Dec. 30, 1947. R. HASTINGS, JR., ET AL 2,433,812

POWER DRIVEN CYLINDER PISTON PUMP

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Fig. 1.

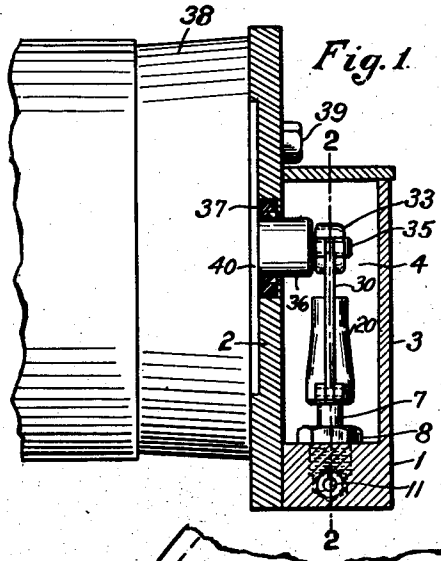


Fig. 3.

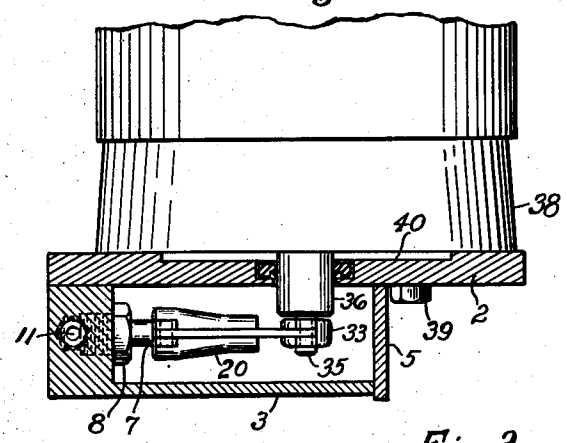
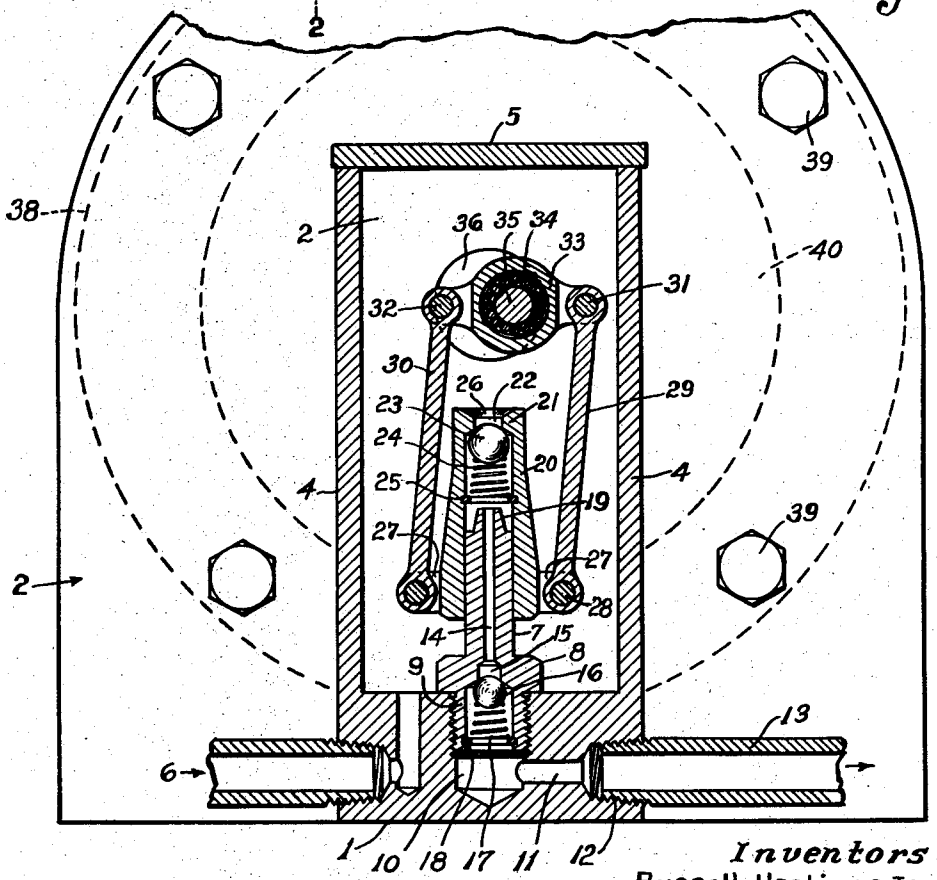


Fig. 2.



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POWER-DRIVEN CYLINDER PISTON PUMP

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11 Claims. (Cl. 103—158)

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This invention relates to improvements in power-driven piston pumps. One of the objects of the invention is to provide a pump of extreme compactness and high efficiency which can be produced at low manufacturing cost.

A further object of the invention is to provide a high speed pump of small size adapted to be driven by low horsepower motors and which will be capable of developing high pressure to permit its use with compact hydraulic mechanisms which are driven by oil delivered by the pump.

To obtain a high efficiency it has been found desirable to employ a piston type of pump as contrasted with other types, such as gear pumps, and to minimize lost motion, either mechanically or hydraulically, to provide the chamber of the pump with a short passage for the liquid with a large intake opening to insure complete filling of the pump chamber upon each intake stroke and prompt closing of the intake valve upon the compression stroke. If the intake valve does not open promptly the cylinder may not completely fill on the intake stroke. This results in the production in the cylinder of a partial vacuum with loss of volumetric efficiency and also produces cavitation which has a severe eroding action and produces objectionable loud noise and vibration during the operation of the pump.

Another object of the invention is to provide a construction in which such defects are avoided.

In order to provide a pump having an intake passage of large area to insure complete filling of the piston, particularly in pumps of small size, the pump embodying the present invention comprises a stationary piston and a complementary cylinder reciprocably mounted upon it provided with a large intake port having a short passage and a cooperating quick-closing valve therefor, instead of a usual construction in which the cylinder is stationary and the piston reciprocable therein, thereby enabling the use of a large intake port and shorter intake passage than would be possible if the valved intake port were located in the piston.

A further object of the invention is to provide valves for the intake and outlet ports of the pump, particularly that for the intake port, which at the end of each stroke is caused by its own inertia to close at the proper time without the usual time lag and loss of volumetric efficiency which in ordinary pump valves depends upon the flow of the liquid to open and close the valve.

A further object of the invention is to provide the reciprocating cylinder with means which will

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cause the inertia of the liquid upon the intake stroke of the cylinder to aid in opening the valve and rapidly filling the cylinder. In order words, to provide a cylinder construction having a scooping action which aids atmospheric pressure in filling the cylinder during the intake stroke.

A further object of the invention is to provide a cylinder with a yoke-shaped pitman connection to diametrically opposite sides of the cylinder and to the actuating mechanism which will minimize the side strain which might cause excessive wear between the cylinder wall and the piston thereby enabling minimum tolerance between the cylinder and piston with substantially no binding effect.

A further object of the invention is to provide a pump in which the piston and cylinder may be mounted vertically or at any angle relatively to the vertical, including upside down, sidewise, with the drive shaft either horizontal or vertical, or in which the drive shaft may be rotated in either clockwise or counterclockwise direction.

These and other objects and features of the invention will more fully appear from the following description and the accompanying drawings and will be particularly pointed out in the claims.

A simple embodiment of the invention is illustrated in the accompanying drawings in which the pump is shown as mounted vertically upon the base of a liquid-containing reservoir with the driving shaft mounted in liquid-tight bearings in the vertical wall, the pump and the end of the driving shaft being submerged in the liquid. It will however be understood that the reservoir may be of any suitable construction and the pump mounted in any suitable manner so long as the intake port is continuously submerged in the liquid.

In the drawings:

Fig. 1 is a view, showing the reservoir in vertical section and illustrating in elevation the pump piston, the pump cylinder, the motor, and the means operated by the shaft thereof for actuating the pump cylinder;

Fig. 2 is an enlarged transverse vertical sectional view on line 2—2 Fig. 1, viewed from right to left; and,

Fig. 3 is a view similar to Fig. 1 showing the reservoir and pump in horizontal position and the motor in vertical position as illustrating the capability of the pump to be mounted upon any desired wall of the reservoir.

In the preferred construction illustrated in the drawings the reservoir comprises a bottom 1, sides

2 and 3, suitable ends 4, and a top or cover 5. The reservoir may be of any suitable material to provide a non-leakable chamber provided with an inlet pipe 6 and suitable means for maintaining liquid at a predetermined level within the reservoir, or preferably full.

The pump comprises a preferably tubular cylindrical piston 7 which, as illustrated in Figs. 1 and 3, is provided with an enlarged base 8 which is mounted upon the bottom 1 of the reservoir and is provided with an enlarged tubular externally screw threaded extension 9 which extends into and engages complementary screw threads in a socket in the bottom 1 of the reservoir. The socket in the reservoir desirably extends below the end of the piston extension 9 and provides a chamber 10 having an outlet conduit 11 having at its end an enlarged screw threaded wall 12 to receive the screw threaded end of a suitable conduit 13 for delivering the liquid under pressure.

The piston 7 has an axial passage 14 having at its lower end an enlargement 15 the wall of which provides a valve seat for a preferably spherical valve ball 16 which is normally supported upon the upper end of a conical coiled spring 17, the larger lower end of which is seated upon a snap ring 18 which is held in a complementary recess in the inner wall of the piston extension 9 and is located above the chamber 10 in the base 1.

The upper end of the piston desirably is provided with a conoidal extension 19 the purpose of which will hereinafter be described. The cylinder 20 of the pump is reciprocably mounted upon and slidably fits the piston 7 with a minimum of clearance and is provided at its upper end with an inwardly extending flange 21 providing a large inlet port 22 the lower wall of which forms a seat for a valve ball 23. The valve ball 23 is seated upon the upper end of a conical spiral spring 24 the enlarged circular lower end of which is seated upon a snap ring 25 which is expanded into a complementary recess in the wall of the cylinder.

The conical end 19 of the piston is adapted to extend into the spring 24 when the cylinder is at the bottom of its stroke, thereby to reduce to a minimum the volume of the chamber at the end of the working stroke for the purpose of assuring the maximum expulsion of any air which may have been drawn into the cylinder and which might cause air-binding of the pump. The inwardly flanged upper end 21 of the cylinder desirably is provided with a conoidal downwardly and inwardly converging wall 26 which during the reciprocation of the piston upon the intake stroke will have a scoop-like action and cause the inertia of the liquid in the reservoir to aid in opening the valve and in forcing liquid into the cylinder.

Any suitable means may be provided for reciprocating the cylinder. In the preferred construction, in order to permit reciprocation of the cylinder without tendency to bind upon the piston, the cylinder is provided with bifurcated diametrically opposite bosses 27 having shafts 28 extending therethrough upon which the lower ends of pitman rods 29 and 30 are respectively mounted. The upper ends of the pitman rods 29 and 30 are mounted respectively upon shafts 31 and 32 in the bifurcated ends of a yoke 33 which is pivotally mounted upon a needle bearing 34 upon an eccentric pin 35 of a driving shaft 36 which is mounted in a suitable liquid-tight bearing 37 in the wall 2 of the reservoir. By reason of the pivotal mounting of the yoke 33 on the eccentric pin 35 of the driving shaft equalized and balanced

forces are always applied through the diametrically opposite pitman rods to the cylinder which will maintain accurate reciprocation of the cylinder and reduce to a minimum side strains and consequent binding and wear of the cylinder and piston.

Inasmuch as one of the principal objects of the invention is to provide a high speed pump of small size adapted to be driven by a low horsepower motor and which will be capable of developing high pressure, means for actuating the driving shaft desirably is in the form of an electric motor 38 which may be conveniently attached to or associated with a wall of the reservoir.

In the preferred construction illustrated herein the wall 2 of the reservoir is sufficiently larger than the area of the reservoir which it encloses and of suitable form, such as shown in Fig. 2, to provide a support for the electric motor 38. The end of the motor casing is secured thereto by suitable cap screws or bolts 39. In order to insure rigidity of the connection of the motor casing to the wall 2 of the reservoir the head of the motor casing desirably is provided with a preferably annular extension 40 which fits and is seated tightly in a complementary recess in the outer face of the wall 2.

In the operation of the device, when the pump is in vertical position as shown in Figs. 1 and 2, the chamber of the reservoir is filled with liquid, or the liquid at least maintained therein at a level considerably above the upper end of the cylinder when the latter is in uppermost position at the end of the intake stroke.

Assuming that the cylinder is at the bottom of its stroke, as shown in the drawings, and the driving shaft rapidly rotating, the upward movement of the cylinder causes the inertia of the valve ball 23 supplemented by the inertia and pressure of the liquid in the reservoir to displace the valve ball from its seat, thus quickly opening the port 22 and permitting the liquid to flow freely into the chamber of the cylinder.

The downwardly converging wall 26 of the short large passage forming the port in the head of the cylinder also aids in filling the cylinder completely as it provides a scooplike action which will more rapidly fill the cylinder than would be the case in the absence of such convergence. When the cylinder is thus completely filled by its upward movement, the downward movement of the cylinder quickly closes the valve ball 23 for the intake port 22 by reason of the momentum of the ball, the pressure of the liquid contained in the cylinder, and the light spring 24 which backs the valve, so that substantially no liquid escapes from the cylinder. Continued downward movement of the cylinder forces the liquid through the passage 14 of the piston thereby displacing the valve 16 against the pressure of the light spring 17 and forces the liquid into the chamber 10 of the socket in the bottom of the reservoir and thence through the outlet 11 and a conduit 13 through which the liquid under pressure is delivered. Upon the next upward movement of the cylinder the valve 16 for the outlet of the piston is quickly closed by the pressure of the liquid in the chamber 10 and the light spring 17 thereby preventing any appreciable back flow of liquid into the passage 14 of the piston. As a consequence the pump acts at a maximum of efficiency and because of the high speed of the motor, liquid under high pressure is rapidly delivered to the conduit 13.

While the invention is illustrated in Figs. 1 and

2 as comprising a pump mounted vertically upon the bottom of the reservoir it may be mounted horizontally upon a suitable vertical wall of the reservoir as illustrated in Fig. 3 or suspended in inverted position from the top of the reservoir, or in fact in any desired position so long as the liquid in the reservoir continually submerges the inlet port of the cylinder.

It will be readily understood that by virtue of the adaptability of the pump thus to be placed in any desired position the reservoir and pump may be readily associated with or incorporated in hydraulic actuating mechanism of any desirable type and will operate at a maximum efficiency.

Furthermore by reason of the present invention a pump construction is provided which can be made of small size and operated by a small motor of low horsepower to discharge liquid under high pressure and is thus adapted to be manufactured at a low cost and to be utilized at a minimum cost of operation because of its efficiency. Of course, pumps of this character may be made of any desired size and capacity. It will therefore be understood that the particular embodiment of the invention shown and described herein is of an illustrative character and that various modifications thereof not only in size and capacity but in form and construction may be made within the spirit and scope of the following claims.

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

1. A high pressure pump construction comprising a liquid-containing reservoir, a pump submerged in said liquid provided with a piston fixedly mounted on the base of said reservoir having a vertical passage therethrough with an outlet port having a valve seat at the lower end of said passage, a spring actuated ball valve normally engaging said valve seat, a conduit for liquid under pressure communicating with said outlet port, a cylinder reciprocably mounted on said piston having a head provided with an intake port of greater area than that of said passage, a ball check valve for said intake port, a spring mounted in said cylinder normally holding the valve ball in engagement with said port, said cylinder having an outwardly diverging wall extending upwardly from said port operable upon upward movement of the cylinder to cause the inertia of said valve ball supplemented by the inertia of the liquid to aid in quickly displacing the valve from said port and in forcing the liquid into the cylinder, and means for reciprocating the cylinder rapidly.

2. A high pressure pump construction comprising a liquid-containing reservoir, a piston mounted on the base of said reservoir, and extending into the liquid therein, having a shouldered conoidal end portion and provided with an axial passage having at its lower end an outlet port, a check valve for said outlet port, a cylinder reciprocably mounted on said piston having a head, continuously submerged in the liquid in said reservoir, provided with an inlet port of greater area than that of said axial passage, a valve ball for said intake port, an upwardly and inwardly tapering coiled spring having its lower end mounted upon the cylinder and its upper end supporting the ball valve and normally causing it to close said intake port, the construction being such that upon downward stroke of the cylinder the tapered end of the piston will enter the coiled spring thereby reducing to a minimum the volume of the chamber of the cylinder at the end of the working stroke thus assuring maximum expulsion of air which may have been drawn into the cylinder during the suction stroke and which might cause air-binding of the pump.

3. A high pressure pump construction comprising a liquid-containing reservoir, a piston mounted on the base of said reservoir, and extending into the liquid therein, having a shouldered conoidal end portion and provided with an axial passage having at its lower end an outlet port, a check valve for said outlet port, a cylinder reciprocably mounted on said piston having a head, continuously submerged in the liquid in said reservoir, provided with a short intake port of greater area than that of the axial passage in said piston having a wall inclined upwardly and outwardly thereby shortening the length of said intake passage and enabling the inertia of the liquid upon upward movement of the cylinder rapidly and completely to fill the cylinder, a ball valve for said intake port, an upwardly and inwardly tapering coiled spring mounted in said cylinder with its upper end supporting said ball valve and normally causing it to close the intake port, the construction being such that upon downward stroke of the cylinder the tapered end portion of said piston will enter the coiled spring and thereby reduce to a minimum the volume of the chamber of the cylinder at the end of the working stroke, thus assuring maximum expulsion of air which may have been drawn into the cylinder during the suction stroke and which might cause air-binding of the pump.

4. A pump construction comprising a liquid-containing reservoir, a pump having a tubular piston mounted upon a wall of the reservoir and provided with a quick-closing valved outlet leading therefrom, a cylinder reciprocably mounted upon said piston having a large intake port provided with a quick-closing valve and provided with diametrically outwardly extending bosses, pitmans pivotally connected at their lower ends to said bosses, a driving shaft having a pin extending eccentrically from its end, a yoke mounted on said pin provided with lateral extensions complementary to said bosses and in the same plane therewith and provided with means pivotally connected to the respective pitmans, means for rotating said driving shaft, and means for maintaining such level of the liquid in said reservoir as will continuously submerge said intake port.

5. A high pressure pump construction comprising a liquid-containing reservoir, a pump having a tubular piston mounted therein and having an axial passage therethrough provided with a quick-closing valved outlet, a cylinder reciprocably mounted on said piston having an inlet of greater area than that of said passage submerged in the liquid in said reservoir and provided with diametrically opposite journals, means for rapidly reciprocating said cylinder comprising a shaft rotatable at high speed, a yoke eccentrically mounted thereon and pitmans symmetrically connecting the arms of said yoke respectively to the diametrically opposite journals of said cylinder to minimize side strain and the consequent binding and wear of the cylinder and piston.

6. A high pressure pump construction comprising a liquid-containing reservoir, a pump having a tubular piston mounted on a wall of said reservoir having an axial passage therethrough provided with a quick-closing valved outlet, a cylinder reciprocably mounted on said piston

having an inlet of greater area than that of said passage and provided with diametrically opposite journals in proximity to the end thereof remote from said inlet, means for rapidly reciprocating said cylinder comprising a high speed motor, a yoke mounted eccentrically upon the shaft of said motor, and pitmans symmetrically connecting the arms of said yoke respectively to the diametrically opposite journals of said cylinder.

7. A high pressure pump construction comprising a liquid-containing reservoir, a pump therein having a tubular piston rigid with a wall of the reservoir and provided with an outlet having a check valve, a cylinder reciprocably mounted on said piston having an intake port submerged in the liquid in the reservoir, means for rapidly reciprocating said cylinder comprising a shaft driven by high speed, a yoke mounted eccentrically upon the shaft of the motor, and pitmans pivotally connecting the arms of said yoke to said cylinder at diametrically opposite points adjacent the end of the cylinder which is remote from said shaft, thereby to provide connections of maximum length and minimum angularity with respect to the axis of the cylinder to minimize side strain and consequent binding and wear of the cylinder and piston.

8. A high pressure pump construction comprising a liquid-containing reservoir, a pump wholly submerged in the liquid therein having a tubular piston rigid with a wall of said reservoir provided with an outlet having a check valve, a cylinder fitting and slidably mounted on said piston means for reciprocating said cylinder at a high speed, said cylinder having an inwardly converging intake port provided with a check valve operable by the inertia of the liquid in front of said intake port upon rapid intake movement of the cylinder to produce a pressure which will rapidly open said check valve and quickly and completely fill the cylinder, and means for rapidly reciprocating said cylinder.

9. A high pressure pump construction comprising a liquid-containing reservoir, a pump wholly submerged in the liquid therein having a tubular piston rigid with a wall of said reservoir provided with an outlet having a check valve, a cylinder fitting and slidably mounted on said piston means for reciprocating said cylinder at a high speed, said cylinder having an inwardly converging intake port provided with a check valve operable by the inertia of the liquid in front of said intake port upon rapid intake movement of the cylinder to produce a pressure which will rapidly open said intake valve and quickly and completely fill the cylinder, and means for rapidly reciprocating said cylinder having means for applying balanced forces to

diametrically opposite portions of said cylinder acting to minimize side strain and consequent binding and wear of the cylinder and piston.

10. A high pressure pump construction comprising a liquid containing reservoir, a pump wholly submerged in the liquid therein having a cylindrical piston with an axial passage therethrough and provided with a relatively larger base stationarily mounted in said reservoir having a chamber of larger area than that of said axial passage communicating therewith, a quick-closing outlet valve in said chamber, a cylinder fitting and slidably mounted on said piston having at its end a conically converging inlet port in axial alinement with and of greater area than that of said axial passage providing a scoop-like construction, a quick-closing valve for said inlet port, and means for reciprocating the cylinder at such high speed as to cause the inertia of the liquid in front of the inlet port upon the intake stroke of the cylinder to exert a pressure which will quickly open the intake valve and rapidly and completely fill the cylinder.

11. A high pressure pump construction comprising a liquid containing reservoir, a pump wholly submerged in the liquid therein having a cylindrical piston with an axial passage therethrough and provided with a relatively larger base stationarily mounted in said reservoir having a chamber of larger area than that of said axial passage communicating therewith, a quick-closing outlet valve in said chamber, a cylinder fitting and slidably mounted on said piston having at its end an inwardly extending annular flange provided with an inwardly converging conoidal wall providing a scoop-like intake port of greater area than and in axial alinement with that of said passage, a spring actuated ball valve for said inlet port, and means for reciprocating the cylinder at such high speed as to cause the inertia of the liquid in front of the converging inlet port to exert a pressure which will quickly open the ball valve and rapidly and completely fill the cylinder.

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