be pumped and delivered simultaneously.

The objectives of this invention are obtained by the use of an auxiliary free piston which is adapted to mount and to operate within the cylinders of reciprocating pump apparatus. The inherent characteristics of liquids, namely their inability to compress, are utilized to form a hydraulic coupling between this auxiliary free piston member and the main reciprocating plunger member. This hydraulic coupling is employed to reciprocate the auxiliary piston thereby enabling the auxiliary piston to serve as a second plunger member for the pump apparatus.

Details of the invention are shown in the selected embodiments illustrated on the accompanying drawings. These illustrations, which provide a base for a wide variety of applications, are briefly described as follows:

FIGURE 1 is an end view of a pump cylinder block containing an arrangement of components which will allow the pumping of a constant charge of a primary liquid and a variable charge of a secondary liquid.

FIGURE 2 is an end view of a pump cylinder block containing an arrangement of components which will pump a constant charge of liquid and will allow the ratio of the primary liquid to the secondary liquid to be altered.

FIGURE 3 illustrates an end view of an apparatus which employs the auxiliary free piston concept to aid in the pumping and simultaneous delivery of a constant charge of primary liquid and a variable charge of a secondary liquid.

FIGURE 1 illustrates the preferred method for operating this invention when it is desired to pump a constant amount of a primary liquid and a variable amount of a secondary liquid when the timing of the delivery of such liquids may be staggered. This illustration shows a metal cylinder block 1 containing an elongated plunger member 3 mounted for reciprocation within a cylinder bore 2. The compression spring 4 and the cam 5 serve to illustrate a suitable means for reciprocating the said plunger 3.

This arrangement is not novel. Further, any other suitable arrangement, wherein a reciprocating plunger is made operative within a pump cylinder bore, will be

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satisfactory for practicing these concepts. The arrangement which may be selected should provide that the diameter of the plunger 3 and the bore 2 correspond to provide a reasonably close sliding fit and an arrangement such as a suitable packing nut or the illustrated O ring 6 to prevent seepage from about the stem of the plunger 3. All surfaces exposed to wear should be polished and hardened by some suitable tempering means to insure a long operating lifetime for the apparatus.

My invention is obtained by providing an auxiliary piston 9 positioned below the reciprocating range of the plunger 3. The uppermost portion of the bore 2 has a diameter equal to the diameter of the plunger 3. Below the lowermost reciprocating limit of the plunger 3, the diameter of the bore 2 is increased, thereby forming a right angled offset 7 within the bore 2 at the point of engagement between the smaller and the larger diameters. The auxiliary piston 9 is mounted for reciprocation within the larger lowermost portion of the bore 2 and prevented from ascending into the reciprocating range of the plunger 3 by the offset shoulder 7. A threaded plug 8 is adapted to seal the bore 2 and to adjust the tension on the spring 10 which urges the piston 9 to remain in a normal rest position against the offset 7.

The piston 9 is mounted for reciprocation within the bore 2. In constructing this piston 9 care should be exercised to insure a smooth slidable fit within the bore 2. The interior of the bore 2 and the exterior surface of the piston 9 should be ground smooth and polished so as to permit free reciprocating movement of the piston 9 within the bore 2.

A primary liquid such as a high test gasoline is communicated through the cylinder bore 2 within the reciprocating range of the plunger 3. An intake duct 11 and a discharge duct 13 serve this purpose. An extremity of a pipe 12 may be press fitted or otherwise mounted in the block 1 and communicated with the intake duct 11. And a second pipe 15 may likewise be fitted into the block 1 and communicated within the discharge duct 13. The opposite extremity of the pipe 12 would connect to a primary liquid source and the opposite extremity of the pipe 15 would connect with the point of final delivery for the said primary liquid. A suitable check valve means 14 should be positioned between the inward extremity of the pipe 15 and the discharge duct 13. This valve 14 is not an absolute requirement, but I have found that the apparatus performs better if such a check valve is provided adjacent the bore 2.

A secondary liquid, such as diesel fuel, is communicated through the cylinder bore 2 of the apparatus below the piston 9. An intake duct 16 and a discharge duct 17 serve this purpose. The preferred method for positioning the intake and discharge ducts 16 and 17 is to place these adits below the reciprocating range of the piston 9 and to provide suitable check valve means 19 and 20 to control the directional flow of the liquid between the pipe 18, which communicates the secondary liquid with the intake duct 16, and the pipe 21 which communicates the secondary liquid with the discharge duct 17. The pipe 18 would connect to the source of secondary liquid and the pipe 21 would connect to the point of final delivery of the secondary liquid.

In a normal operation of the apparatus of FIGURE 1 the primary liquid would course from a primary liquid source, through the pipe 12, through the intake duct 11 and would fill the bore 2 between the uppermost extremity of the piston 9 and the lowermost extremity of the plunger 3. The primary liquid would also fill the discharge duct 13 up to the point of contact with the check valve 14.

The secondary liquid would course from a secondary liquid source through the pipe 18, be drawn around the

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check valve 19 and would fill the bore 2 between the inward extremity of the plug 8 and the lowermost extremity of the piston 9. The secondary liquid would also fill the discharge duct 17 up to the point of contact with the check valve 20.

When the apparatus is primed, that is when the primary liquid fills the upper confines of the bore 2, and the secondary liquid fills the lower confines of the said bore 2, a rotation of the cam 5 which exercises downward pressure on the plunger 3 will initially cause the primary liquid to course back through the intake duct 11 and through the pipe 12. After such downward movement causes the pump to pass the bottom of the intake duct 11 at point 22, the primary liquid will be forced through the discharge duct 13, around the check valve 14 and through the pipe 15.

A critical point of construction is the compression spring 10. The spring 10 and the tension held thereon by the plug 8 must be of a force greater than the resistance offered by the check valve 14 and/or such other restraining force as may be contained in the primary liquid delivery line 15. This is necessary because should the force acting to restrain the delivery of the primary liquid overcome the force acting against the piston 9, the primary liquid cannot be forced from the apparatus.

The effective stroke for the secondary liquid will begin as the lowermost extremity of the plunger 3 passes and thereby seals the discharge duct 13 opening at the point 23.

The liquid entrapped between the point 23 and the top of the piston 9 will not compress, hence the entrapped liquid serves as the media to transfer the downward pressure exerted by the plunger 3 onto the piston 9. This hydraulic coupling serves to disengage the piston 9 from its seat against the shoulder 7 and to force it inward. Disengaging the piston 9 and forcing it inward starts the flow of the secondary liquid through the discharge duct 17, around the check valve 20, and through the delivery pipe 21.

Outward movement of the plunger 3 releases the hydraulic pressure acting on the piston 9 and the spring 10 will urge the piston 9 toward its normal position of rest against the shoulder 7. The outward movement of the piston 9 creates a suction force which acts to close the check valve 20 and to draw the secondary liquid around the check valve 19 and into the lower confines of the cylinder 2.

The intake of secondary liquid will continue until the piston 9 becomes seated against the shoulder 7 at which time the suction force will cease in the lower cylinder and begin within the upper confines of the cylinder 2. The suction created within the upper cylinder 2 by the plunger 3 will close the check valve 14 and draw the primary liquid through the intake duct 11 and into the upper confines of the cylinder 2.

In a normal stroke cycle of the apparatus depicted in FIGURE 1 the reciprocating range of the plunger 3 would extend from a point above the intake duct 11 and would continue through to a point below the discharge duct 13.

There are several known means for adjusting the effective stroke and/or changing the depth of the reciprocating range of the plunger 3 within the bore 2. One such means is described in my copending application, Serial No. 188,082. Such adjustable means will permit the effective stroke of the plunger 3 to be adjusted within the bore 2. When an adjustable means is provided, the apparatus of FIGURE 1 may be set to pump and deliver variable amounts of the primary liquid and none of the secondary liquid, set to pump and deliver a constant amount of the primary liquid and a variable amount of the secondary liquid, or set to deliver a constant amount of the secondary liquid and none of the primary liquid. For examples:

When the plunger travel is set to begin above the intake duct 11 and to be stopped between the points 22 and

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23, only the primary liquid will be delivered. The amounts of primary liquid may be varied by changing the stopping position of the plunger 3 between the two points 22 and 23.

When the plunger travel is set to begin above the intake duct 11 and is continued through and beyond the point 23, the total amount of liquid in the bore 2 between the points 22 and 23 will be forced from the apparatus through the pipe 15. Also, a volume of secondary liquid will be pumped. The volume of secondary liquid will be equal to the volume displaced by the plunger extremity extended below the point 23. The amounts of secondary liquid may be varied by changing the stopping position of the plunger 3 below the point 23.

When the plunger travel is set to begin below the point 23 only the secondary liquid will be pumped and delivered.

A second useful means of employing the invention is illustrated in FIGURE 2.

The components of FIGURE 2 correspond with like components described for the apparatus of FIGURE 1. It will be noted that the intake duct 11 and the discharge duct 13 are on the same plane, are laterally placed with respect to the cylinder 2 and that a check valve 24 has been provided in the intake duct 11.

The primary liquid would be delivered through the pipe 12, be drawn around the check valve 24 and would fill the upper confines of the bore 2. The secondary liquid would be delivered through the pipe 18, be drawn around the check valve 19 and would fill the lower confines of the bore 2.

Any movement of the plunger 3 of the apparatus in FIGURE 2 is effective. A rotation of the cam 5 which exercises downward pressure on the plunger 3 will start the liquid flowing from the bore 2 and a rotation of the cam 5 which permits the spring 4 to exercise an outward movement of the plunger 3 will start the liquids flowing into the bore 2.

The apparatus of FIGURE 2 may also be provided with an adjustable means of raising and/or lowering the reciprocating range of the plunger 3 within the bore 2. However, as the complete plunger stroke is effective in this apparatus, such adjustable means will not increase or decrease the amount of liquid pumped and delivered. Adjustments which alter the depth of the reciprocating range of the plunger 3 within the cylinder 2 will alter the ratio of the primary liquid to the secondary liquid in the total volume pumped and delivered during an apparatus stroke cycle. For example:

When the plunger travel is set to begin and to terminate above the lateral ducts 11 and 13 only primary liquid will be pumped and delivered; when the plunger travel is set to begin and terminate below the lateral ducts 11 and 13 only the secondary liquid will be pumped and delivered; and when the plunger travel is set to begin above and to terminate below these ducts 11 and 13 both primary and secondary liquid will be pumped and delivered.

Another useful means of employing the invention is illustrated in FIGURE 3.

The block 1 of the apparatus of FIGURE 3 is formed to provide covered receptacles 25 and 26 which are adapted to contain the primary and secondary liquid. These liquids would be delivered from their respective sources through pipes 12 and 18. The bowls 25 and 26 would be filled to a level above the intake ducts 11 and 11a so as to permit the cylinders 2 and 2a to be gravity fed through the submerged intake ducts.

The auxiliary piston 9 is positioned below the reciprocating range of the plunger 3. A suitable means for holding the piston 9 below the plunger 3 may be provided by extending the inward extremity of a rivet 7 into the cylinder 2 as illustrated. The spring 10 is to be inserted within the cylinder 2 and to hold this piston 9 against the obstruction 7 with sufficient force to overcome the resistance of the check valve arrangement 14 and such other resistance as may be contained in the delivery pipe 15.

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The rotation of the cam 5 and the compression pressure of the spring 4 will act to reciprocate the plungers 3 and 3a in unison and as the inward extremities of the plungers pass and seal off their respective intake ducts 11 and 11a, both the primary and the secondary liquids will be forced from the apparatus through the discharge ducts 13 and 17.

During a reciprocating stroke of the apparatus of FIGURE 3, the primary liquid in the bowl 25 will be forced from the cylinder 2 until the inward extremity of the plunger 3 passes the point 23. The hereinabove described hydraulic coupling will then be formed and continued inward pressure on the plunger 3 will unseat the piston 9. Inward movement of the piston 9 will force the primary liquid below the piston through the port 27. While this action is taking place, the plunger 3a, which is traveling in unison and extended into the block 1 at a uniform depth, will continue to force the secondary liquid from the cylinder 2a. In this manner the application of the free piston 9 allows the apparatus to pump and deliver the primary and secondary liquid in unison and, further, to deliver variable amounts of both primary and secondary liquids or to deliver a constant amount of the primary liquid and a variable amount of the secondary liquid.

The structures shown in FIGURES 1 and 2 illustrate the auxiliary piston 9 held by the spring 10 against an offset shoulder 7. The shoulder 7 was formed by providing two different sized diameters within the bore 2 as hereinabove explained. A second and obvious means of limiting the upward travel of the piston 9 would be to extend a pin or rivet through a sidewall of the blocks 1 in a manner so as to extend the end of the pin or rivet into the bore 2. Such an arrangement is shown in FIGURE 3. Note that, in FIGURE 3, the rivet 7 extends into the bore 2 and restrains the piston 9 from ascending into the reciprocating range of the plunger 3. It is obvious that the arrangement of the rivet 7 as shown in FIGURE 3 would serve the apparatus of FIGURES 1 and 2 equally as well as the offset shoulder 7.

The applications of the invention which have been shown in the selected embodiments should not be construed as limiting the invention to these particular cases. It is to be understood that the concept of the auxiliary piston may be applied in other configurations and is in no way limited to the selected embodiments depicted and described. All modifications and variations of any application which may fairly fall within the scope of the following claims are reserved.

I claim:

1. The combination of a pump cylinder block, a cylinder bore within said block, an elongated plunger member having an end portion thereof equal in diameter to and slideably encased within said bore, a reciprocating means outward from said block and engaged with the free end of said plunger, an obstruction within and partially blocking said bore, said obstruction being inward from the innermost reciprocating limit of said plunger, a free piston member having a diameter equal to said bore, said piston mounted for reciprocation within said bore inward from said obstruction, a compression spring within said bore between the inward extremity of said free piston and the bottom of said bore; a liquid admitting and discharging duct through said block, said duct disposed on an angle to and intersected with said bore between the inward and the outward reciprocating limits of the encased end of said plunger, and a second liquid admitting and discharging duct through a sidewall of said block and engaged with said bore inward from the innermost reciprocating limit of said free piston.

2. An apparatus for pumping and delivering liquids comprising the combination of a pump cylinder block, a cylinder bore within said block, an elongated plunger member having an end portion thereof equal in diameter to and slideably encased within said bore, a reciprocating means outward from said block and engaged with

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the free end of said plunger, an obstruction within and partially blocking said bore, said obstruction being inward from the innermost reciprocating limit of said plunger, a free piston member having a diameter equal to said bore, said piston mounted for reciprocation within said bore inward from said obstruction, a compression spring within said bore between the inward extremity of said free piston and the bottom of said bore, a first liquid admitting and discharging duct through said block, said first duct substantially transversely disposed with and intersecting said bore between the inward and the outward reciprocating limits of the encased end of said plunger and a second liquid admitting and discharging duct through said block, said second duct intersecting said bore inward from the innermost reciprocating limit of the inward extremity of said free piston.

3. An apparatus for pumping and delivering liquids comprising the combination of a pump cylinder block, a cylinder bore within said block, an elongated plunger member having an end portion thereof equal in diameter to and slideably encased within said bore, a reciprocating means outward from said block and engaged with the free end of said plunger, an obstruction within and partially blocking said bore, said obstruction being inward from the innermost reciprocating limit of said plunger, an elongated free piston member having a diameter equal to said bore, said piston mounted for reciprocation within said bore inward from said obstruction, a compression spring within said bore between the inward extremity of said free piston and the bottom of said bore, a first liquid admitting and discharging duct through said block, said first liquid ducts substantially transversely disposed to and intersected with said bore between the inward and the outward reciprocating limits of the encased end of said plunger and a second liquid admitting and discharging duct through said block, said second liquid duct intersected with said bore inward from the innermost reciprocating limit of the inward extremity of said free piston, there being a check valve means disposed within the discharging extremity of said first liquid duct.

4. An apparatus for pumping and delivering liquids comprising the combination of a pump cylinder block, a cylinder bore within said block, an elongated plunger member having an end portion thereof equal in diameter to and slideably encased within said bore, a reciprocating means outward from said block and engaged with the free end of said plunger, an obstruction within and partially blocking said bore, said obstruction being inward from the innermost reciprocating limit of said plunger, an elongated free piston member having a diameter equal to said bore, said piston mounted for reciprocation within said bore inward from said obstruction, a compression spring within said bore between the inward extremity of said free piston and the bottom of said bore, a first liquid admitting and discharging duct through said block, said first liquid duct disposed on an angle to and intersected with said bore between the inward and the outward reciprocating limits of the encased end of said plunger and a second liquid admitting and discharging duct through said block, said second liquid duct transversely disposed to and intersected with said bore inward from the innermost reciprocating limit of the inward extremity of said free piston, there being a check valve means disposed within the discharging extremity of said first liquid duct, and check valve means disposed within the admitting and the discharging extremities of said second duct.

5. An apparatus for pumping and delivering liquids comprising the combination of a pump cylinder block, a cylinder bore within said block, an elongated plunger member having an end portion thereof equal in diameter to and slideably encased within said bore, a reciprocating means outward from said block and engaged with the free end of said plunger, an obstruction within and partially blocking said bore, said obstruction being inward

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from the innermost reciprocating limit of said plunger, an elongated free piston member having a diameter equal to said bore, said piston mounted for reciprocation within said bore inward from said obstruction, a compression spring within said bore between the inward extremity of said free piston and the bottom of said bore, a first liquid admitting and discharging duct transversely disposed to and intersected with said bore between the inward and the outward reciprocating limits of the encased end of said plunger and a second liquid admitting and discharging duct transversely disposed to and intersected with bore inward from the innermost reciprocating limit of the inward extremity of said free piston, there being check valve means disposed within the admitting and the discharging extremities of said first duct and check valve means disposed within the admitting and discharging extremities of said second duct.

6. The combination of a pump cylinder block, a first bore within said block, an elongated plunger member having an end portion thereof equal in diameter to and slideably encased within said first bore, a reciprocating means outward from said block and engaged with the free end of said plunger, a second bore extended from said first bore, said second bore having a larger diameter than said first bore and joined thereto in a manner whereby an offset shoulder is formed at a point inward from the innermost reciprocating limit of said plunger; a free piston member having a diameter equal to said second bore, said free piston mounted for reciprocation within said second bore inward from said offset, a compression spring within said second bore between the inward extremity of said free piston and the bottom of said second bore; a liquid admitting and discharging duct through said block, said duct intersected with said first bore between the inward and the outward reciprocating limits of the encased end of said plunger, and a second liquid admitting and discharging duct through a sidewall of said block and intersected with said second bore inward from the innermost reciprocating limit of said free piston.

7. An apparatus for pumping and delivering liquids comprising the combination of a pump cylinder block, a first bore within said block, an elongated plunger member having an end portion thereof equal in diameter to and slideably encased within said first bore, a reciprocating means outward from said block and engaged with the free end of said plunger, a second bore extended from first bore, said second bore having a larger diameter than said first bore and joined thereto in a manner whereby an offset shoulder is formed at a point inward from the innermost reciprocating limit of said plunger; a free piston member having a diameter equal to said second bore, said free piston mounted for reciprocation within said second bore inward from said offset, a compression spring within said second bore between the inward extremity of said free piston and the bottom of said second bore; a first liquid admitting and discharging duct through said block, said first duct substantially transversely disposed with and intersecting said first bore between the inward and the outward reciprocating limits of the encased end of said plunger and a second liquid admitting and discharging duct through said block, said second duct intersecting said second bore inward from the innermost reciprocating limit of the inward extremity of said free piston.

8. An apparatus for pumping and delivering liquids comprising the combination of a pump cylinder block, a first bore within said block, an elongated plunger member having an end portion thereof equal in diameter to and slideably encased within said first bore, a reciprocating means outward from said block and engaged with the free end of said plunger, a second bore extended from said first bore, said second bore having a larger diameter than said first bore and joined thereto in a manner whereby an offset shoulder is formed at a point inward from the innermost reciprocating limit of said plunger, an elon-

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gated free piston member having a diameter equal to said second bore, said free piston mounted for reciprocation within said second bore inward from said offset, a compression spring within said second bore between the inward extremity of said free piston and the bottom of said second bore, a first liquid admitting and discharging duct through said block, said first liquid ducts substantially transversely disposed to and intersected with said first bore between the inward and the outward reciprocating limits of the encased end of said plunger and a second liquid admitting and discharging duct through said block, said second liquid duct intersected with said second bore inward from the innermost reciprocating limit of the inward extremity of said free piston, there being a check valve means disposed within the discharging extremity of said first liquid duct.

9. An apparatus for pumping and delivering liquids comprising the combination of a pump cylinder block, a first bore within said block, an elongated plunger member having an end portion thereof equal in diameter to and slideably encased within said first bore, a reciprocating means outward from said block and engaged with the free end of said plunger, a second bore extended from said first bore, said second bore having a larger diameter than said first bore and joined thereto in a manner whereby an offset shoulder is formed at a point inward from the innermost reciprocating limit of said plunger, an elongated free piston member having a diameter equal to said second bore, said free piston mounted for reciprocation within said second bore inward from said offset, a compression spring within said second bore between the inward extremity of said free piston and the bottom of said second bore, a first liquid admitting and discharging duct through said block, said first liquid duct disposed on an angle to and intersected with said first bore between the inward and the outward reciprocating limits of the encased end of said plunger and a second liquid admitting and discharging duct through said block, said second liquid duct transversely disposed to and intersected with said second bore inward from the innermost reciprocating limit of the inward extremity of said free piston, there being a check valve means disposed within the discharging extremity of said first liquid duct, and check valve means disposed within the admitting and the discharging extremities of said second duct.

10. An apparatus for pumping and delivering liquids comprising the combination of a pump cylinder block, a first bore within said block, an elongated plunger member having an end portion thereof equal in diameter to and slideably encased within said first bore, a reciprocating means outward from said block and engaged with the free end of said plunger, a second bore extended from said first bore, said second bore having a larger diameter than said first bore and joined thereto in a manner whereby an offset shoulder is formed at a point inward from the innermost reciprocating limit of said plunger, an elongated free piston member having a diameter equal to said second bore, said free piston mounted for reciprocating within said second bore inward from said offset, a compression spring within said second bore between the inward extremity of said free piston and the bottom of said second bore, a first liquid admitting and discharging duct transversely disposed to and intersected with said first bore between the inward and the outward reciprocating limits of the encased end of said plunger and a second liquid admitting and discharging duct transversely disposed to and intersected with said second bore inward from the innermost reciprocating limit of the inward extremity of said free piston, there being check valve means disposed within the admitting and the discharging extremities of said first duct and check valve means disposed within the admitting and discharging extremities of said second duct.

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LAURENCE EFNER, *Primary Examiner.*