March 6, 1934. J. DUBROVIN 1,949,710

VALVE FOR VACUUM PUMPS

Filed Jan. 17, 1931 2 Sheets-Sheet 1

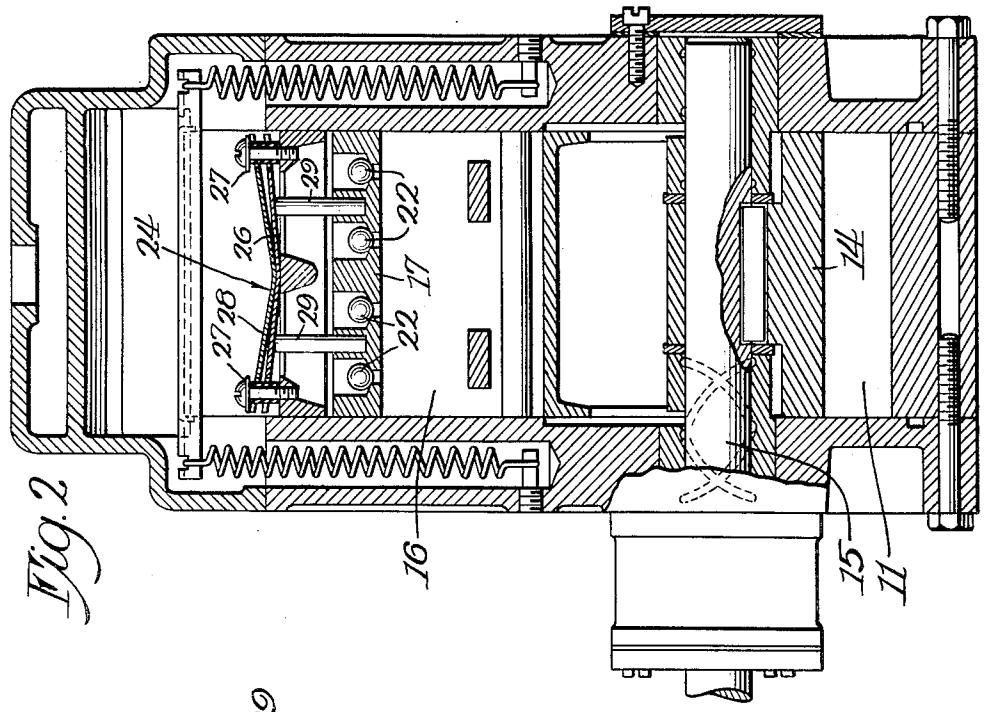


Fig. 2

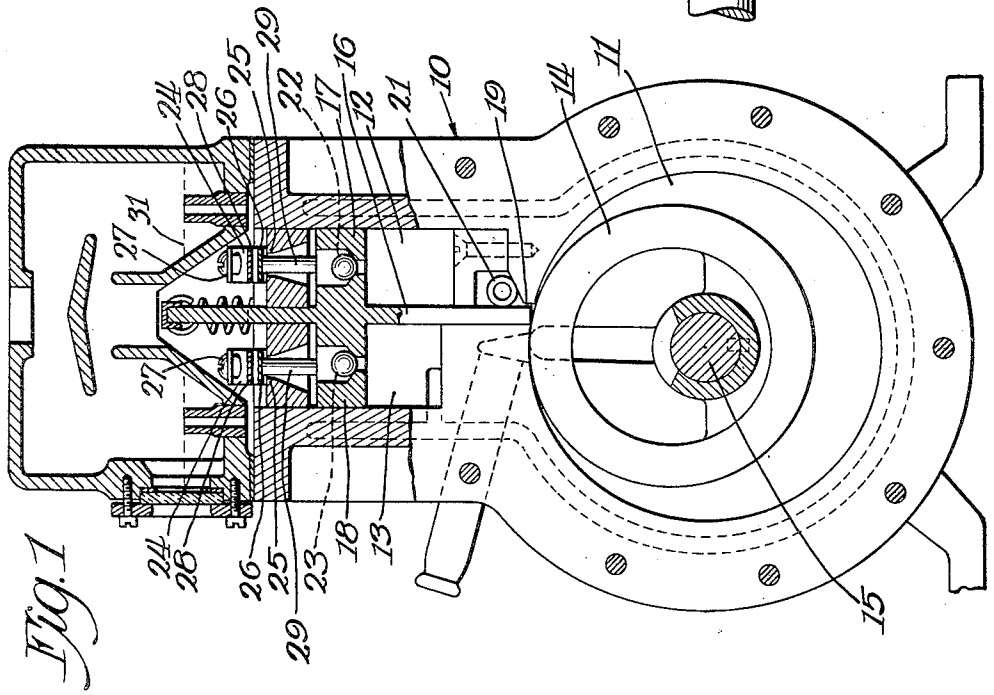


Fig. 1

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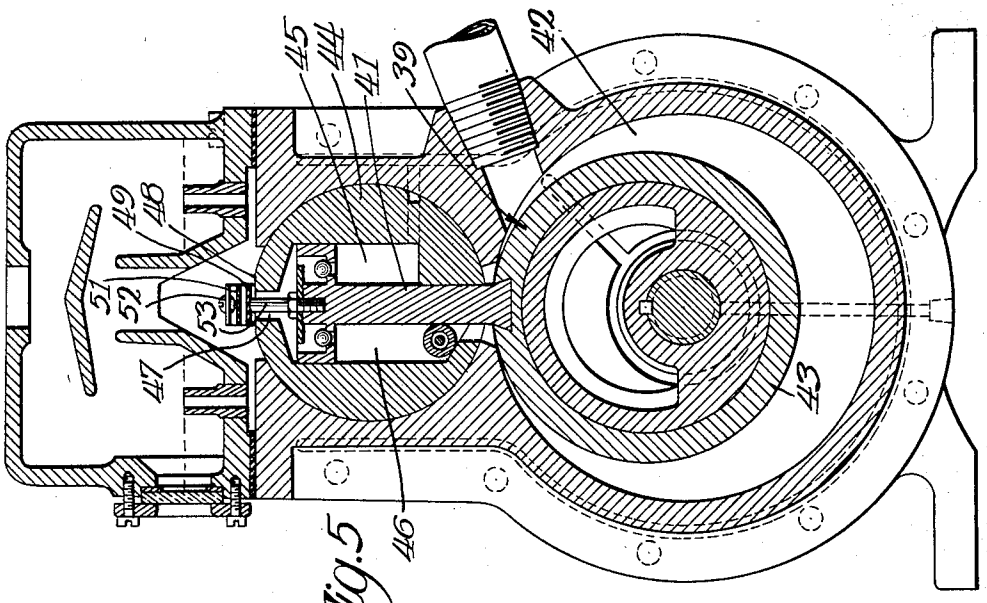


Fig. 5

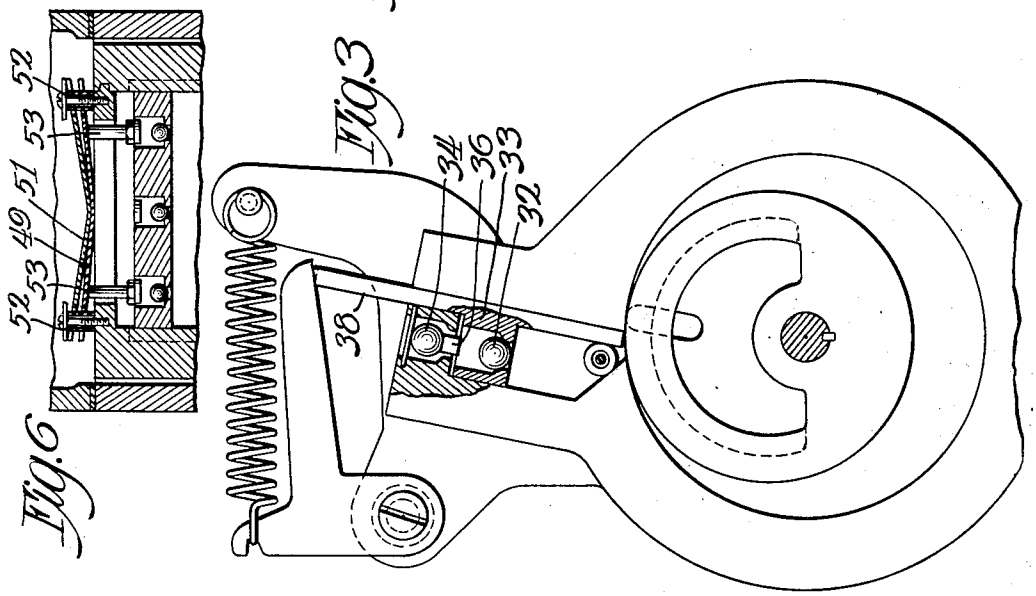


Fig. 3

Fig. 6

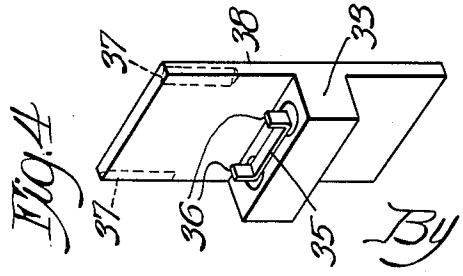


Fig. 4

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UNITED STATES PATENT OFFICE

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VALVE FOR VACUUM PUMPS

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Application January 17, 1931, Serial No. 509,431

4 Claims. (Cl. 230—149)

This invention relates to vacuum pumps and has for its objects to secure the sealing and lubrication of the pump; to allow the operation of the pump at high speeds; and to prevent hammering during the operation of the pump.

The exhaust valves of vacuum pumps are usually submerged in oil to prevent the possibility of leaks into the pump. In fact, the great majority of vacuum pumps operate when entirely submerged in a tank of oil. Certain of these pumps combine a rotary and a reciprocating pump in a single unit, the reciprocating pump serving as a backing pump for the rotary stage. As can be readily appreciated, due to the great difference in pressure existing between the interior of the high vacuum cylinder and the surface of the oil, the oil is driven down through the smallest of mechanical clearances and penetrates all parts of the pump, but since the exhaust is to the atmosphere and under an inch or so of oil at least, it has been necessary for the backing stage to build up a pressure above its piston and below its exhaust valve to something more than atmospheric pressure before the gas can be exhausted. Since there is no pressure differential tending to force oil from the reservoir above the valve to the space above the piston, it has been customary to provide a passage which opens on the down stroke of the piston to allow the oil to flow into the space. From this space, the oil creeps all over the interior surface of the two pumps without difficulty.

The most obvious way to increase the capacity of a pump is to increase the number of strokes per minute, and while the valve mechanism of these pumps has proved satisfactory for slow and medium speeds, the pumps thump and clatter badly when the speed is raised. I have determined that the thumping is due to a "water hammer" effect caused by surges of oil being thrown against the closed exhaust valve. When the spring is made thin enough to open easily and reduce the hammering effect, the operation of the exhaust valve becomes uncertain.

In the drawings,

Fig. 1 illustrates a preferred form of high vacuum pump incorporating my improvements, shown in transverse, vertical section;

Fig. 2 is a vertical, longitudinal section through the same pump;—

Fig. 3 is a plan view of the essential parts of a common form of vacuum pump incorporating my improvements;

Fig. 4 is a perspective view of the blade and piston shown in Fig. 3;

Fig. 5 is a transverse, vertical section through still another form of high vacuum pump; and

Fig. 6 is a longitudinal, vertical, detail section showing my improved exhaust valve as applied to the pump shown in Fig. 5.

The pump illustrated in Fig. 1 is described in my copending application, Serial No. 411,755, filed December 5, 1929. Briefly, it consists of a casing 10 having a high vacuum cylinder 11, a backing cylinder 12 and an oil treating cylinder 13. An eccentric rotor 14 is splined on a shaft 15 axially located with respect to the cylinder 11. A spring pressed blade or slide 16 bears against the periphery of the rotor in such a way that the cylinder 11 is divided into intake and exhaust portions. The blade carries two pistons 17 and 18 disposed, respectively, in the pump chambers 12 and 13, one wall of which, as is indicated, is formed by the blade itself.

The exhaust from the high vacuum stage is through the narrow slot 19 between the casing 10 and the blade 16 and into the pump cylinder 12. The valve 21 closing the slot is a cylindrical rod or tube which is urged into contact with both the casing 10 and the blade 16 by the shape of the floor of the cylinder 12. Ball valves 22 and 23 are located in the pistons. The exhaust valves 24, 24 of the cylinders comprise valve seats 25, 25 and a flat leaf spring 26, 26 which forms the valve element. The spring is guided and retained in position by the studs 27, 27 which also retain a bowed spring 28 which bears upon the central portion of the spring 26. The pistons carry pins 29, 29 which at the end of the upward piston stroke touch the valve 26 and raise its ends slightly from the seat.

During the first few seconds of operation, gas considerably above atmospheric pressure is forced out through the valves. Also, while the pump has been standing, oil seeps down into the high vacuum chamber. The pressure of the gas and the force of the oil raise the valve 26 completely off its seat and bow up the spring 28. The valves 21, 22 and 23 open freely to outward pressure. Accordingly, the oil and gas find a free path to the exterior. This is the relief valve operation of the device.

The normal oil level of the pump is shown by the dotted line 31. After the pump is run for a few minutes, pressures within the cylinders are very much below the atmosphere and consequently whenever the valve 26 is opened on the upstroke, some of the oil, due to the atmospheric pressure, rushes in to fill the space above the piston. The inrush of oil is advantageous for

it scavenges completely any vestige of gas that may be within the space and gives a supply of oil which is then forced by the pressure differential all over the pump. As the piston rises, before there can be any pocketing or pressure thrown on the oil between the piston and the closed valve, the valve is opened and the pressure above and below the valve are once more equalized and any gas again scavenged. The valve 26 may now be made stiff enough to function properly at high speeds, and since the valve is open before any compressive force is exerted, the oil is not banged or thrown against the closed valve. Furthermore, the inrush of oil displaces all gas within the cylinder. It is no longer necessary for the gas to build up to atmospheric pressure before it passes the valve. These two features are important in a high speed pump.

The type of pump shown in Fig. 3 utilizes but a single reciprocating pump which is provided with a ball valve 32 in the piston 33 and a ball exhaust valve 34. At high speeds the valve 32 operates as an inertia valve, i. e., on the down stroke the valve will lag behind the movement of the piston due to its inertia and gas can pass freely above the piston, thereby eliminating the necessity for building up pressure beneath the piston sufficient to overcome the weight of the valve. The piston carries a U-shaped retainer 35, the upturned ends 36 of which engage the balls of the valve 34 to lift them upon the completion of the upward piston stroke.

I have indicated by dotted lines 37, 37 a chamfer upon the upper end of the blade 38. This was the means previously used to admit oil under the exhaust valve, which is now rendered unnecessary by the automatic opening of the valve.

The pump shown in Fig. 5 is an analogous device to that shown in Fig. 1. It differs, however, in that the piston 39 oscillates instead of rotates and that the blade 41 dividing the cylinder 42 into intake and exhaust compartments is rigidly affixed to the eccentric strap 43. This necessitates an oscillating gland 44 in which the pump cylinders 45 and 46 are formed. A longitudinal slot 47 across the exposed portion of the gland forms the common exhaust passage for the two reciprocating pumps. A portion of the gland is flattened at 48 to form a seat for the exhaust valve, best shown in Fig. 6. The valve comprises parts similar to those shown in Fig. 1, viz. a flat valve spring 49, a bowed spring 51 and retaining studs 52, 52. The pins 53, 53 located on the center line of the blade engage the valve 49 and lift it slightly at the end of the upward piston stroke. As before remarked, I find that this slight opening of the valve admits enough oil to the cylinder to thoroughly seal and lubricate the pump, and that it leaves a passage open when the oil is hurled upwards with considerable velocity, which prevents any momentary building up of pressure which has heretofore caused the noisy action of such pumps at high speed.

What I claim, therefore, is:

1. A vacuum pump comprising a casing having a pump chamber therein, a rotary piston therein, a reciprocating blade engaging said piston and cooperating therewith, a second pump chamber through which said blade extends, a passage for conducting the fluid discharged from said first chamber into said second chamber, a piston on said blade for said second pump chamber, a discharge valve for said second named chamber above the same, an oil reservoir surrounding said valve above the same, a passage through the second named piston, an inertia operated valve for said passage, and means associated with said piston for opening said discharge valve when said second named piston nears the limit of its upward stroke.

2. In a vacuum pump, a cylinder, a rotary piston for said cylinder, a reciprocating blade cooperating with said piston for separating the intake and exhaust sides of said pump, a second cylinder, a passage extending alongside said blade and constituting the discharge passage of said first named cylinder and the intake passage of said second named cylinder, a gravity valve in said passage and engaging said blade whereby the movement of said blade during the exhaust period of said first named cylinder will assist in opening said valve, a discharge passage for said second cylinder above the same, a discharge valve for said last named passage, an oil reservoir surrounding said last named valve, a piston for said second cylinder operated by said blade, inertia operated valves carried by said piston and means on said piston for positively opening said discharge valve when said piston nears the end of its discharge stroke.

3. In a vacuum pump, a cylinder, a reciprocating piston in the cylinder, a discharge passage for said cylinder and a discharge valve for said passage, a casing located above and surrounding said discharge valve for containing oil, a gravity valve in said piston adapted to be opened by its inertia during the normal operation of the piston, means on said piston for opening said discharge valve near the end of the stroke of said piston for discharging oil and air from the cylinder and for permitting admission of said oil during the operation of said piston, an intake passage for the cylinder below the piston and an intake valve in the intake passage.

4. A vacuum pump comprising a cylinder, a rotary piston, a reciprocating blade cooperating with said piston to separate the intake and exhaust sides of the pump, a second cylinder forming the exhaust passage of the first named cylinder, a piston reciprocating in the second cylinder operated by said blade, a discharge valve for the second cylinder, a chamber located above and surrounding said valve for containing oil, an inertia valve in the reciprocating piston for the exhaust from the first cylinder and means associated with the reciprocating piston for opening said discharge valve near the end of the discharge stroke of the reciprocating piston for permitting oil and gas to be discharged from said second named cylinder and for permitting oil to be admitted thereto at the beginning of the return stroke.

JOHN DUBROVIN.