Feb. 9, 1937. C. J. WESTIN 2,070,151

VACUUM PUMP

Filed May 10, 1934 2 Sheets-Sheet 1

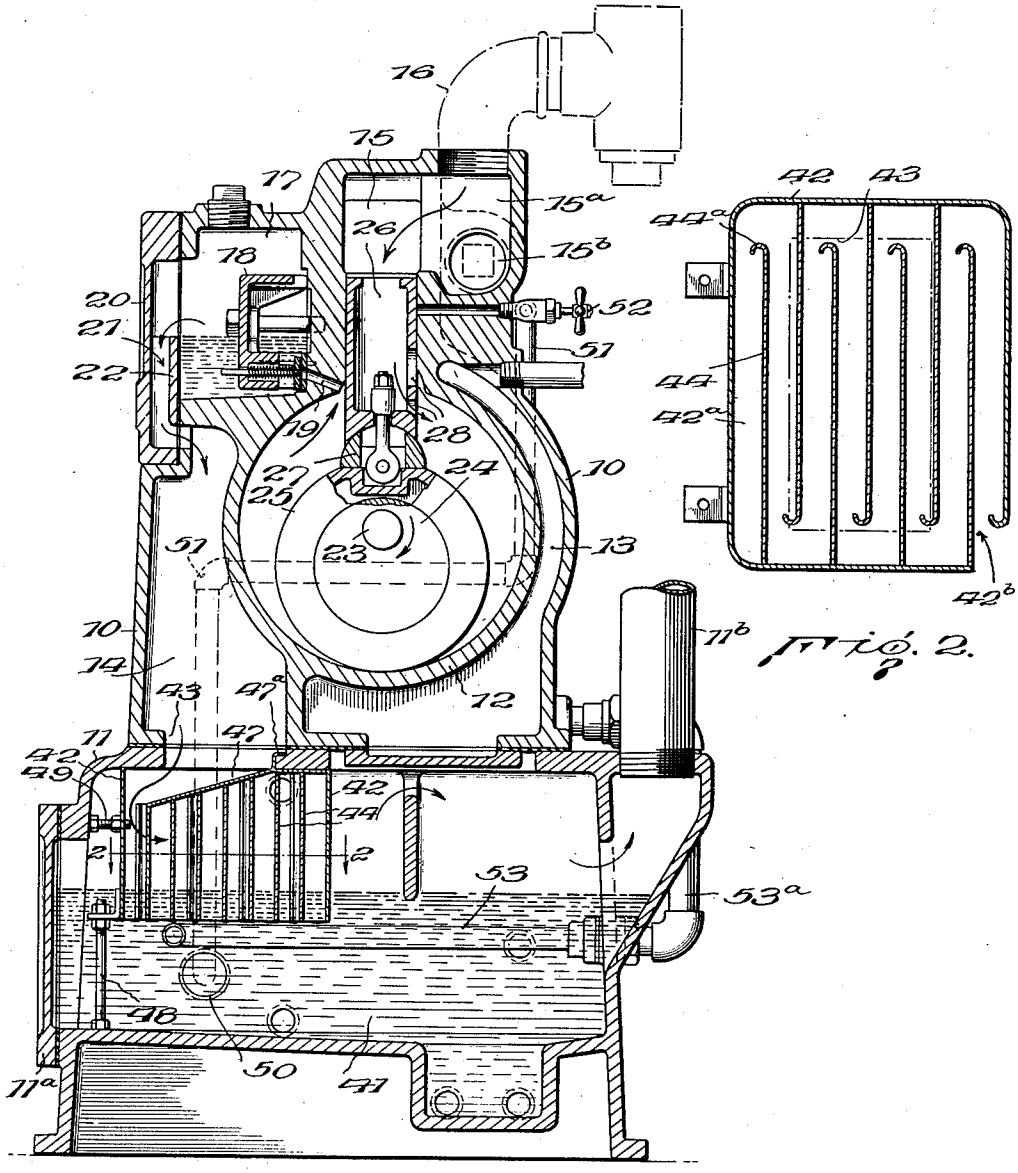


Fig. 2.

Fig. 1.

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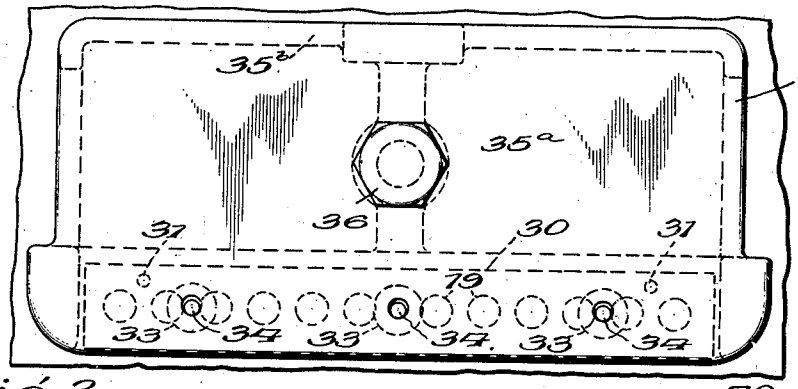


Fig. 3.

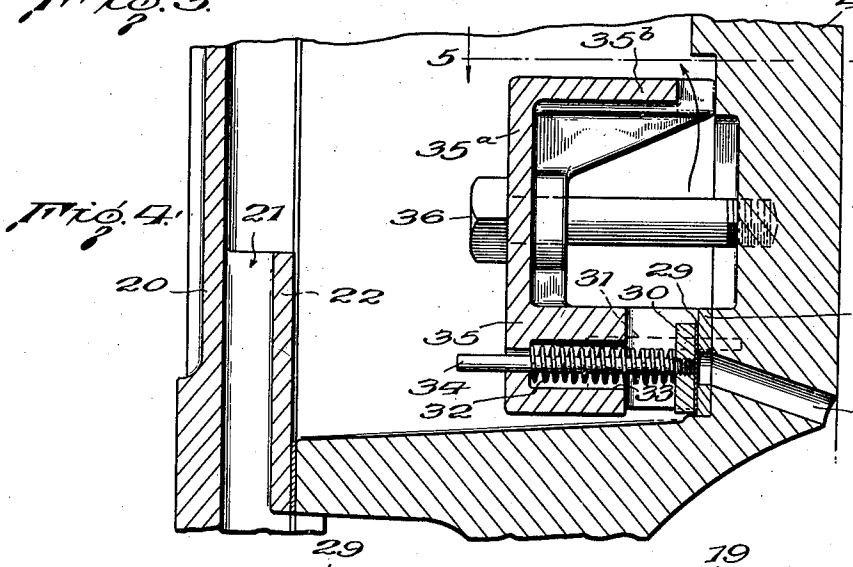


Fig. 4.

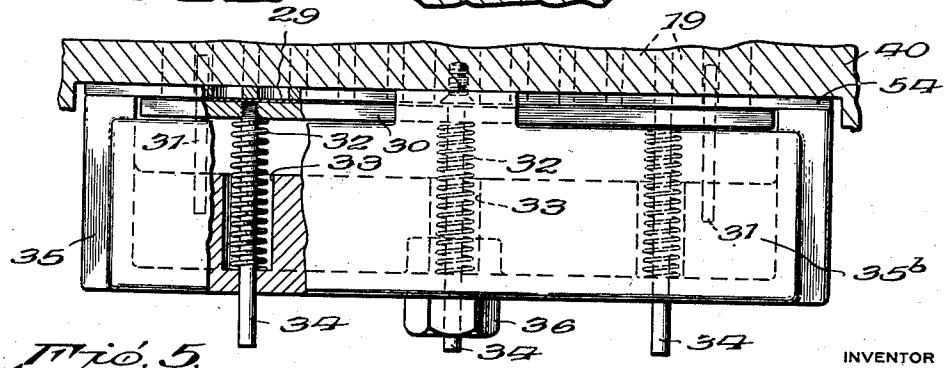


Fig. 5.

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UNITED STATES PATENT OFFICE

2,070,151

VACUUM PUMP

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Application May 10, 1934, Serial No. 724,974

8 Claims. (Cl. 230—205)

This invention relates to improvements in mechanical gas pumps having a rotating piston and utilizing a liquid as a sealing medium, and particularly to the type of pumps used either as compressors or as vacuum pumps and disclosed in U. S. Letters Patent No. 1,899,904, granted to O. S. Sleeper and C. J. Westin on February 28, 1933.

One object of my invention is to provide new and improved means for producing a gas-tight seal in the discharge valve as well as between the moving parts throughout the cycle of operation.

A more specific object of my invention is to devise a discharge valve construction in which the valve is submerged in the sealing medium.

Another object of my invention is to provide new and improved means for continuously degasing the sealing medium.

A further object is to devise a unitary oil separator construction which is arranged in the base of the pump above the oil reservoir and through which the discharge gases are passed.

By means of these and other improvements which will be understood from the specification, I obtain several advantages, such as: increased capacity to handle larger volumes of gas in the same space of time; a higher vacuum for the same operating speed; a saving in the amount of lubricating and sealing oil used, and in general a cleaner operating machine.

In order to operate at practical efficiency, all moving parts must be machined to close fits or small clearances so that they will cooperate throughout the cycle with the lubricating and sealing medium in forming a perfect or nearly perfect seal between the high and low pressure sides of the pump. The majority of vacuum pumps in commercial practice are made from cast iron, although other metals or alloys sometimes are used for special purposes. Regardless of the kind of material used in the various parts of the pump, a good grade of lubricating oil is required, and this should also be suitable as a sealing medium. Some of the desirable properties of the lubricating-sealing medium, which hereafter will be referred to merely as "oil", are a low percentage of volatile constituents and a low demulsibility. Oil will, however, absorb gas in considerable quantities, particularly when churned around with gas under pressure as is the case in machines of the type here described. As the oil is continually circulating from atmospheric pressure, through the low pressure stage approaching the high pressure, and being expelled at high pressures into atmospheric pressure again, it is bound to become more and more polluted, thereby gradually decreasing the efficiency of the pump. Furthermore, the oil and gas are discharged at considerable speed and pressure through comparatively small discharge ports and this has a tendency to vaporize or atomize some of the oil, which vapors or atomized oil would pass off with the gas and be lost unless properly trapped and separated from the free gases before these reach the outside space.

The principles of construction and novel arrangement of parts will be readily understood by reference to the annexed specifications and drawings.

In the drawings, Figure 1 represents a vertical cross section through a pump embodying my preferred construction;

Figure 2 is a sectional view taken along line 2—2 of Figure 1 showing the details of construction of the separator unit;

Figure 3 is an enlarged fragmentary view showing the discharge valve assembly in elevation;

Figure 4 is an enlarged fragmentary view showing the cross section of the discharge valve assembly; and

Figure 5 is a view, partly in section, taken along line 5—5 of Figure 4.

Referring to the drawings, there is shown a rotary pump having a housing 10 mounted on a hollow base 11. In the housing is formed a cylinder 12, closed at both ends by end-plates, and partially surrounded on one side by a space 13 adapted to receive water or other cooling medium, and on the other side by a passage 14 for conducting the discharge gases and sealing medium from the discharge valve to the base 11. The housing 10 is extended at the top to form an intake compartment 15 of rectangular outline connected directly to and extending the full length of cylinder 12 and being closed at both ends by extensions on the cylinder end-plates. The intake compartment 15 has a lateral extension 15*a* to which an intake connection 16 is secured. A plug 15*b* is provided for the purpose of draining the intake extension 15*a*. Alongside the intake compartment 15 in the extension of housing 10 is formed the outlet compartment 17 with suitable accommodations for the outlet valve assembly 18, and is connected on the one side to the interior of the cylinder 12 by a row of cylindrical discharge ports 19, and closed on the other or outer side by a cover-plate 20 which is made hollow so as to provide a free passage 21 for the discharged gases and sealing medium into the corresponding passage 14 of the housing to which it is connected. The inside wall 22 of the passage 21 in

cover-plate 20 is made of such height that it will act as a dam to retain a sufficient amount of the sealing medium in the outlet compartment 17 to completely cover the outlet ports and valves, only the excess of sealing medium spilling over the dam 22 and escaping down into the base 11 together with the free gases and vapors. It will be understood that plate 22 need not be formed integral with plate 20, but may be a separate plate secured to the housing and forming the oil dam independently of the plate 20.

Through the center of cylinder 12 is mounted a shaft 23 with supporting bearings in the cylinder end-plates and driven from any suitable source of power. Keyed or otherwise fastened to shaft 23 is the rotary eccentric 24 which carries on its outer surface the tube-shaped oscillating piston 25. A slide valve 26 is fastened to the piston 25 by means of a hinge 27 of such construction as to provide a gas-tight and flexible connection between piston 25 and valve 26. This construction is described in greater detail and claimed in the Sleeper and Westin patent referred to above. Through this connection, valve 26 receives a reciprocating rectilineal motion in the rectangular inlet compartment 15, and as the valve 26 slides back and forth, the inlet ports 28 in the valve connect the inlet compartment 15 with the cylinder 12 at the proper time in the cycle.

The construction of the outlet or discharge valve assembly 18 can best be seen in Figures 3, 4 and 5 and comprises a valve body 35 of hollow or cup-like outline with the valve plate 30 yieldably mounted in the lower part thereof. The valve proper consists of the leaf spring 29 slidably supported on pins 31 and pressed against the discharge ports 19 by valve plate 30 which is also slidably supported on pins 31 and yieldably pressed against the leaf spring 29 by compression springs 32, housed in spring chambers 33 of valve body 35. The springs 32 are supported by pins 34 which also serve the purpose of guides for valve plate 30 and keep this plate in proper alignment with the face of the pump housing containing discharge ports 19. The cup-like construction of valve-body 35, having front wall 35*a* and roof 35*b*, makes a very effective baffle to retain the sealing medium or oil around the valve. The top wall 35*b* does not extend entirely up to the wall of the pump housing, as shown in Figures 4 and 5, thus forming passages through which the discharge gases may escape out of the valve assembly. The ends of the valve housing 35 may also be left open to facilitate the escape of the gases. Pumps of this type operate at considerable speed (300 to 400 cycles per minute), and the pressure and speed of the discharge is so great that it blows practically all of the oil away from the valve and out of the compartment. Unless a sufficient amount of oil is retained in the outlet compartment to cover the valve, the pump will not operate efficiently. I have found that by my improved construction of the valve assembly, valve housing 35 acts as a baffle to retain sufficient oil in the compartment to cover the valve, thus giving a better seal and a much higher vacuum. The whole valve assembly is fastened in the outlet compartment 17 in any suitable manner, for example, by a bolt 36 secured to the partition 40 of the pump housing.

All discharged gases, vapors and oil must pass over dam 22, through passages 21 and 14 down into the oil reservoir 41 in the base 11 and from here it is desirable that only the gases are allowed to pass off, while the oil entrained in the gases or vaporized during the cycle of operation is separated out and retained in the oil reservoir. If the vapors are allowed to pass out, the surrounding room will be quickly filled with smoke which, of course, is very objectionable as well as wasteful.

I have found that by using a separator of the type shown in Figures 1 and 2 the above objections are practically eliminated in pumps of sizes up to 50 cubic feet and a very satisfactory degasing and separation obtained. The separator 42, Figure 1, is placed in the hollow base 11, under the opening 43 in the base communicating with passage 14 of the pump housing and is of such height that it extends well down below the oil level in the oil reservoir. It comprises a unitary structure consisting of a box-like casing containing a labyrinth-like arrangement with vertical baffle plates or partitions 44, through which the gases and vapors are guided back and forth, meeting hook-like obstructions or gutters 44*a* at each turn in the passage from the entrance 42*a* to the exit 42*b*. The top of the labyrinth is formed either by a plate 47 welded to the top edges of the partitions or by the ceiling of the oil reservoir, while the bottom of the separator casing is open and extends down into the oil as shown in Figure 1. The plate 47 is placed so as to form an incline to guide the oil coming down from passage 14 into the first space or entrance 42*a*. The front end of the separator is supported by bolts 48 secured to the bottom of the base 11, and the rear end is supported by a hook extension 47*a* on top plate 47 engaging the top inside edge of opening 43. The separator is held in position by bolts 49 engaging the wall of base 11, as shown in Fig. 1. The entire separator structure is formed as a unit outside of the base and is introduced into the base through the opening covered by cover-plate 11*a*. Only eight passages are shown in the separator but any number may be used, limited only by the space available. It will be noticed that the construction is such as to provide a very long confined passage of suitable area to keep the gases and vapors traveling through at considerable speed, which is desirable, as separation is aided by a high speed of current and the abrupt turn of the passage.

The hollow base 11 is of such construction as to form ample space for the storing of the sealing medium or oil in reservoir 41 and also provides head-room or air space above the oil level for separator 42. Connections are made from an oil filter 50 in the reservoir 41, through pipe line 51 to a valve 52, through which oil is drawn into the reciprocating valve chamber for lubricating and sealing purposes. A cooling coil 53 is usually provided in reservoir 41 and materially aids in keeping the operating temperature of the pump low by cooling the oil. Coil 53 is connected to the space 13 by pipe 53*a*. The air space is suitably vented by an outlet connection 11*a* to permit the free escape of the gases.

The machine shown represents a preferred construction of a pump used in vacuum service, although it may be used as a compression pump with merely incidental modifications.

To operate as a vacuum pump the shaft 23 with its eccentric 24 will rotate in a clockwise direction imparting an oscillating motion to piston 25 and establishing constantly changing points of contact between the piston and the

cylinder wall. With the piston in its uppermost position which may be called the starting point in the cycle, there is but one space in the cylinder, but the next moment, as the eccentric rotates, the point of contact changes towards the right and the cylinder is divided into two compartments—the one on the right constantly increasing in volume allowing the gases on this side to expand while on the other side the gases are being compressed by the gradually decreasing size of this compartment and forced out through ports 19 together with the oil collected during the cycle. As the compartment on the right is growing larger by the movement of piston 25 away from the starting point, the slide valve 26 also moves down, and the inlet ports 28 are opened, thereby establishing connection between the cylinder 12 and the intake compartment 15. It is evident that oil will accumulate just ahead of the piston as the point of contact circulates, and the gases in turn are compressed ahead of the oil against the slight pressure of the yieldably supported outlet valve 29 and 30, and when the pressure exceeds that of springs 32 the gases commence to leak out. Towards the end of the cycle the space and ports become filled with oil, some of the oil being expelled with the gases, but no gas can remain to re-expand and cause poor volumetric efficiency and loss of vacuum. Neither can any gas return into the cylinder because of the novel construction of having the valve in a vertical position and constantly sealed by the oil whether open or closed. All gases, of course, have a tendency to rise to the surface and this tendency is aided by the pressure from below on the oil so that when the valve is opened the gases rush upward expanding and carrying with them a spray of oil, and vaporized oil, and while the gases and vapors find a free passage around the edges of the valve housing the oil is thrown against wall 35*a* and roof 35*b* of the valve housing and drops or rebounds back to momentarily form a higher oil level within the valve housing than is normal for the outlet compartment. As soon as the discharge is completed, the oil level is restored by the excess oil spilling over dam 22. The usefulness of my novel valve-assembly can readily be appreciated from the above description, for without this arrangement of parts I have found that the sealing oil of compartment 17 is blown out and the valve left unprotected and open to atmospheric pressure, thus causing leaks into the vacuum side of the system, although provision has been made by the use of leaf spring 29 to guard against this in case there should be insufficient oil in compartment 17. The leaf spring 29 is of such thin body as to be very flexible, and, therefore, will conform to the outline of the surface of partition 40 surrounding the ports 19. This area of partition 40 may be referred to as the valve seat, and I have found that it is subject to considerable wear from the continual squirting of oil under pressure between the valve and the seat. Not only must this wear, causing roughness of the seat, be considered but there is always the danger of having foreign matter pulled through with the gases or the oil, which might lodge temporarily between the valve and the seat, and prevent the forming of a perfect seating of leaf spring 29, unless sufficient oil is present to cooperate in forming the seal. To take care of any excessive wear I have provided a replaceable valve-seat 54 fastened to the partition 40 in any suitable manner, and having holes corresponding with the ports 19, as well as openings to permit the valve-supporting pins 31 to pass through. The use of a replaceable valve-seat is also of material aid in machining these parts as it makes the grinding-in of the valve more convenient and, therefore, is economical of manufacture. When very high vacuum is desired the valve-seat 50 may be fastened to partition 40 with a gasket cemented in between the two faces so as to obviate any possible leaks in this joint.

I have herein described the principle of my invention and illustrated a preferred embodiment thereof. Various modifications will occur to those skilled in the art, and I desire it to be understood that all modifications which fall within the terms of the appended claims are to be considered as falling within the scope of my invention.

What I claim is:

1. A vacuum pump comprising, in combination, a housing having a cylinder compartment, inlet and outlet compartments connected thereto, a discharge port between the cylinder compartment and the outlet compartment, a valve yieldably pressed against the discharge port and supported in a valve body formed independently of the walls of said outlet compartment and having walls partly surrounding the valve forming a valve chamber and serving as baffles for retaining the sealing medium in said valve chamber, and a hollow cover plate closing the outlet compartment having a dam to maintain a constant oil level in the compartment.

2. A vacuum pump comprising, in combination, a housing having a cylinder compartment, inlet and outlet compartments connected thereto, a wearing plate in the outlet compartment covering the outlet port, a valve yieldably pressed against the wearing plate and supported in a valve body detachably secured to said housing, said valve body being formed independently of the walls of said outlet compartment and having walls partly surrounding the valve forming a valve chamber and serving as baffles for retaining the sealing medium in said valve chamber.

3. In a valve structure, the combination of a valve seat having a row of ports formed therein, a valve member covering said ports comprising a thin strip of spring material, a plurality of guide pins supported by said valve seat for maintaining said valve member in position over said ports, a rigid valve plate arranged over said valve member, guide pins secured to said valve plate and having fixed guides for slidably supporting said valve plate parallel with said valve seat, and resilient means for pressing said valve plate against said valve member.

4. In combination, a pump having inlet and outlet compartments communicating by ports with a piston compartment, a hollow base supporting said pump and having an oil reservoir therein arranged below said piston and outlet compartments, means for pumping oil from said reservoir through said piston compartment, said outlet compartment and back to said reservoir, a discharge valve arranged over the outlet port in said outlet compartment, a detachable valve member formed independently of the walls of said outlet compartment for supporting said valve over said port and provided with walls surrounding said port to prevent oil from being blown away from said port, and means for maintaining a predetermined level of oil above said port for submerging said valve.

5. In a gas pump, the combination of a cylinder having a piston therein, an outlet compartment connected with said cylinder by a discharge passage, a baffle member arranged over the port of said discharge passage in said outlet compartment, means for detachably securing said baffle member to the wall of said outlet compartment, a valve member slidably supported by said baffle member and arranged over said port, and means for maintaining a predetermined level of oil in said outlet compartment for submerging said outlet valve.

6. In a gas pump, the combination of a cylinder having a piston therein, an outlet compartment connected with said cylinder by a discharge passage, a baffle member arranged over the port of said discharge passage in said outlet compartment, means for detachably securing said baffle member to the wall of said outlet compartment, a valve member arranged over said port comprising a thin strip of spring material, guide pins supported by the wall of said outlet compartment for maintaining said valve member in position over said port, a rigid valve plate arranged over said valve member, guide pins secured to said valve plate and slidably supported by said baffle member to maintain said valve plate parallel with said valve seat, and resilient means cooperating with said baffle member and said valve plate for pressing said valve member against said port.

7. In a gas pump, the combination of a piston chamber having a piston therein, an outlet compartment connected with said piston chamber by a discharge passage, a valve housing arranged over the port of said discharge passage and removably secured to one wall of said outlet compartment, a valve member arranged over said discharge passage, guide pins secured to said valve member and slidably supported by said valve housing to position said valve member over the port of said discharge passage, resilient means carried by said valve housing for pressing said valve member against said discharge port, said valve housing being provided with walls surrounding said valve member to serve as baffles for retaining a sealing medium around said valve member.

8. In a gas pump, the combination of a cylinder provided with a piston, an outlet compartment connected with said cylinder by a discharge passage having a port formed in a vertical wall of said outlet compartment, means for maintaining a reservoir of oil in said outlet compartment to submerge said discharge port, a valve body arranged in said outlet compartment and detachably secured to one wall thereof, a valve carried by said body and arranged over said outlet port, said valve body having a wall spaced from and arranged parallel with the wall containing said discharge port and extending above the level of said oil reservoir to serve as a baffle for preventing oil from being blown away from said discharge valve.

CHARLES J. WESTIN.