Nov. 15, 1938. B. STELZER 2,136,528

VACUUM PUMP

Filed March 8, 1937

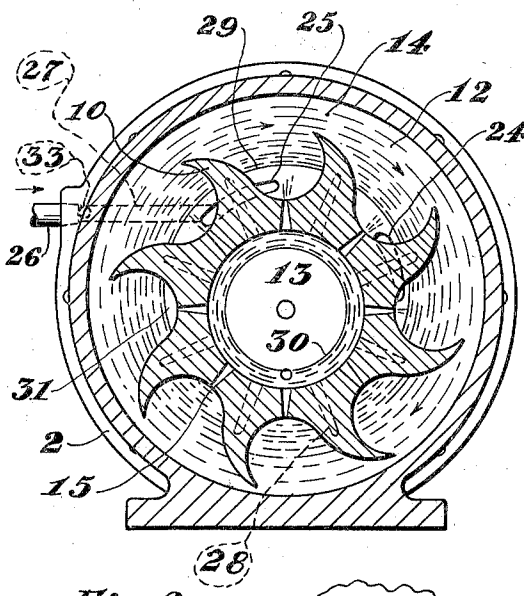


Fig. 2

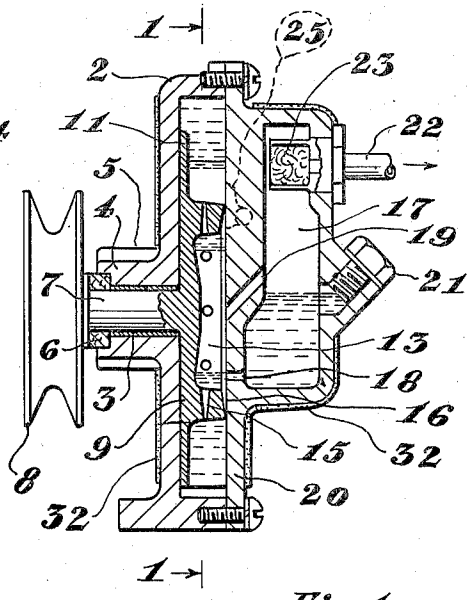


Fig. 1

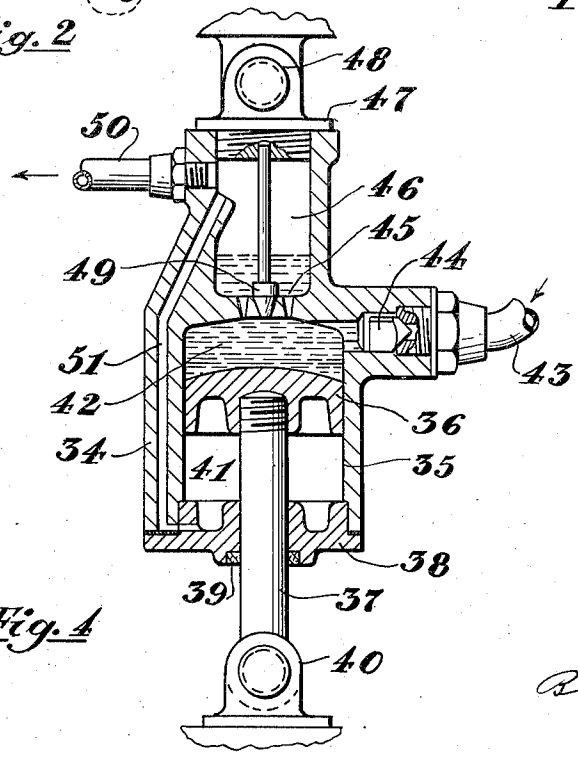


Fig. 4

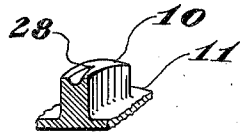


Fig. 3

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VACUUM PUMP

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Application March 8, 1937, Serial No. 129,633

7 Claims. (Cl. 230—79)

The invention relates to vacuum pumps, and more particularly to a scavenging system for vacuum pumps of the liquid ring type to be used to create a vacuum to evaporate water, as for instance in refrigerating systems where water or fuel is evaporated for the purpose of cooling, as already shown in my application Serial No. 55,625, filed Dec. 21, 1935, of which this application is a continuation-in-part.

The object is to provide a vacuum pump capable of producing a high degree of vacuum, which is accomplished in a novel device for completely flushing and discharging the vapors or residual gases from the vacuum producing element.

Another object is to provide a liquid seal for the vacuum producing element so that the rotating member can be spaced freely from the stationary housing to prevent friction.

These objects, among others, are obtained by a construction illustrated in the drawing, wherein:

Fig. 1 is a sectional elevation of the improved pump;

Fig. 2, a section taken on lines 1—1 of Fig. 1;

Fig. 3, a detail sectional view of a vane to show the sealing groove; and

Fig. 4, a sectional elevation of a modified form, where the invention is applied to a reciprocating piston type pump.

Referring to Figs. 1 and 2, there is shown a stationary housing 2 having a bearing 3 in a boss 4 provided with cooling fins 5 and seal 6. A shaft 7 carrying a drive pulley 8 turns in said bearing and drives the runner or impeller 9 having blades or vanes 10 and a shroud flange 11 reinforcing said blades and producing a seal for the operating fluid 12 which is of low viscosity and has a high evaporation point, such as certain paraffin oils. The central portion of said impeller is hollowed out to form a chamber 13 communicating with the outer chamber 14 through restricted passages in the form of tapered holes 15 and a tapered clearance space 16, and with a static reservoir 17 through passages 18 and 19. The reservoir 17, which is a part of the cover or plate 20 secured to the stationary housing 2, is provided with a filler plug 21 and an exhaust or discharge outlet 22 having a filter 23 to prevent discharge of the operating fluid. The outer chamber communicates with reservoir 17 directly by a port 24, whereas the intake or suction 25 connects to the intake pipe 26 by means of a drilled hole 27. To complete the liquid seal between outlet port 24 and inlet port 25 a small shallow groove 28 is provided in every blade, illustrated and somewhat exaggerated in Fig. 3. This groove is tapering, reducing in size towards the tip of the blade, so that when passing one of the ports only a small amount of fluid is discharged. The depth of the groove must be in proportion to the clearance space between the vane and plate 20, so that by reducing the clearance, the groove can be reduced too. The passages 15 are tapered, increasing in area towards reservoir 13, to provide a greater resistance to the flow of liquid outwardly, or away from chamber 13, and to provide a reduced resistance to the flow of liquid or gases from the outer ring to the inner one in chamber 13. The same applies to the clearance space 16. I have found that the best taper has an included angle of about 8 degrees. If it is reduced, the wall friction increases, and if the angle is increased, the fluid is likely to break away from the wall, so that the resistance nears that of the smallest section. It is a known fact that fluid may be accelerated by entering a restricted passage with almost no loss of energy, the pressure changing into velocity. However, it is difficult to economically change velocity into pressure; in the flow of a fluid through a sudden opening the impulse energy is completely lost, changing into heat by turbulence. Thus by neglecting the difference in wall friction, and the small loss through gradual widening of the passage, it is safe to say that the flow of liquid outwardly from chamber 13 is about the same as through an orifice equal in area to the narrowest section of the passage; and in the opposite direction, to the widest. The purpose of the arrangement is to allow the superfluous fluid in the outer chamber to pass quickly into reservoir 13 with very little loss or resistance, and to prevent the liquid in said reservoir 13 to fill pocket 31 while it is forming. Since the slightest amount of residual gas would prevent the creation of a sufficient vacuum for water evaporation at low temperatures, it is absolutely necessary that the pumping chambers are completely flushed, which would be impossible with the usual exhaust port 24, because in order to make sure that all gases are removed, some fluid must escape too, and the escaped fluid must be returned in an economical manner. Furthermore, the amount of the escaped fluid must not be larger than necessary, in order not to lose efficiency, which would be impossible with the ordinary ports.

In operation, considering rotation in the direction of the arrows, the fluid in chamber 14 due

to centrifugal inertia assumes a level indicated by the line 29, while in chamber 13 the surface level is maintained at 30 due to the overflow port 18. The increasing vacuum pocket at 31 when registering with the inlet port 25 is filled with the vapors from line 26, which are compressed until discharged through port 24 into reservoir 17 and from there dissipated through the exhaust pipe 22. The residual vapors are flushed by the operating fluid through the orifices 15 and clearance space 16 into chamber 13 and from there escape through hole 19 into chamber 17 and out through the exhaust.

The flushing operation is produced by the leakage of fluid through orifices 15 and clearance space 16. While a suction pocket is formed between the blades, fluid is ejected from inner passages 15 and 16 to join the outer mass of fluid 12. While the outer periphery of the chamber 14 is again nearing the impeller the ejected extra amount of fluid is forced back into chamber 13 through the same way it came from, taking all residual vapors with it.

In order to prevent condensation of the water vapor it is desirable to operate the pump at a high temperature. For this purpose I harness the inherent heat produced by friction by applying a coat of heat insulation 32. The bearing however is kept cool by the radiating fins 5.

To prevent the vacuum in line 26 from drawing any fluid or air from the pump, a check valve 33 is provided allowing flow in the direction of the arrow only. This check valve may be interposed in line 26. The exhaust line 22 may lead to the intake manifold of an internal combustion engine as is shown in my co-pending application Serial No. 55,625.

In the modification shown in Fig. 4 the invention is applied to a reciprocating pump or a shock absorber. The housing or cylinder 34 has a cylinder bore 35 adapted to take a reciprocating piston 36, secured to a piston rod 37 guided by a cover 38 screwed to the cylinder and having an oil seal 39, and being pivoted to a hinge 40, which is part of, or secured to a reciprocating member, for instance the axle of an automobile or the crank of a drive shaft. The piston 36 divides the cylinder into the atmospheric chamber 41 and the suction chamber 42, the latter communicating with the suction line 43 through a check valve 44 of standard construction, and through tapered holes 45 with a reservoir 46 partly filled with liquid and closed on top by a plug 47 having a hinge 48 secured to a stationary member, for instance the body or chassis member of an automobile. The lower extremity of said plug has a central hole to guide a check valve 49 which serves to increase the passage area when the piston 36 is ascending. The upper end of chamber 46 is open to the exhaust line 50, while a passage 51 leads to chamber 41 so that leakage past the piston 36 is returned into the reservoir.

The suction chamber 42 is ordinarily filled with liquid, which, when the piston is rises, is displaced into reservoir 46 through the orifices 45, and valve 49 when the rise is sudden. When the piston descends, a vacuum is created in chamber 42 because fluid cannot pass through the orifices 45 fast enough to follow the piston. Thus check valve 44 opens and vapor is drawn from the suction line 43 to fill the vacuum. As the descent ceases, the vapor by buoyant action escapes through the orifices 45 into reservoir 46 and out through the exhaust, whence chamber 42 fills again with liquid.

The construction shown in Fig. 4 can be used as a shock absorber. The exhaust line 50 may lead to an air filter or to the engine intake manifold. Line 43 is equivalent to line 26, and leads to the device to be evacuated, for instance the vapor generator of the refrigerator. It is apparent that chamber 41 is filled with liquid, breathing into chamber 46, but the resistance offered to the travel of the piston downwardly is very small, being less than atmospheric pressure, passage 51 offering only a very small resistance. As during rapid descent of piston 36 a vacuum is created in chamber 42, the damping action is momentarily lost, however, while the piston comes to a stop at the end of its downward stroke, some of the fluid in chamber 46 has time to pass through the passages 45 to fill chamber 42. At the beginning of the upward stroke, the resistance to the movement is smaller, increasing towards the end, when only incompressible fluid is left in chamber 42. Valve 49 may be left off. The action thus is similar to that of any present day shock absorber, the difference being only that the energy otherwise dissipated is usefully applied.

Since the gases or vapors drawn from line 43 are forced into chamber 46 under pressure, the device also serves as a compressor, whereby 50 may be the pressure line. The pressure may be used for the operation of booster brakes or other auxiliary equipment.

Reservoir 46 may be equipped with a filter similar to 23 as shown in Fig. 1, also the filler plug 21 should be incorporated. Chamber 14 is equivalent to chamber 42, while the reservoirs 46 and 17 are identical. The orifices 45 are substantially the same as already described in Fig. 2.

Since Fig. 4 illustrates that the invention can be applied to kinds of pumps different from that shown in Fig. 1, I do not wish to be limited to any particular type of pump. The principle can be applied to any pump having one or a plurality of chambers or pockets of variable volume, and the chambers or pockets may be increased and decreased in different manners, thus the type shown in Fig. 4 may be actuated not only as a shock absorber, but in a similar manner to any reciprocating pump; furthermore, a plurality of cylinders may be used, as a multi-cylinder pump. Since this pump will be mostly used for refrigeration, it may be connected as shown in my co-pending application Serial No. 55,625.

While the invention is especially adapted to be used in rotary pumps having an eccentric or digressing housing and using an operating fluid so serve as piston between the vanes of the impeller, as shown in Fig. 2, it lends itself also to a pump illustrated in Fig. 6 in my co-pending application Serial No. 55,625; furthermore, the pump may be constructed similar to the embodiment shown in Fig. 4 of said application.

Since the pump is used for a very high vacuum, the volume of the water vapor compressed to atmospheric pressure is extremely small, therefore port 24 is shown in exaggerated size. In certain constructions, where the pump is built narrow, this port may be omitted entirely, as the restricted passages or orifices 15 are sufficient to lead the vapors into reservoir 13 from where they can escape in the manner already described.

Though I have shown the restricted passages from the pockets between the vanes to the inner or rotary reservoir as round tapered holes, and a tapered clearance space, these passages may be of different shapes. The main principle and

object is to construct them so that the resistance offered to the flow of fluid is increased for outward direction, and reduced towards the reservoir.

It will be noticed by inspection of the drawing, that liberal fillets are provided between the vanes. This is to obtain complete scavenging and to prevent pockets where vapors might be locked, making the pump ineffective.

Other objects and modifications may be resorted to within the scope of the invention, as here claimed.

I claim:

1. In a vacuum pump for evaporating water, an impeller having vanes to form pockets therebetween, a stationary housing digressing from the periphery of the vanes, said impeller being adapted to turn within said housing, a fluid with a high evaporation point in said housing to be circulated by said impeller so as to perform a reciprocatory motion relative to said pockets to create a pumping action, a reservoir within said impeller, a revolving fluid therein, and a restricted passage from said reservoir to each of said pockets to allow the escape of residual vapors, said restricted passage being so shaped that it offers a greater resistance to the flow of fluid from said reservoir to the pocket to which it leads than it does from said pocket to said reservoir, and an outlet from said reservoir to permit the exhaust of the vapors and gases.

2. In a vacuum pump for evaporating water, an impeller having vanes to form pockets therebetween, a stationary housing digressing from the periphery of the vanes of said impeller, said impeller being adapted to turn within said housing, a fluid having a high evaporation point in said housing to be circulated by said impeller so as to perform a reciprocatory motion relative to said pockets to create a pumping action, a rotary reservoir inward of said impeller, a fluid in said reservoir to revolve with said impeller, a restricted passage from said reservoir to each of said pockets, the fluid due to centrifugal action having a tendency to flow into said pockets and thereby displace vapor or air in said pockets, a stationary reservoir to receive fluid, a passage from said stationary reservoir to said rotary reservoir to maintain a certain fluid level in said rotary reservoir, a suction line leading to said pockets at a point before said pockets reach their maximum volume, and an exhaust connected to the stationary reservoir at a point above the fluid level.

3. The construction as claimed in claim 2, where the said vanes are provided with such fillets as are necessary to allow the vapor to escape through said restricted passages, whereby said restricted passages are placed at the innermost points of said pockets.

4. The construction as claimed in claim 2, where the sides of said vanes are provided with grooves to form a liquid seal for the vapors.

5. The construction as claimed in claim 2, with a check valve in the suction line to allow flow of vapor towards the pump only.

6. The construction as claimed in claim 2, with a filter in the exhaust to prevent the escape of the operating fluid.

7. In a vacuum pump, a plurality of pumping chambers, a fluid having a high evaporation point in said pumping chambers, means to produce reciprocating movement of said fluid in said pumping chambers, a reservoir, a restricted passage between said reservoir and each of said pumping chambers, said passage being so constructed that it offers a greater resistance to the flow of fluid from said reservoir to said pumping chambers than vice versa, said reservoir being placed in such a way that the fluid therein has a tendency to flow into said pumping chambers to fill said pumping chambers and to thereby displace all vapor and air due to buoyant action.

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