Aug. 24, 1943. T. S. HARRIS 2,327,637

DEEP WELL PUMP

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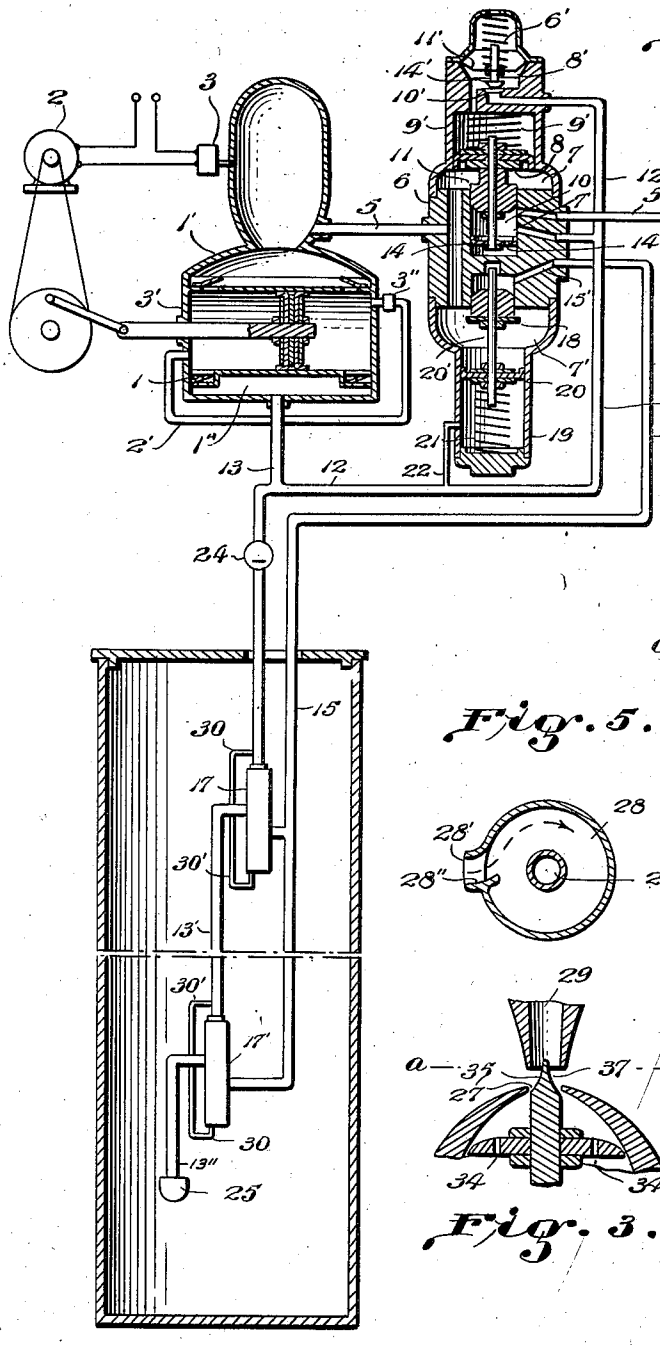


Fig. 1.

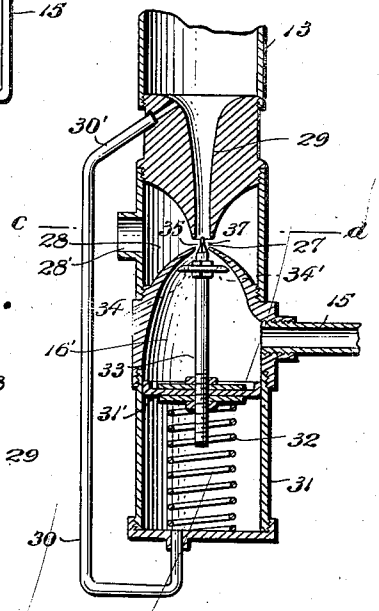


Fig. 2.



Fig. 5.



Fig. 3.



Fig. 4.

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## DEEP WELL PUMP

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4 Claims. (Cl. 103—5)

My invention relates to an improved form of the deep well pump as described in my former Patents 2,183,351, Dec. 12, 1939, 2,246,678, June 24, 1941, and 2,275,364, Mar. 3, 1942, and in my forfeited application 256,713 filed Feb. 16, 1939.

My present invention has the advantage that the automatic control unit is protected from variations in pressure in the intake passage near the pump so that a small plunger and supporting spring give the same uniform operation to the unit that could otherwise be secured only by the use of a large diaphragm and very heavy supporting spring.

Another advantage of the construction here shown and described is that the flow to the jet is controlled by a separate valve and pressure unit so that this valve responds to variations in the pressure within the intake passage, to automatically decrease the jet flow whenever the intake pressure becomes greater than a desired maximum.

Another advantage of this construction is that the jet flow is further automatically controlled at the nozzle of the jet unit, this control being supplementary to the control already mentioned and being influenced by the pressure in the intake passage at a point just above the jet booster unit.

A further advantage is found in means for more readily clearing the pump of air, this being of especial advantage when the pump is discharging against considerable pressure.

Referring to the accompanying drawing,

Figure 1 shows a vertical section through the complete pumping plant, well and storage tank.

Figure 2 shows an enlarged section through the booster jet unit, both of the jet units being of the same construction.

Figure 3 shows a more enlarged section of the jet nozzle construction, with the surrounding parts cut away.

Figure 4 shows a transverse sectional view of the jet slide valve at the line *a—b*, Figure 3.

Figure 5 shows a transverse sectional view through the jet unit, on the line *c—d* of Figure 2.

Referring to Figure 1, the double acting pump, 1 is operably connected to the motor 2, motor 2 being controlled by switch 3. A storage tank, 4 is connected to the discharge chamber 1' by passages 5, 5' and the chambers 7 and 10 of the master control unit 6.

The control unit 6 has two distribution chambers 7, 7' each of which is connected to passage 5. A plunger 8 extends across the top of chamber 7, being supported against the discharge pressure by a spring 9. The sliding plunger type valve, 11 controls the passage from chamber 7 to chamber 10, and is fixed to plunger 8.

Chamber 10, in addition to being connected to passage 5', has the repriming port, 7'', port 7'' being controlled by the slide valve, 14 which is fixed to plunger, 8. Port 7'' is connected by passage 12 to he intake passage 13. A passage, 14'', extends through the plunger slide valve, 14, to equalize pressure on its two sides at all times.

The cylinder 9' extends upwardly from chamber 7, and contains the spring 9. Diaphragm chamber, 8' is connected to cylinder 9' and has the pressure release port, 10', which is controlled by valve, 14'. Diaphragm 11' is exposed to atmospheric pressure on its top surface and is supported by the spring 6'. Valve 14' is fixed to diaphragm 11'. The port 10' is connected to the intake passage 13 by passages 12, 12'.

The lower control chamber, 7' has the port 15' which is controlled by the valve member, 18. From port 15' the passage 15 extends to the booster jet units, 17, 17'. A cylinder, 19 extends from chamber 7' and has in it the plunger, 20 which is supported by the spring, 21. Valve 18 is fixed to plunger 20 by plunger rod, 20'. At a point under plunger, 20, cylinder 19 is connected to passage 13 by passages 12 and 22.

In the pump, 1, the air relief passage, 2' extends from end to end of the cylinder, 3', with the ball check valve, 3'' connected into the passage at one point.

The main intake passage 13 is extended downwardly from the intake chamber 1'', and to the jet booster unit, 17 and thence by passage 13' to booster unit 17'. A check valve 24 is preferably connected into passages 13, while the foot valve 25 is preferably connected to passage 13'' which extends from unit 17' to the water of the well. The booster units 17, 17' are identical in construction except that unit 17' is adjusted to operate at the lower level at which it is placed.

The construction of units 17, 17' is better seen by referring to Figures 2, 3, 4, and 5. The jet chamber 16' has the jet orifice or nozzle, 27 which opens into the jet intake chamber, 28. The cone shaped expansion tube, 29 is disposed with its smaller end opening into chamber, 28 just over the jet nozzle, 27. The expansion tube, 29 has its upper and larger end connected to intake passage 13, or 13' as the case may be.

The cylinder 31 is extended downwardly from chamber 16' and has the plunger 31' disposed in it. A spring, 32 supports plunger 31'. Plunger rod 33 is extended upwardly and through

the jet nozzle, 27, approximately closing the nozzle when plunger 31' is at its top most position, as shown. The tip of plunger rod, 33 is cut away at a number of points on its circumference, the channels 35, 36, 37 and 38, Figure 4, becoming deeper at the point of rod 33, so that a downward movement of rod 33 opens the jet nozzle in proportion to the extent of the downward movement of rod 33.

The disc 34 fixed on rod 33 limits the upward movement of plunger, 31', and a small air port, 34' allows air to pass through the nozzle even when disc 34 is seated. A pressure release passage, 30, 30' is extended from the top of tube, 29 to cylinder 31, at a point under plunger, 32. The port, 28' into chamber 28 preferably has the deflecting wing, 28'' Figure 5, to give the incoming flow a rotative motion.

The operation of this pump is as follows: When first putting the pump into operation, with all piping being empty of water, a small quantity of water is placed in the tank 4. The repriming passage 12 connects the main intake pipe, 13, to the chamber, 10, of the pressure control unit, and thence, by passage 5' to the tank, 4. Therefore, when the pump is started, water is drawn from the tank, 4, to the pump intake, so that water is discharged to the pressure control unit.

Valves 11 and 18 of the control unit are closed at low pressures, so pressure quickly builds up in chambers 7, 7'. The pressure of spring 21 is preferably set so that valve 18 opens when the discharge pressure has built up to about 10 pounds per square inch, with the pressure under the plunger 20 being about five pounds of vacuum, since this chamber is connected to the intake pipe 13, by pipes 12 and 22.

When the discharge pressure causes valve 18 to open, water then flows to the pipe, 15, so that the air within it becomes compressed. This pressure is communicated to chamber, 16', of the jet unit, causing plunger, 31', to move downward. Eventually pressure builds up, opening the jet slide valve, so that the air and water pass on to fill pipe, 13.

The downward movement of plunger, 31', to open the jet, is controlled by setting the tension of spring, 32, to properly cooperate with the normal operating discharge pressure, and the height of the water column in pipe, 13—or, more exactly, the vertical distance of the jet unit below the pump head. This vertical distance, of course, varies with the depth of the well, since the jet unit is preferably placed close to the bottom of the well. Supposing the jet unit is to be used at a distance of fifty feet below the pump head, then it is necessary to provide for maintaining a pressure, at the bottom of pipe 13, of about twenty pounds per square inch. Such a pressure lifts the water about forty feet, the remaining ten feet of lift being secured by ordinary suction. Or, if we state the matter in terms of absolute pressure, saying nothing of suction, then the absolute pressure at the bottom of pipe, 13, must be about thirty-four pounds per square inch, which is sufficient to deliver the water to the pump at a pressure of about nine pounds, disregarding friction losses. But in the remaining description, the figures will be those of pump pressure, and pounds of vacuum, rather than absolute pressure.

Having determined what the normal operating pressure must be at the bottom of pipe 13, and under plunger, 31', through by pass, 30, it is then necessary to fix a normal discharge pressure before determining a tension of spring, 32, that will open the jet valve in a way to always supply the required boost to the water column in pipe 13, and thus put the pump into continuous and full operation.

The pump, of course, has a capacity of more than enough to supply the jet flow. Therefore, with the main discharge valve, 11, closed, and the repriming valve, 14, open, the pump quickly builds up a discharge pressure even with the jet passage valve open. When this discharge pressure has increased to a prearranged point the plunger 8 is forced back opening valve, 11, and closing the repriming valve, 14. The pump is then in full operation.

The movement of valve 11 results out of the differences of pressure above and below plunger, 8, cooperating with the spring, 9. In order that the plunger 8 shall move at a uniform discharge pressure it is necessary that the pressure under it be mintained at a uniform degree of pressure. Plunger, 8, like also plunger 20, is preferably of a rough leather cup, which, while it contacts the wall of the chamber, nevertheless permits a certain amount of leakage past it. If there was no provision for removing this leakage, then the pressures above and below the plungers would soon become equal, and the plungers become unresponsive to the discharge pressure. Since it is not necessary that valve 18 operate at a fixed pressure, the leakage past plunger 20 is allowed to pass directly to pipe 13, by pipes 22 and 12. But a more uniform operation of valve 11 is to be preferred, so, in order that the pressure under plunger 8 shall not be effected by changes in pressure in pipe 13, a valve, 14' is provided to control the passage, 12, 12', passing to pipe 13. Valve 14' is carried on diaphragm, 11', and the top side of diaphragm 11' being open to atmospheric pressure it moves to open valve, 14' at any desired pressure, within cylinder 9' which pressure is manually controlled by adjusting spring, 6'. Spring 6 is preferably adjusted so that valve 14' opens only when the pressure under plunger 8, from leakage past the plunger, has become about ten pounds per square inch. Having thus provided for a uniform pressure under plunger, 8, spring 9 is adjusted to maintain a discharge pressure of, preferably, about forty pounds per square inch.

Taking forty pounds as the normal operating discharge pressure at the pump, the adjustment of the spring controlling the jet unit may then be made. To this forty pounds of discharge pressure must be added about twenty-five pounds, the weight of a fifty foot water column, which is the total pressure which is delivered to chamber 16' over the plunger 31' of the jet unit. The pressure under this plunger, as already mentioned, must be about twenty pounds per square inch, for a fifty foot well. Therefore spring 32 must be so adjusted, or proportioned, that it supplies the necessary pressure to balance the plunger against a pressure of sixty-five pounds on its top surface, or the spring must supply a pressure of about forty-five pounds per square inch of plunger surface. Spring 32 is preferably a rather long spring, and well compressed, so that a slight change in the pressure differentials of plunger 31' produces sufficient movement to completely open or close the jet valve. In this way a satisfactory uniformity of operating boost is delivered at all times, regardless of changing water levels, and without the jet flow being un-

necessarily great at high water levels. For instance in a hundred foot well, where the water level usually stood at the fifty foot level, the jet unit would consume only 50% of its full volume, thereby increasing the flow to the tank. In such an instance the use of two separate units, allows the lower unit to be automatically and entirely out of operation, and the top unit operating at full capacity at fifty foot water levels, while, as the water level goes lower the lower jet unit goes into operation to whatever extent is required to keep the pressure right at the bottom of the intake pipe.

There is normally a drop in pressure of about five pounds at valve, 11, of the pressure control unit. If it desired to put the tank pressure up to a maximum of forty pounds, then the pressure in chambers, 7, 7' will run to forty-five pounds, at which pressure the cut out switch 3 stops the pump. At this increased discharge pressure, the jet unit automatically produces an increase of pressure at the bottom of the pipe 13, and this increased pressure is, of course, reflected in increased pressure, or decreased vacuum, at the pump intake. But, due to the control valve 14', on diaphragm, 11' this increase of intake pressure does not affect the operation of the main pressure control valve.

Should the jet unit nozzle become clogged, a slight manual pressure on diaphragm, 11', for a time, causes the pressure under plunger 8 to increase, and this, in turn causes the discharge pressure to build up so sharply that the jet unit plunger moves down to entirely draw the control rod, 33 from the jet, thus freeing it of any trash, or scale.

If it is desired, the jet passage check valve 18 may be adjusted to open at a pressure of about five pounds below the normal operating pressure, in which case it automatically controls the jet flow, without the use of the special jet unit. For when so set this valve tends to partly close whenever the intake pressure rises above normal, as when the water level becomes very high. Such a control, however, is not so efficient as the volume control, by the jet unit, since it operates to decrease the pressure at the jet.

The by-pass 2' on the pump helps to clear the pump of air, especially when it is discharging against considerable pressure, as it usually is when the switch is set to operate at a twenty to forty pound rank range. Under such an instance air becomes compressed in the main pump cylinder, then on the return stroke it expands preventing the taking in of more air, so that air in the intake pipe is not readily removed. In such an instance by-pass 2' enables the compressed air in the right end of the cylinder, to escape to the left end where the pressure, at that instant, is very low. Air is thus well discharged from the right end, which keeps drawing in air from pipe 13, while the pressure in the left end builds up until it is discharged to pipe 5. This by-pass is so small that it conducts practically no water, and the check valve 3'' entirely prevents water or air from flowing in one direction.

I claim as new:

1. In a deep well pumping plant, the combination of a double acting pump, an intake chamber and a discharge chamber on said pump, means for operating said pump, a storage tank, a well, a discharge passage from said discharge chamber, a discharge control unit connected to said discharge passage, a main discharge control chamber in said unit, a secondary or jet passage control chamber in said unit, each of said chambers being connected to said discharge passage, a cylinder extended from said main control chamber, a plunger in said cylinder, a spring disposed to support said plunger against the discharge pressure, a diaphragm chamber connected to said cylinder, back of said plunger, a diaphragm across said chamber, a pressure release port from that side of said diaphragm chamber which is adjacent to said cylinder, a valve controlling said port, said valve being fixed to said diaphragm, a spring disposed opposite to said valve to support said diaphragm, that side of said diaphragm chamber containing said spring being open to atmospheric pressure, a valve chamber, with opening from said main control chamber, a valve controlling said opening, said valve being fixed to said plunger, a port and passage from said valve chamber to said tank, also a second port from said valve chamber, a valve controling said port, said valve being connected to said plunger, a passage connecting said port to said intake chamber, a port from said jet passage control chamber, a cylinder extended from said chamber, a plunger in said cylinder, a spring supporting said plunger, a valve controling said port, said valve being fixed to said plunger, a passage from said cylinder back of said plunger to said intake chamber, a booster jet unit, said unit comprising a jet chamber, said chamber being connected by a passage to the said port from said jet passage control chamber, a jet nozzle opening from said jet chamber, a main intake passage extended downwardly from said intake chamber, an elongated cone shaped expansion tube disposed over said jet nozzle, said tube being connected into said intake passage, a cylinder extended downwardly from said jet chamber, a plunger in said cylinder, a spring supporting said plunger, a plunger rod fixed to said plunger and extended upwardly through said jet nozzle, radially disposed longitudinal channels disposed at the top of said rod and a passage from said cylinder, at a point under said plunger and extending to the large end of said expansion tube.

2. In a deep well pumping plant of the jet booster type, an automatic jet booster unit, comprising a tubular cone type expansion tube, a jet control chamber fixed to said tube, a jet opening in the wall of said chamber, said jet opening being disposed to discharge into the small end of said tube, a cylindrical casing fixed to said control chamber, one end of said casing opening into said chamber, the opposite end being closed, a plunger in said casing, a spring disposed in the closed end of said casing to support said plunger, a control rod fixed to said plunger and extending through said jet opening, a plurality of tapered channels cut in the end of said control rod and a closed passageway from the closed end of said casing to the large end of said expansion tube.

3. In a deep well pump, an automatic unit to provide control of the discharge flow from the pump, said unit comprising a main tubular control chamber, a plunger disposed in said chamber, a spring disposed in one end of said chamber to support said plunger, a diaphragm chamber fixed to this end of said control chamber, a diaphragm across said diaphragm chamber, a passage from one side of said diaphragm chamber to that portion of said control chamber adjacent thereto, a port opening outwardly from this portion of said diaphragm chamber, a valve

controlling said port, said valve being fixed to said diaphragm, a spring disposed on the opposite side of said diaphragm to support said diaphragm, this side of said diaphragm chamber being open to atmospheric pressure, a port opening into that side of said control chamber which is opposite to said plunger spring, a valve chamber fixed to this portion of said control chamber and connected to it by a passage, a valve controlling said passage, said valve being fixed to said plunger, two ports opening outwardly from said valve chamber, a valve controlling one of said ports, said valve being fixed to said plunger; a second control chamber, said second chamber being fixed to said main control chamber, a movable partition across said second chamber, a spring disposed on one side of said movable partition to support it, a port opening outwardly from this portion of said chamber, an intake passage extending from the opposite portion of said second chamber to said main control chamber, also a discharge port from this portion of said second chamber, and a valve controlling said port, said valve being fixed to said movable partition.

4. In a deep well pumping plant of the jet booster type, an automatic jet booster unit, said unit comprising a tubular, cone type conversion tube, a jet control chamber fixed to said tube, a jet opening in the wall of said chamber, said jet opening being disposed to discharge into the small end of said tube, a cylindrical casing fixed to said control chamber, one end of said casing opening into said chamber, while the opposite end is closed, a plunger in said casing, a spring disposed in the closed end of said casing to support said plunger, a jet control valve disposed to control said jet opening and being fixed to said plunger, and a closed passageway from the closed end of said casing to the large end of said conversion tube.

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