United States Patent [19]

Moore

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[54] **PUMP**

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[21] Appl. No.: **388,449**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 34,808, May 5, 1970, abandoned.

[52] **U.S. Cl.** **417/378**

[51] **Int. Cl.** **F04b 17/00**

[58] **Field of Search** 417/378

[56] **References Cited**

UNITED STATES PATENTS

108,365	10/1870	Knecht	417/378
376,382	1/1888	Hearn	417/378
2,058,455	10/1936	Huff	417/378

FOREIGN PATENTS OR APPLICATIONS

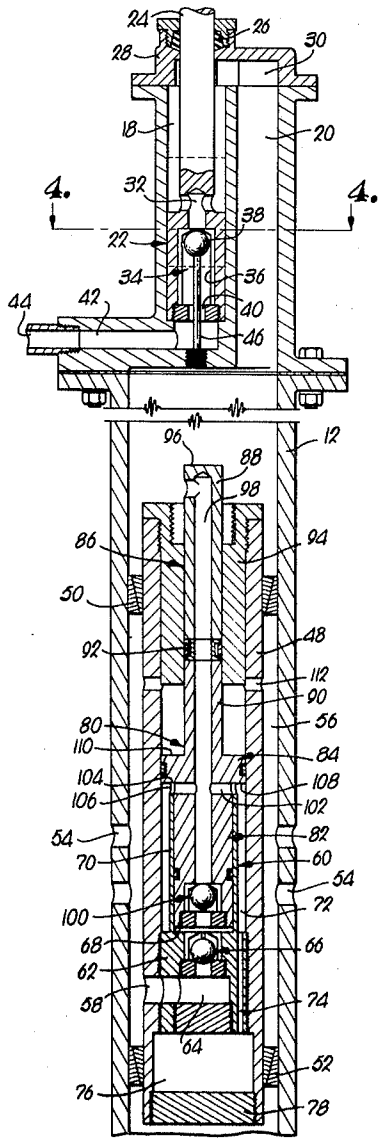
806,941	5/1936	France	417/378

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Assistant Examiner—Richard Sher
Attorney, Agent, or Firm—Schmidt, Johnson, Hovey & Williams

[57] **ABSTRACT**

A rodless and tubeless pump, especially suited for deep-well pumping installations, has a lower pumping piston that is forced to move through its intake stroke in opposition to the direction of force in the fluid between the upper operating piston and the lower pumping piston during the compression stroke of the operating piston. The lower face of the pumping piston has a greater amount of surface area exposed to pressurized fluid from the operating piston than the upper face, thereby causing the pumping piston to rise during its intake stroke in opposition to fluid thereabove that is forced downwardly by the operating piston during its compression stroke. During the compression-release stroke of the operating piston, the pumping piston completes its exhaust stroke by gravity return.

12 Claims, 6 Drawing Figures



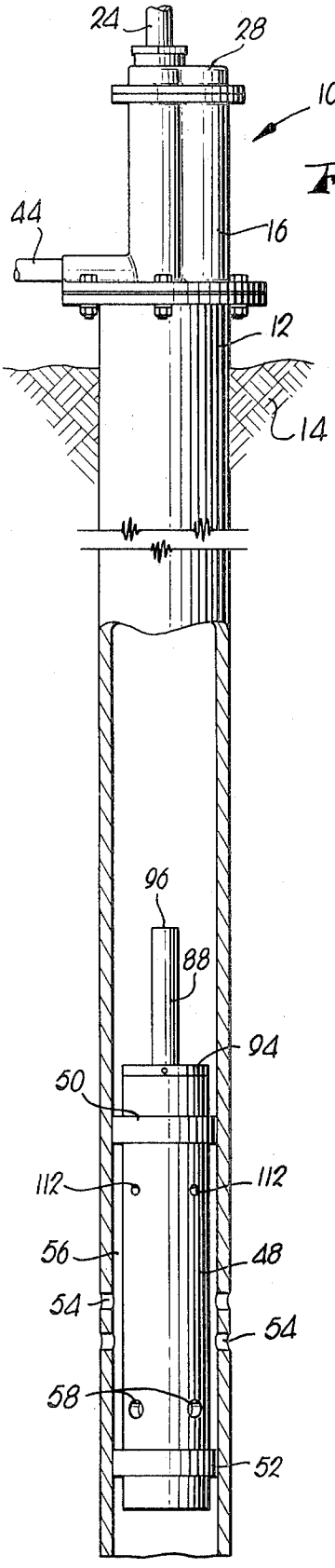

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Fig.1.

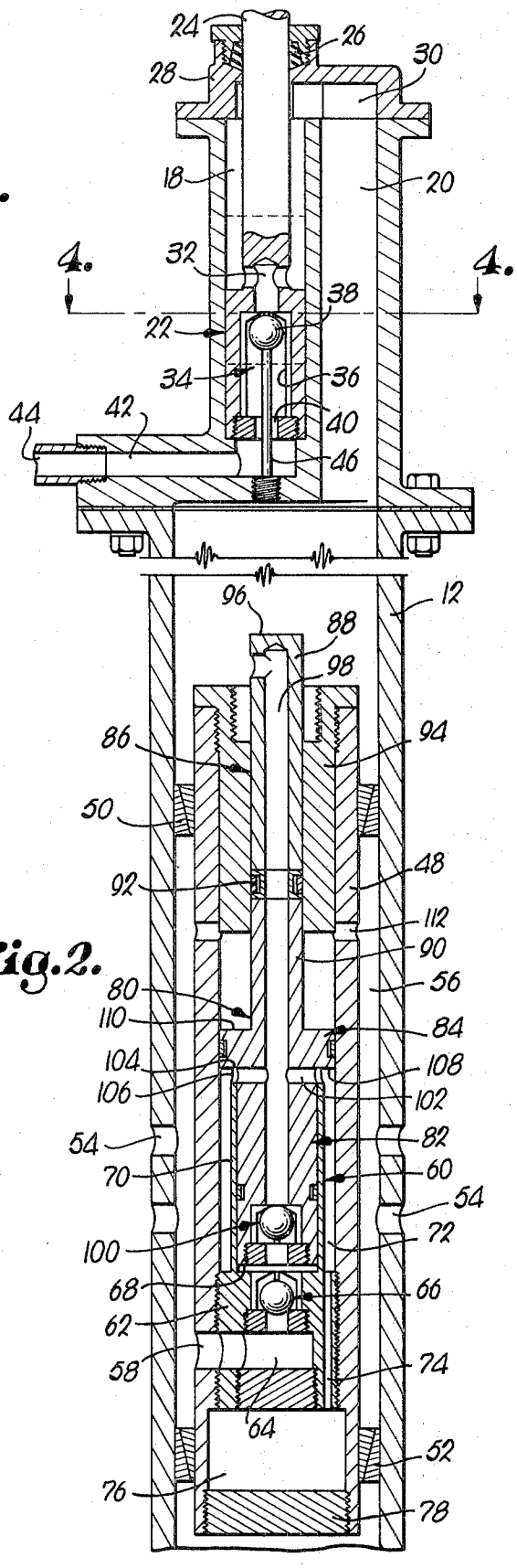

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Fig.2.

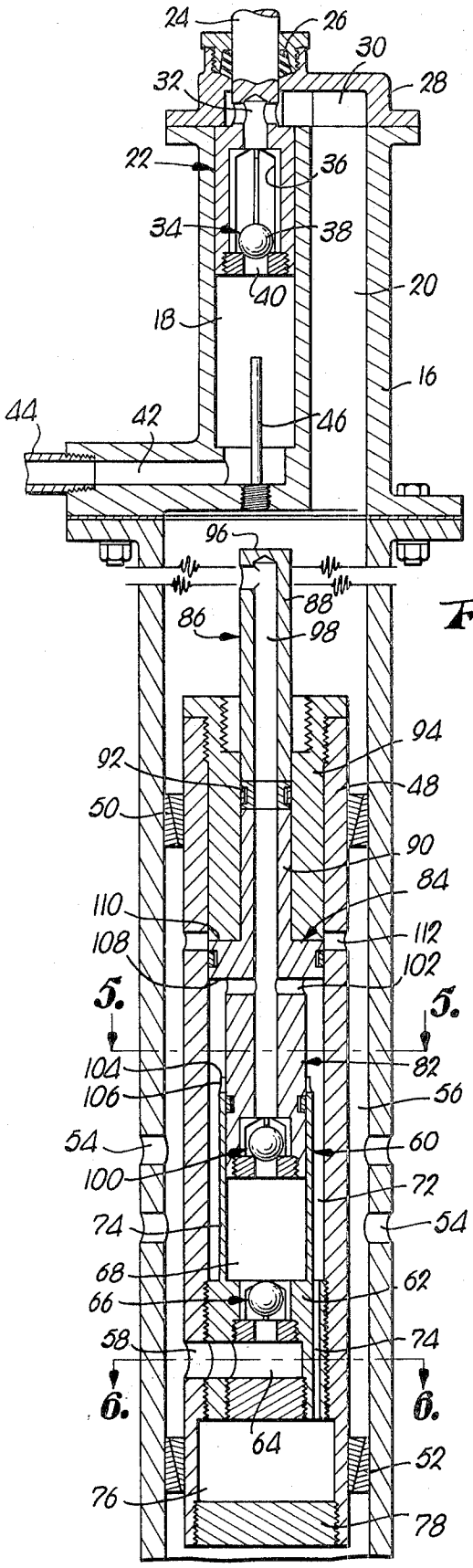


Fig.3.

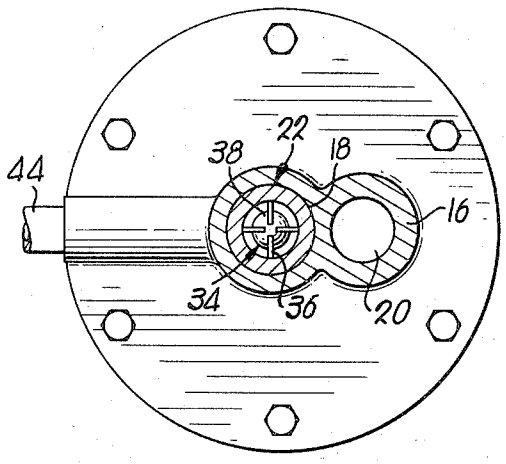


Fig.4.

Fig.5.

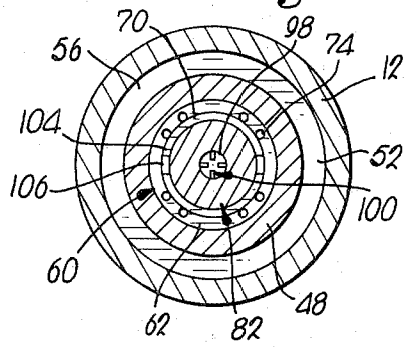
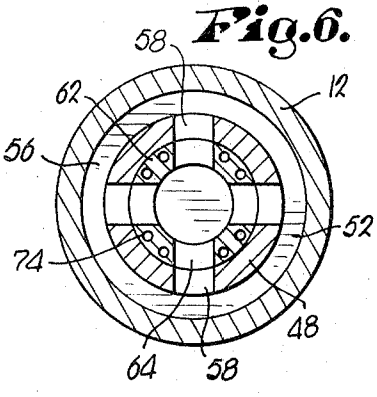


Fig.6.



PUMP

CROSS REFERENCE

This is a continuation-in-part of my copending application Ser. No. 34,808, filed May 5, 1970, and entitled "PUMP," now abandoned.

This invention relates to a pump having particular utility for deep-well installation such as encountered during the pumping of petroleum products from their subterranean location to positions above the surface of the ground.

One important object of the present invention is to provide a pump that utilizes the body of fluid being pumped to actuate the pumping piston thereof in order to eliminate the cumbersome pump rods and other connecting structures often utilized in deep-well pumps.

Another important object of this invention is to provide a rodless and tubeless pump as aforesaid wherein the pumping piston thereof, actuated in response to the compression stroke of the mechanically driven operating piston of the pump, is displaced through its intake stroke in opposition to the direction of force in fluid between the pistons during the compression stroke of the operating pump so that the pumping piston may simply return by gravity at the completion of its intake stroke without the need for assorted return devices such as coil springs and the like.

As a corollary to the foregoing, it is an important object of this invention to provide the side of the pumping piston facing away from the operating piston with a greater effective surface area than the side facing toward the operating piston so that, although the pressures on both sides of the pumping piston may be the same, the total force against the side facing away from the operating piston is greater than against the other side, hence causing the aforementioned oppositional displacement of the operating piston.

An additional important object of this invention is the provision of a rodless and tubeless pump as set forth above which can be readily adapted for connection with other similar pumps in a series thereof so as to provide simultaneous, parallel pumping action at multiple subterranean levels.

In the drawings:

FIG. **1** is a partly elevational and partly crosssectional view of a pump embodying the principles of the present invention installed for deep-well use;

FIG. **2** is an enlarged, vertical cross-sectional view of the pump illustrating the conditions of the operating and pumping pistons at the completion of a compression-release stroke of the operating piston just prior to the beginning of a compression stroke thereof;

FIG. **3** is an enlarged, vertical cross-sectional view of the pump similar to FIG. **2** but showing the condition of the pistons at the completion of the compression stroke of the operating piston just prior to the beginning of the compression release stroke of the operating piston;

FIG. **4** is a horizontal cross-sectional view of the pump taken along line **4—4** of FIG. **2**; and

FIGS. **5** and **6** are horizontal cross-sectional views of the pump taken along lines **5—5** and **6—6** respectively of FIG. **3.**

The pump **10** has tubular structure that includes an elongated, hollow casing **12** disposed in an upright condition and extending for a substantial distance into the

subterranean recesses of the ground **14** and a pump head **16** secured to the uppermost end of casing **12** by the conventional means illustrated. A bore **18** in head **16** disposed alongside a second bore **20** houses a reciprocable operating piston **22** having a rod **24** that projects upwardly through a stuffing box **26** in head cover **28** for operable connection to a suitable prime mover (not shown). The cover **28** has a recess **30** therein that communicates the bores **18** and **20** with one another.

The piston **22** has a passageway **32** therethrough that is controlled by a ball-check valve **34** consisting of a cage **36** and a ball **38,** the latter being adapted to seal the orifice **40** at the lowermost end of piston **22** when ball **38** is disposed in covering relationship to orifice **40.** Below the bore **18** is disposed a fluid outlet **42** adapted for receiving at its outermost end a threaded pipe **44** and communicating at its inner end with bore **18.** An elongated, upright valve opener **46** extends from outlet **42** into bore **18** in concentric relationship with orifice **40** for projecting through the latter into cage **36** when the piston **22** is disposed as shown in FIG. **2** to unseat the ball **38,** thus allowing fluid to escape from above piston **22** to outlet **42** via passageway **32.** As shown in FIG. **3,** when the piston **22** is at the opposite end of its stroke, the opener **46** is of insufficient length to unseat ball **38** hence maintaining passageway **32** closed.

Disposed a substantial distance below piston **22** in casing **12** is a hollow cylinder **48** supported within casing **12** in spaced relationship thereto by upper and lower packers **50** and **52** respectively. One or more openings **54** in the casing **12** adjacent cylinder **48,** allow the entry of petroleum or other fluid into the annular space **56** between cylinder **48** and casing **12.** Apertures **58** in cylinder **48** adjacent the lower end thereof allow entry of the fluid from space **56** to the interior of cylinder **48** which contains a barrel assembly **60** having a lower plug portion **62** threaded into cylinder **48** at apertures **58.** A series of inlets **64** in plug portion **62** register with apertures **58** and have a ball-check valve **66** (similar to check valve **34**) that controls fluid flow between apertures **58** and a chamber **68** defined by an upright, tubular portion **70** of barrel assembly **60.** As illustrated, the check valve **66** is so arranged as to allow fluid flow into chamber **68** through inlets **64** but not in the opposite direction.

Tubular portion **70** of barrel assembly **60** is of reduced diameter relative to cylinder **48** so as to define an annular area **72** between cylinder **48** and portion **70** above the plug portion **62.** A series of circumferentially spaced bypass conduits **74** extend vertically through plug portion **62** without intersecting inlets **64** and communicate the area **72** above plug portion **62** with a region **76** below plug portion **62** and above a stopper **78** threadably coupled with cylinder **48** at the lowermost end thereof.

A pumping piston, broadly denoted by the numeral **80,** has a first part **82** that slidably reciprocates within chamber **68** of barrel assembly **60,** and a second part **84** integral with part **82** and located above the latter that reciprocates in sliding engagement with cylinder **48.** The part **84** has a sectionalized stem **86** of reduced diameter consisting of an uppermost weight section **88,** a lowermost section **90,** and an intermediate piston section **92,** all of which slidably reciprocate within a bushing **94** threaded into the uppermost end of cylinder **48.**

Preferably, for reasons which will hereinafter become apparent, the weight section **88** is removably attached to the other sections **90** and **92** and has an uppermost tip end **96** exposed to the fluid in casing **12** between bushing **94** and operating piston **22.**

A continuous central passage **98** extends the full length of piston **80,** opening at the uppermost end thereof beyond bushing **94** and at the lowermost end thereof within chamber **68.** A ball-check valve **100** (similar to valves **34** and **66**) within the first piston part **82** controls passage **98** in a manner to allow fluid flow into the latter from chamber **68** but not flow in the reverse direction. A cross channel **102** through piston **80** between parts **82** and **84** thereof intersects passage **98** to communicate the same with the receiving area **72.** The uppermost end **104** of tubular portion **70** may serve as a seat for piston part **84,** in which case ports **106** must be provided therethrough for registration with cross channel **102** when the piston **80** is at the bottom of its stroke as shown in FIG. **2** to communicate the passage **98** with area **72.** On the other hand, tubular portion **70** may be made short enough to simply cause part **82** to seat against plug portion **62,** in which case the extra ports **106** are not required. In many instances the latter is the preferred arrangement.

The second piston part **84** has one side **108** that faces away from the operating piston **22** and is annular in configuration, overlying the area **72.** As will hereinafter be made clear, the side **108** is subjected to pressurized fluid during a compression stroke of the operating piston **22** and, while the piston part **84** does have a shoulder **110** opposite side **108** because of the reduced size of stem **86,** shoulder **110** does not receive pressurized fluid during operation of pump **10.** Instead, the uppermost end **96** of stem **86** effectively serves as the opposite side of piston part **84** for operational purposes because it is the end **96** that receives the fluid pressure thereagainst from operating piston **22** and not shoulder **110.** Moreover, the surface area of side **108** must be greater than the surface area of the opposite side defined by end **96** in order for piston **80** to perform in the special manner contemplated by the present invention. Because the shoulder **110** does not receive pressurized fluid, its particular surface area has no bearing on the operation of pump **10.** Drain holes **112** are provided just below bushing **94** within cylinder **48** to vent the area above shoulder **110.**

OPERATION

At the completion of an operating cycle wherein fluid has been discharged from pump **10** into pipe **44,** the components of pump **10** are in the condition illustrated in FIG. **2.** At this time the ball **38** of check valve **34** is maintained unseated from orifice **40** by the valve opener **46,** and such continues as the piston **22** is drawn upwardly in its compression stroke until the dotted line position of piston **22** is reached as illustrated in FIG. **2.** From this dotted line position until piston **22** completes its upstroke or compression stroke, as shown in FIG. **3,** the valve **34** remains closed so that pressure is exerted against the body of fluid existing between operating piston **22** and pumping piston **80.**

The direction of force in the fluid body during the compression stroke of piston **22** is downwardly through casing **12** against the top end **96** of piston stem **86** and similar horizontal surfaces. Such pressure forces fluid downwardly into passage **98** to close check valve **100** and also cause some fluid to flow laterally out of passage **98** into area **72** via cross channel **102** and ports **106.** Thus, while fluid pressure from the rising piston **22** is directed downwardly against end **96,** such pressure is also simultaneously directed upwardly against side **108** of piston part **84.** Because the surface area of side **108** is greater than the surface area of end **96,** the piston **80** is caused to rise in cylinder **48** in opposition to the direction of the bulk of force emanating from piston **22.**

As the piston **80** is caused to rise in its intake stroke by the piston **22** moving in its compression stroke, the lower piston part **82** creates a vacuum within chamber **68** to open valve **66** and draw fluid into chamber **68** via openings **54,** apertures **58,** and inlet **64.** This action continues until the piston **80** reaches the upper limit of its travel as illustrated in FIG. **3,** at which time the chamber **68** below piston part **82** will be completely filled with fluid.

The mechanism driving piston **22** then reverses its motion to lower piston **22** in its compression release stroke, such action relieving the fluid pressure against side **108** of piston part **84** and allowing piston **80** to descend by gravity in its exhaust stroke toward the plug portion **62.** This immediately closes valve **66** and opens valve **100** so that the fluid contained within chamber **68** is forced upwardly into passage **98** for flow through the latter into the large body of fluid located above piston **80** in casing **12.** When the piston **22** arrives at the dotted-line position of FIG. **2,** the valve **34** thereof is opened by opener **46** to allow the fluid behind piston **22** in bore **18** to rush therefrom via passageway **32** into the outlet **42** and discharge pipe **44.** This continues until the pumping piston **80** has fully completed its exhaust stroke, at which time the piston part **84** seats against the uppermost end **104** of tubular portion **70** in readiness for a new pumping cycle to begin.

It will be appreciated that the pumping piston **80** actually operates during its intake stroke in opposition to the bulk of fluid that drives it. In other rodless pumps the pumping pistons thereof are forced by their operating pistons to move in the same direction as the major fluid pressure forces in the body of fluid. However, in the present pump **10,** while the major fluid forces are directed downwardly through the casing **12** by the piston **22** during its compression stroke, the pumping piston **80** actually rises in the opposite direction to draw a new supply of fluid into the chamber **68** behind the vacating piston part **82.** Thus, during return of the piston **80** on its exhaust stroke, it is only necessary to rely upon the force of gravity to complete such return stroke, instead of using a complicated arrangement of spring mechanisms. In this respect, it is possible that, in various situations, different amounts of weight could be required to properly lower the pumping piston **80** and, therefore, the removability of the weight section **88** of stem **86** is helful because it allows for such varying needs to be accommodated.

By virtue of the present invention, it is also possible to utilize a vertical series of the cylinders **48** and their pumping pistons **80** within a single deep well casing **12** if such is desired. To this end, it is only necessary to remove the lower stopper **78** from each cylinder **48** in the series (except from the lowermost cylinder **48**) so that fluid at the different levels can flow upwardly through bypass conduits **74** into area **72** and through passage **98** during the exhaust stroke of each piston **80.** During the

intake stroke thereof, the fluid is simply drawn into the area **72** until the exhaust stroke begins, whereupon the fluid is drawn into passage **98** via cross channel **102.**

It is to be noted that the pump **10** is "tubeless" as this word is used in this particular field because there is no pipe directly connecting the cylinder **48** with the discharge outlet **42.** The casing **12** is used instead. However, such pipe can be provided if such is desired by simply connecting the same to the upper threaded end of bushing **94.** Moreover, if desired, a number of pump cylinders **48** in a vertical series can be interconnected by means of piping threaded into the lower ends thereof presented by the vacated stoppers **78** and into the upper ends thereof at the bushings **94.**

It should be apparent from the foregoing that minor modifications could be made in the pump **10** by those skilled in this art without departing from the true spirit of the present invention. Accordingly, this invention should be limited only by the fair scope of the claims which follow.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In a pump:
tubular structure having a fluid outlet;
an operating piston reciprocable within said structure through a compression stroke and a compression-release stroke;
a barrel assembly spaced from said operating piston within said structure and defining a fluid chamber;

a pumping piston reciprocable within said structure through an intake stroke and an exhaust stroke,
said pumping piston having a first part reciprocable within said chamber and a second part reciprocable exteriorly of said chamber,
said second part having a pair of opposed sides facing toward and away from said operating piston respectively,
said barrel assembly having a valved inlet communicating said chamber with the exterior of said structure during the intake stroke of said pumping piston for filling the chamber,
said pumping piston having a valved passage therethrough communicating said chamber with the outlet during the exhaust stroke of the pumping piston for emptying the chamber; and
means for applying pressurized fluid from said operating piston against both sides of said second piston part simultaneously during the compression stroke of said operating piston,
said side facing away from the operating piston having greater effective surface area exposed to the pressurized fluid than the opposite side whereby said pumping piston moves through its intake stroke in opposition to the direction of force in the fluid between the pistons during the compression stroke of the operating piston.

2. In a pump as claimed in claim **1,** wherein said pumping piston is returned by gravity during said exhaust stroke thereof and the compression-release stroke of the operating piston.

3. In a pump as claimed in claim **1,** wherein said means for applying pressurized fluid includes a cross channel in said pumping piston between said parts thereof and intersecting said passage.

4. In a pump as claimed in claim **3,** wherein said first piston part is of reduced cross-sectional size relative to said second part, there being a fluid-receiving area exteriorly of said barrel assembly on said side of the piston part facing away from the operating piston for accepting pressurized fluid from said cross channel.

5. In a pump as claimed in claim **4,** wherein said operating piston is disposed between said outlet and the inlet and is provided with a valved passageway therethrough for exhausting fluid to said outlet during the compression-release stroke of the operating piston.

6. In a pump as claimed in claim **5,** wherein said structure is provided with means for mechanically holding the valve of said passageway open during the compression-release stroke of the operating piston.

7. In a pump as claimed in claim **1,** wherein said operating piston is disposed between said outlet and the inlet and is provided with a valved passageway therethrough for exhausting fluid to said outlet during the compression-release stroke of the operating piston.

8. In a pump as claimed in claim **7,** wherein said structure is provided with means for mechanically holding the valve of said passageway open during the compression-release stroke of the operating piston.

9. In a pump as claimed in claim **1,** wherein said structure includes a pump casing containing said pumping piston and a pump head containing said operating piston, said casing having a cylinder supported axially therewithin in spaced relation thereto, said cylinder housing said barrel assembly and said pumping piston with said second part of the latter slidably engaging the cylinder.

10. In a pump as claimed in claim **9,** wherein said assembly includes a plug portion engaging said cylinder and having said inlet, and a tube portion having said chamber and being of reduced size relative to said cylinder to define an area between the latter and said tube portion, said first piston part being of reduced cross-sectional size relative to said side facing away from said operating piston, and said pressurized fluid applying means including a cross channel in said pumping piston between said parts communicating said passage with said area.

11. In a pump as claimed in claim **10,** wherein said plug portion is provided with a conduit therethrough bypassing said inlet and communicating said area with the opposite side of the plug portion, said cylinder having a removable stopper therein on the side of the plug portion opposite said area for opening said cylinder to additional fluid from other sources remote from the cylinder in the casing.

12. In a pump as claimed in claim **10,** wherein said second piston part has a central stem of reduced cross-sectional size, said cylinder having a bushing slidably receiving said stem, said stem having an outer end defining the effective, pressurized fluid contacting surface area of said side of the second piston part facing said operating piston.

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