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CENTRIFUGAL PUMP UNIT

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FIG. 1

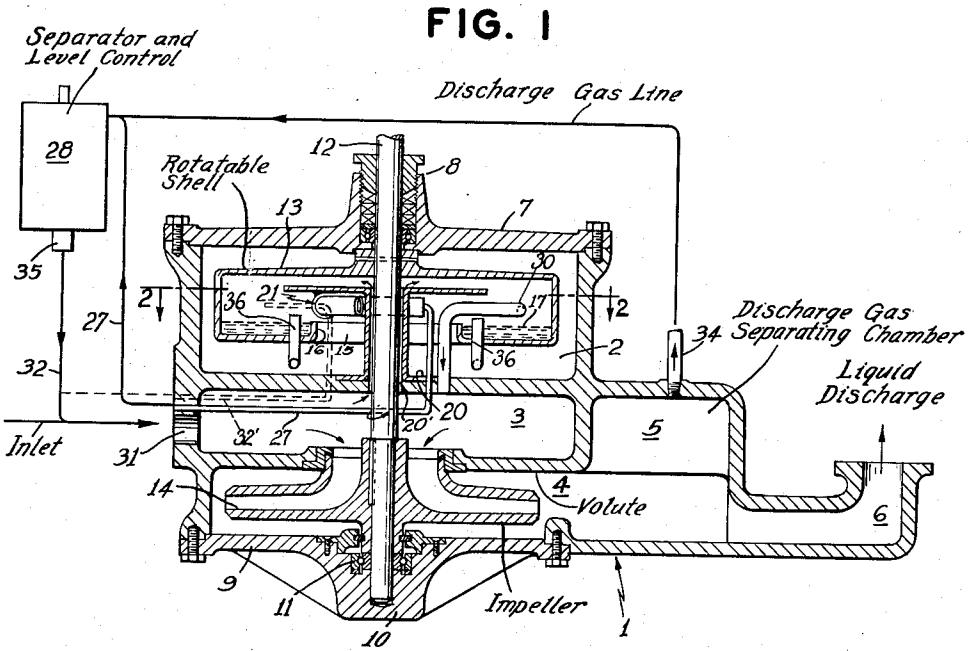
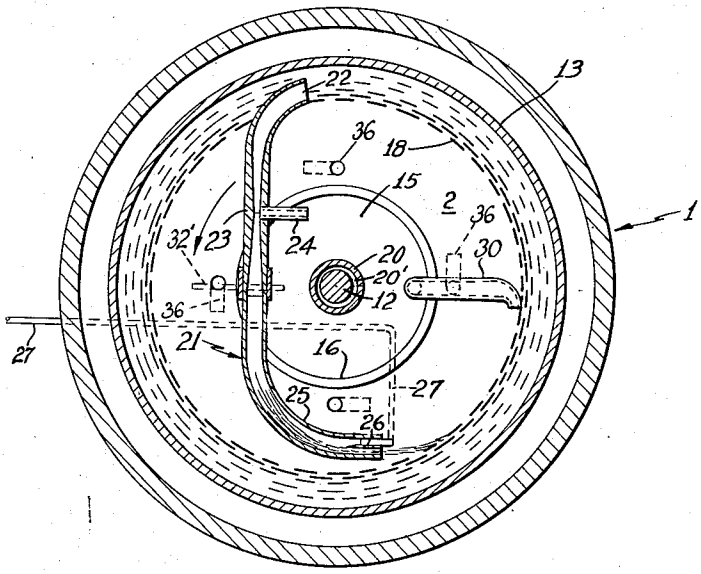


FIG. 2



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CENTRIFUGAL PUMP UNIT

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11 Claims. (Cl. 103—113)

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This invention relates to centrifugal pumps and vacuum pumps and has for its principal object the provision of a pump unit comprising in combination a centrifugal pump and a vacuum pump in which the centrifugal pump is self-priming. In a preferred embodiment of my invention I provide a self-priming centrifugal pump unit with but a single moving part in a compact structure of exceptional simplicity. The combination of my invention fills the need for a simple, efficient and trouble-free pump unit to pump various liquids, for example, water and chemicals, notably volatile liquid fuels such as gasoline or petrol, and solvents.

My invention comprises a centrifugal pump having an impeller, and a vacuum pump having a shell for confining a liquid annulus which is rotatable on the impeller shaft and a jet pump, and a duct connecting the suction side of the centrifugal pump with the jet pump to remove air, gas or vapor (hereinafter called "gas") from the suction side of the pump and prime the pump. Advantageously I mount the impeller of the pump with its suction and discharge chambers and the shell for confining the liquid annulus in a compact integral housing. The combination also includes means to supply liquid to the annulus, preferably by duct means connected to the centrifugal pump, and means for removing excess liquid from the annulus to maintain it at a uniform depth. The shell and its annulus are within a chamber evacuated by the jet pump and the duct for priming the pump connects the chamber with the suction side of the centrifugal pump.

One of the important features of my invention is the provision of a jet pump mounted in a stationary operating position inside the shell to receive rotating liquid from the annulus to create the vacuum and suck gas from the intake or suction side of the centrifugal pump and thus prime the pump.

The centrifugal pump and the vacuum pump are preferably enclosed within a housing including a vacuum chamber in which the shell rotates, a suction chamber for the centrifugal pump between the impeller and the vacuum chamber, and a liquid discharge chamber for the centrifugal pump. Advantageously the shaft on which the impeller and shell are mounted passes through a partition which divides the vacuum and suction chambers with such a clearance as to provide a free passage for gas but a restricted passage for liquid. The suction side of the jet pump opens into and evacuates the vacuum chamber and the

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passageway around the shaft provides an annular duct for the flow of gas in priming the centrifugal pump and thereafter a restricted passageway for the flow of liquid to supply the annulus with make-up liquid. The liquid thus flowing from the suction chamber of the centrifugal pump enters the liquid annulus and means are provided to remove the excess liquid and return it to the liquid circuit. The gas separated by the jet pump is accompanied by a certain amount of liquid which is discharged from the pump. Means are also provided for the separation of the gas and liquid and the return of the liquid to the system when desired, as when chemicals or fuels are being pumped.

My combination of pumps may be constructed and arranged with the common shaft in either a vertical or a horizontal position. For convenience in illustrating the invention, the drawings show a combination with a vertical drive shaft together with means in the shell to trap a body of starting liquid.

These and other objects of the invention will be better understood after considering the following discussion taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a sectional elevation of a self-priming centrifugal pump unit embodying the invention, and

Fig. 2 is a sectional view along line 2—2 of Fig. 1.

In the embodiment of the invention illustrated in Figs. 1 and 2, the housing 1 encloses a vacuum chamber 2, a suction or inlet chamber 3, an outlet or discharge chamber 4 for the centrifugal pump, a gas separating chamber 5, and a liquid discharge outlet port 6. Chamber 5 is provided for pumps intended for pumping such liquids as gasoline where gas or vapor elimination is necessary. For other liquids chamber 5 may be eliminated. Chamber 2 is closed by the cover 7 in which is mounted the combined shaft bearing and stuffing box 8. The cover 10 closes the lower part of the centrifugal pump discharge chamber 4 and has the thrust bearing 11 mounted therein.

The drive shaft 12 is in a vertical position in the embodiment of apparatus shown, is mounted in the said bearings, and is driven in the usual way by an electric motor not shown. The annular shell 13 and pump impeller 14 are fixed to the shaft and rotate therewith. The shell provides an annular chamber and has a central opening 15 within the upturned lip 16 which forms a retainer for the body of liquid 17 when

the pump is at rest (Fig. 1). When the shaft is rotating at operating speed, the liquid annulus 18 assumes the position shown in Fig. 2.

The collar 20 is fixed to the housing and there is a sufficient clearance 20' between it and the shaft to provide a relatively free passage for the flow of gas but a restricted passage for the flow of the liquid. With a 0.500 inch diameter shaft, for example, an effective opening is about 0.525 inch. The jet pump 21 is attached to the collar as by welding and is held in a fixed position. The vacuum pump may be constructed to embody features as more particularly described and claimed in my copending application Serial Number 128,265, filed November 19, 1949, now Patent No. 2,632,597, to achieve relatively low vacuums and high efficiency. The vacuum pump shown comprises an inlet opening 22 in the liquid annulus 18, and a jet pump 23 with a gas inlet 24 for sucking gas out of the vacuum chamber 2 and creating a reduced pressure therein. The curved portion 25 causes a centrifugal separation of the gas and liquid and the baffle 26 aids in directing the liquid back to the annulus and the gas, with some liquid, through tube 27 into the separator and level control 28. Gravity also aids in separating the gas and liquid. The skimmer 30 is mounted in a fixed position in the housing and serves to remove excess liquid from the liquid annulus and return it to the suction side of the centrifugal pump. The suction chamber 3 of the pump has a liquid inlet 31 to which is connected a tube 32 for the return of liquid from the separator. Tube 32 may be branched as 32' shown in broken lines to return a part of the liquid back to the annulus and thereby assure a supply of operating liquid. Moreover line 32' may connect to an outside or independent source of liquid to provide a liquid annulus which is independent of the liquid being pumped. In such a modification the shaft clearance can be smaller and line 32 is not connected to the liquid inlet. An orifice 35 is inserted in the tube 32 to control the flow of liquid from the separator back to the centrifugal pump.

The discharge chamber 4 of the centrifugal pump connects to a laterally disposed but somewhat elevated pocket or chamber 5 into which gas accompanying the discharge liquid may rise and escape under pressure through tube 34 to the separator 28. The liquid being pumped passes laterally to the outlet port 6.

When the pump is constructed for operation with a vertical shaft, a valve is necessary in the liquid outlet. If the pump should be started with the suction and discharge chambers empty, it is necessary to close the valve, otherwise the valve may be open.

When the pump is first set in motion, the liquid assumes the position shown in Fig. 2 and is forced to flow through the jet pump 23. Most of the liquid returns to the annulus while some liquid and the gas sucked out of chamber 2 through duct 24 are forced to flow to the separator 28. By reason of the reduced pressure in chamber 2, gas is sucked out of the suction chamber 3 through the clearance between the shaft and collar 20, resulting in liquid being drawn in through port 31, and the pump is thus primed. When the centrifugal pump is in operation, some liquid is sucked through the shaft clearance by reason of the lower pressure in chamber 2 than in chamber 3 and spills over the top of the collar entering the shell 13 to make up for liquid lost through tube 27. The excess liquid is skimmed off the annulus and returned by skimmer 30 to to the suction chamber. In operation there is a little spillage of liquid from the annulus and this collects in the bottom of chamber 2. Scoops 36 are so positioned and shaped that they scoop the liquid off the bottom and return it to the annulus.

Any gas or vapor which accompanies a liquid, such as the vapor of gasoline, enters the chamber 5 from which it flows under pressure through tube 34 to the separator 28. The separator may be equipped with a float controlled valve to maintain some liquid in the separator and allow the gas to escape without returning to the pump. The orifice 35 can serve this purpose. If the gas separated is inert like air, then it may be allowed to escape to the atmosphere. If it is a dangerous or useful gas, it may be recovered as by passing it from the separator through an activated carbon or like adsorber (not shown).

I claim:

1. A self-priming liquid pump unit comprising a liquid pump, a suction chamber communicating with the intake of the liquid pump and having an intake for liquid thereto, a vacuum chamber, a vacuum pump including a jet pump stationarily mounted in said vacuum chamber, means for forming in said vacuum chamber a rotating annulus of liquid, the vacuum pump having an inlet positioned to receive liquid from said rotating annulus of liquid, means for conducting liquid entering said inlet to the jet pump, a gas inlet for the jet pump communicating at one side with the space of the vacuum chamber to be evacuated and at its other side with the jet pump at a position to have gas from said space of the vacuum chamber drawn therethrough when liquid is passed through the jet pump, and a duct connecting the vacuum chamber with said suction chamber for evacuation of the suction chamber to cause liquid to flow through the inlet thereto and prime the liquid pump.

2. A pump unit as defined in claim 1 in which the inlet for the vacuum pump is positioned to lie within the rotating annulus of liquid.

3. A pump unit as defined in claim 1 in which the duct connecting the vacuum chamber with the suction chamber is of such size as to permit ready flow of gas therethrough in priming of the pump, but to restrict liquid flow therethrough.

4. A pump unit as defined in claim 1 in which the suction chamber is positioned between the vacuum chamber and the liquid pump chamber, a common partition separates the vacuum chamber from the suction chamber, the liquid pump is mounted on a rotatable shaft which passes through said partition and said chambers, and said shaft carries means for forming said annulus of liquid.

5. A pump unit as defined in claim 4 in which the duct connecting the vacuum chamber with the suction chamber is a clearance space around said rotatable shaft where it passes through said common partition.

6. A self-priming liquid pump unit comprising a liquid pump, a suction chamber communicating with the intake of the liquid pump and having an intake for liquid thereto, a vacuum chamber, a vacuum pump, including a jet pump, stationarily mounted in said vacuum chamber, a drive shaft on which said liquid pump is mounted, said drive shaft passing through said chambers, a shell for receiving liquid mounted on said drive

shaft within said vacuum chamber for rotation with said shaft, means for maintaining a supply of liquid within said shell, the vacuum pump having an inlet positioned to receive liquid from a rotating annulus of liquid caused by rotation of said shell, means for conducting liquid entering said inlet to the jet pump, a gas inlet for the jet pump communicating at one side with the space of the vacuum chamber to be evacuated and at its other side with the jet pump at a position to have air from said space of the vacuum chamber drawn therethrough when liquid is passed through the jet pump, and a duct connecting the vacuum chamber with the suction chamber for evacuation of the suction chamber to cause liquid to flow through the inlet thereto and prime the liquid pump.

7. A pump unit as defined in claim 6 in which the duct connecting the vacuum chamber with the suction chamber is of such size as to permit ready flow of gas therethrough in priming of the pump, but to restrict liquid flow therethrough.

8. A pump unit as defined in claim 6 which includes means for removing excess liquid from the rotating annulus of liquid.

9. A pump unit as defined in claim 6 in which a common partition separates the vacuum chamber from the suction chamber, the drive shaft passes through said partition, and the duct connecting the vacuum chamber with the suction chamber is a clearance space of about 0.025 inch around said drive shaft where it passes through said common partition.

10. A pump unit as defined in claim 6 in which the drive shaft is positioned vertically, the rotatable shell has a central opening in the bottom thereof and the edge portion of the shell defining the opening is an annular upturned lip for trapping a layer of liquid in the bottom of the shell when it is at rest.

11. A pump unit as defined in claim 10 in which the means for stationarily mounting the vacuum pump in the vacuum chamber extends through the central opening in the shell and a conduit for passing gas drawn from the vacuum chamber by the jet pump passes through said opening to a point outside of the unit.

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