Nov. 18, 1947. D. GRUDIN 2,430,872

TWO STAGE VARI-VOLUME HAND PUMP

Filed May 4, 1944

FIG. 1.

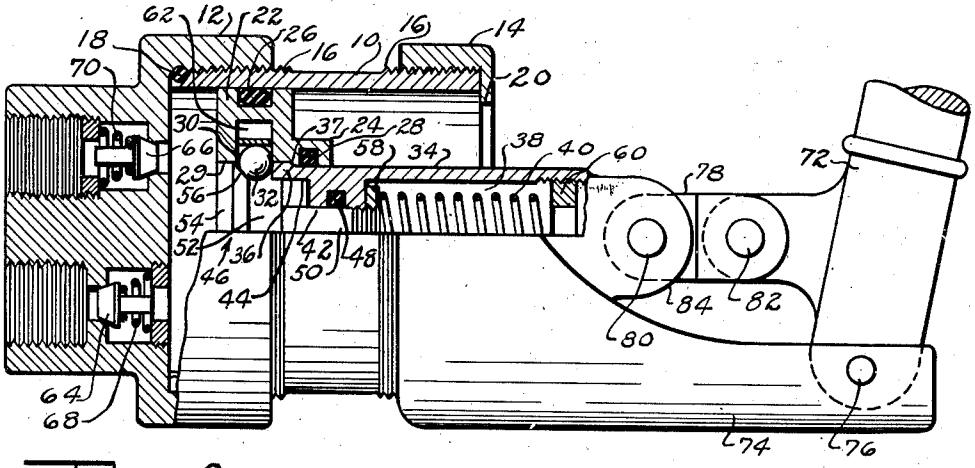


FIG. 2.

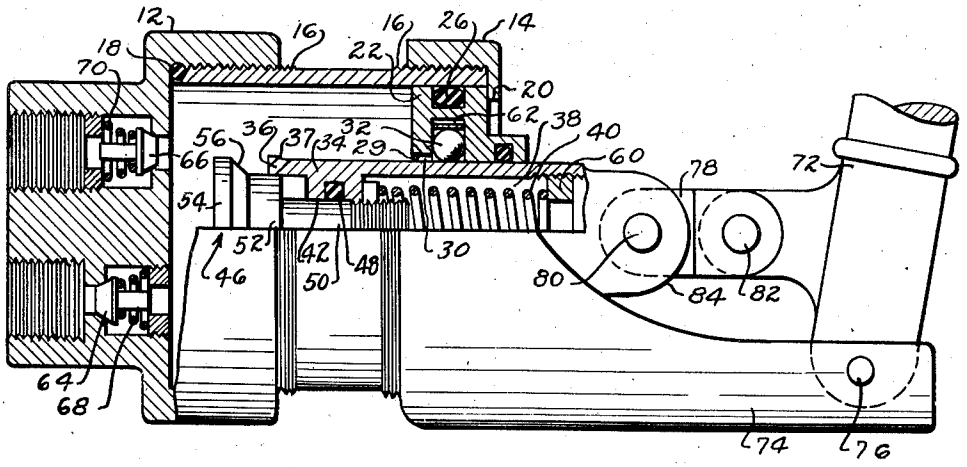
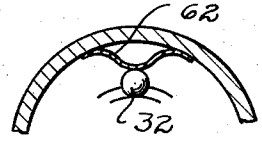


FIG. 3.



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Patented Nov. 18, 1947

2,430,872

UNITED STATES PATENT OFFICE

2,430,872

TWO STAGE VARIVOLUME HAND PUMP

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Application May 4, 1944, Serial No. 534,125

6 Claims. (Cl. 103—37)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to fluid pumps, having particular reference to a piston pump of variable piston-displacement. As is well known with respect to fluid pressure actuated devices, there are many applications wherein initial operation requires the delivery of a large volume of fluid at a relatively low pressure but thereafter a much smaller volume of fluid at a relatively higher pressure.

It is therefore an object of this invention to provide, in a pump of this character, means for automatically reducing the piston displacement for a given piston stroke when the discharge pressure exceeds a predetermined value.

More specifically, it is an object of the invention to provide a pump of this character with two pistons, one within the other, with means to automatically retire one of the pistons to an inactive position to reduce the volumetric discharge per unit stroke when the pressure being pumped against rises to a predetermined height.

Other objects and advantages will be evident as the invention is described in greater detail, reference being had to the drawing, wherein:

Fig. 1 is a view of my improved pump, partly in elevation and partly in vertical-axial section, showing the mechanism as it appears when set for pumping a large volume against a relatively low back pressure.

Fig. 2 is a view similar to Fig. 1 except that the layer piston has automatically moved to its retired position and the device is now arranged for pumping a smaller volume against a relatively higher back pressure.

Fig. 3 shows a detail of the locking means which holds the larger piston in the operative position shown in Fig. 1.

Referring more particularly to Fig. 1, the pump body comprises a cylinder 10 provided with a front head 12 which houses the valves, and a rear head 14 which carries the pump handle. Heads 12 and 14 are internally threaded to fit external threads 16 on the cylinder, the head 12 being provided with a pressure seal 18, and the head 14 with an inturned lip 20 which abuts the cylinder end when the head is screwed up tight.

Slidably fitted to the bore of the cylinder 10 is a large piston 22 having a hub 24, the piston being externally grooved for a seal 26, and the hub being internally grooved for a seal 28. The large piston 22 has a bore 29 which is of a somewhat larger diameter than the bore of the hub 24, the larger bore 29 having an internal annular cavity 30 which is wide enough to receive several circumferentially spaced locking balls 32 when they are pushed radially outward into the groove.

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Slidably fitted to the bore of the hub 24 is a small piston 34 which, in the embodiment shown, is of substantially half the diameter of the large piston, although any other relative proportion between the large and small pistons may be employed which the pumping requirements indicate as desirable. The front end of the small piston 34 carries an external annular rib 36 over which the bore 29 of the piston 22 may pass freely. The rearward face of the annular rib 36 is beveled as at 37, the bore 29 of the large piston 22 being correspondingly beveled to provide camming surfaces for a purpose which will hereinafter appear. The forward face of the external rib 36 is in the same plane as the rearward face of the internal annular cavity 30.

The interior of the small piston 34, at the rearward end, has a chamber 38 for the spring 40, and, at the forward end, is bored at 42 and counterbored at 44 for the unlocking plunger 46, the bore 42 being provided with an internal annular groove for the seal 48.

The rear portion 50, middle portion 52, and front portion 54 of the unlocking plunger 46 are slidable respectively in the bores 42, 44 and 29, the rear face of the front portion 54 being beveled at 56 to provide another camming surface, the purpose of which will be later explained.

The extreme rear end of the part 50 is threaded for the nut 58. Adjustment of nut 58 snugs up the beveled cam surface 56 to the locking balls 32. The forward end of the spring 40 reacts against the nut 58 and holds it against its shoulder in the small piston 34 while the rearward end of the spring reacts against the nut 60. Adjustment of the nut 60 may be made to vary the stress of the spring 40. Adjustment of the spring 40 varies the degree of back pressure at which the device will operate to retire the larger piston 22. A single-leaf spring 62 is provided for each locking ball 32 for urging the ball radially inward against the middle portion 52 of the locking plunger 46.

A suction valve 64 and a discharge valve 66 are built into the front head 12 and are held on their respective seats by the springs 68 and 70. A pump handle 72 is fulcrumed on the bracket portion 74 of the rear head 14 by a pin 76, a link 78, and pins 80 and 82 being employed to connect the pump handle to the ears 84 on the rear end of

the small piston 34. The device shown in its normal unoperated position in Fig. 1 operates as follows:

Where the operation of a fluid actuated device requires a relatively low pressure in the beginning, the two pistons 22 and 34 will be locked together in the relative position shown in Fig. 1. Each full stroke of the pump handle 72 will therefore displace a volume of fluid equal to the area of the bore of the cylinder 10 times the stroke, this volume being drawn through the suction valve 64 and forced through the discharge valve 66 in the manner of any ordinary piston pump.

When the back pressure against which the pump must discharge rises to such a height that the locking plunger 46 is forced rearward on the pressure stroke, against the resistance of the spring 40, the locking balls 32 are forced radially outward by the camming surface 56 on the annular rib 54, into the cavity 30, outward movement of the balls being opposed by the springs 62, whereby the balls 32 pass over the annular rib 36 and the large piston 22 is thereafter free to slide rearwardly on the small piston 34.

If the unlocking mechanism should operate to unlock the large piston when the pistons are in the forward position shown in Fig. 1, the fluid drawn in through the suction valve 64 in the next two or three strokes of the pump may be required to move the large piston 22 to its fully retired position shown in Fig. 2 where further rearward movement has been arrested by the inturned lip 20. While there is some tendency on the suction stroke to draw the large piston forward from its retired position, Fig. 2, the friction of the seal 26 is great enough to hold the piston against the equivalent suction head within the cylinder on the suction stroke.

Thereafter pumping may continue with the small piston 34 only, whereby the same expenditure of energy applied to the pump handle 72 will move fluid through the discharge valve 66 against four times the back pressure possible when both pistons were operative.

When it again becomes desirable to pump the large volume against the lesser back pressure, the large piston 22 may be operatively reconnected to the small piston 34 by bringing the pump handle 72 to the extreme rearward position, which will cause the cam surface 37 on the annular rib 36 to raise the locking balls 32 enough to let them pass over the rib to their locked position shown in Fig. 1. The two pistons will thereafter operate coincidentally.

Having described my invention, I claim:

1. In a pump of the character described, a pump body, a piston slidable within said pump body, a second piston slidable within said pump body, means to reciprocate one of said pistons, a lock for connecting said first piston to said second piston for simultaneous reciprocation, and means associated with said pistons automatically responsive to a predetermined discharge pressure within said pump body to release said lock to thereby disconnect said first piston from said second piston for independent reciprocation.

2. In a pump of the character described, a pump cylinder, a piston slidable in said cylinder, a second piston slidable within the first piston, means to reciprocate one of said pistons, a lock carried by one of said pistons and operative to engage the other of said pistons for connecting said pistons for simultaneous reciprocation, and means associated with the said other of said pistons automatically responsive to a predetermined discharge pressure within said cylinder to release said lock from engagement with the said other of said pistons.

3. In a pump of the character described, a cylinder, a piston having a concentric bore reciprocable in said cylinder, a second piston having a bore, said second piston being reciprocable in the bore of said first piston, means to reciprocate one of said pistons, a radially movable lock for connecting said pistons for unitary reciprocation, an unlocking plunger movable axially in the bore of said second piston by a predetermined discharge pressure within said cylinder, and means carried on said unlocking plunger automatically operative upon axial movement of said unlocking plunger in response to said discharge pressure to move said lock radially to unlock said lock.

4. In a pump of the character described, a hollow cylinder with one end closed, a hollow piston with a concentric bore reciprocable in said cylinder, a second bored piston reciprocable in the bore of the first piston, means to reciprocate one of said pistons, a lock normally connecting said pistons for unitary reciprocation, an unlocking plunger slidable in the bore of the second piston, a spring in said second piston for holding said plunger in the unoperated positions, said spring being yieldable at a predetermined pressure in the closed end of said cylinder to move axially, and means carried on said plunger for unlocking said lock.

5. In a pump of the character described, a pump cylinder with one end closed, a pump piston slidable in said cylinder, a second pump piston, the first said piston being bored to slidably receive the second said piston, an unlocking plunger slidable in said second piston, the said second piston being bored to slidably receive said unlocking plunger, said plunger normally extending from the front end of said bore, a locking ball, the first said piston having a cavity into which said locking ball may move from the bore radially outward, the rear face of said cavity and the front face of the second said piston being in the same right plane, a spring urging said ball radially inward against said unlocking plunger, said plunger being of such diameter that when it arrests radially inward movement of said ball substantially half of said ball will extend beyond the inner extremity of said cavity, cam means carried on said plunger normally resting against the forward side of said locking ball but adapted upon rearward movement of said plunger to move said ball radially outward to a position wholly within said cavity, a resilient means tensioned to hold said plunger in its forward position but adapted to be overcome to allow said plunger to move rearwardly by a predetermined pressure in said closed end, and means to reciprocate the second said piston.

6. In a reciprocatory piston pump, the improvement which comprises two pistons, the second axially slidable within the first, an unlocking plunger axially slidable within the second piston, the forward face of the first piston and the forward face of the plunger extending beyond the forward face of the second piston, a spring urging said plunger forwardly, a stop limiting said forward movement, an internal annular groove in said first piston, the rearward face of said groove being in the same plane as the forward face of the second piston, a ball in said groove, a spring urging said ball radially inward against said plunger, said plunger being of such diameter that half of the ball protrudes from said

groove, an annular rib around the front end of said plunger, a second annular rib around the front end of the second piston, the rearward face of the first said rib being formed into a cam surface operative when moved rearwardly against the ball to move said ball radially outward whereby it may pass rearwardly over the second said annular rib, and the rearward face of the second said annular rib being formed into a cam surface operative when moved rearwardly against the ball to move the ball radially outward, whereby it may pass forwardly over the second said annular rib.

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