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LIQUID SEALED MECHANICAL VACUUM PUMPS

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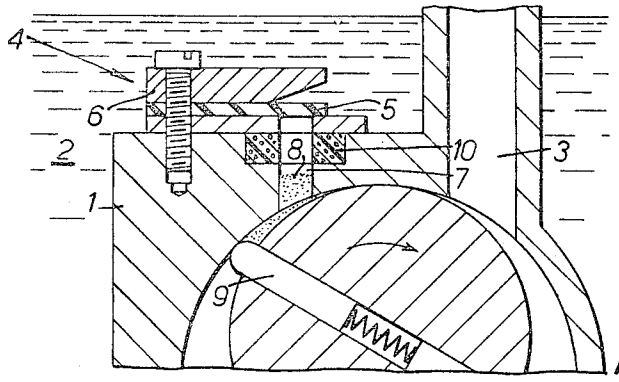


FIG. 1.

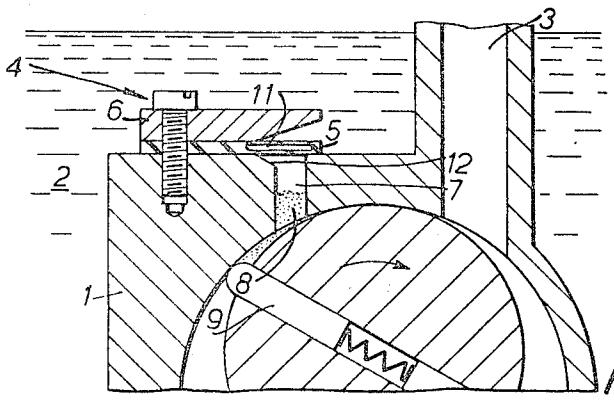


FIG. 2.

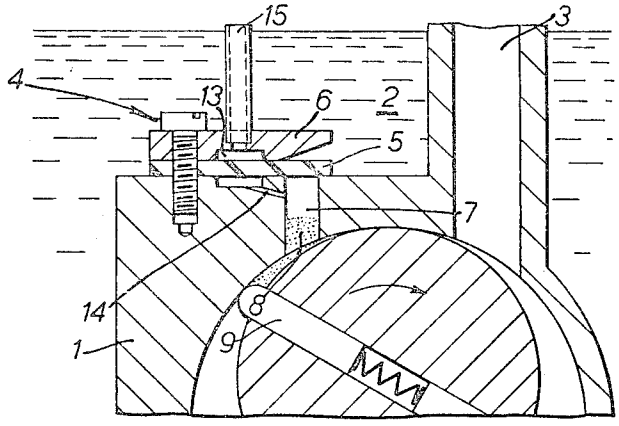


FIG. 3.

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LIQUID SEALED MECHANICAL VACUUM PUMPS

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ABSTRACT OF THE DISCLOSURE

A sound suppressor arrangement for the exhaust valve of a liquid sealed mechanical pump comprising means for absorbing at least part of the pressure surge, known as "oil knock," at the end of the pumping cycle. The absorbing means is operable on the pumping fluid within the clearance volume of the exhaust valve and comprises one or more gas pockets separated therefrom by a low inertia partition which may, for example, be part of the valve flap or a closed cell foam material placed as a liner for the clearance volume.

This invention relates to liquid sealed mechanical vacuum pumps and particularly to sound suppressor arrangement on the exhaust or discharge side of such pumps.

A desirable design characteristic of these pumps is the development and improvement of quiet running pumps. In some cases quietness has only been achieved at the expense of some deterioration in the ultimate pressure (degree of vacuum) the pump can produce. This is because one of the most important noise sources tends to become increasingly prominent as the ultimate pressure is approached and is strongly dependent on the degree of vacuum obtained.

This noise, known as "oil knock," is located on the exhaust side of the pump. The "knock" is caused by the sudden generation of very high pressure in the exhaust system when the exhaust passage in front of the outlet valve (i.e. on the pump side) becomes completely filled by the lubricating and sealing oil swept along in front of the pumping element, such as the pump blade of an eccentric rotor type of rotary pump. Under high vacuum conditions there is no gas in the exhaust passage to "cushion" the pressure shock. The exhaust valve can open to permit the passage of some oil and to release the pressure, but, even if the exhaust valve member is light and flexible, it is submerged under oil and the inertia of the valve plate and the oil above it prevent it from opening sufficiently rapidly to eliminate the high pressure surge and the "knock" associated with it.

To eliminate the very high pressure surge and the associated "oil knock," the rate of pressure build-up in the exhaust passage has to be made more gradual so that the exhaust valve can open before the pressure build-up becomes excessive. This can be done by introducing into the clearance volume an easily compressible medium of low inertia and gas is ideal for this purpose. In present designs either air entering the pump with the lubricating oil is allowed to accumulate on the exhaust side to a sufficient extent or air is deliberately introduced through a metering device directly into the exhaust side of the pump. Quietness of operation is achieved, but the presence of the air causes a deterioration in the ultimate pressure because some of the air penetrates to the inlet on the high vacuum side of the pump. Many pumps engineered for very quiet running thus produce a slightly inferior vacuum to pumps where high noise level has been accepted.

According to the present invention there is provided a liquid sealed mechanical vacuum pump including an outlet passage to which is delivered a mixture of the pumped medium and the sealing liquid during each pumping cycle, an outlet valve closing the said passage, a flexible member and a gas filled chamber defined at least in part by the flexible member which separates the said outlet passage and the gas filled chamber so that deformation of the flexible member absorbs at least part of the pressure energy of sealing liquid forced into the passage at the end of each pumping cycle.

In one pump constructed in accordance with the invention there is a plurality of gas filled chambers which comprised the individual cells of a closed cell foamed rubber member situated in the outlet passage.

In another construction the outlet valve includes a flexible valve flap extending over an end of the exhaust passage and a valve plate retaining the flap in position in such a way as to permit deformation of the flap to open the exhaust passage, and a part of the valve plate bearing against the flap is recessed whereby the plate and flap together define the said gas filled chamber, a region directly opposite the recess on the other side of the flap being in fluid communication with the exhaust passage.

Three embodiments of the invention will now be described in greater detail, by way of example, with reference to the accompanying drawing in which FIGURES 1 to 3 show diagrammatically a section through an oil sealed rotary vacuum pump having different exhaust arrangements constructed in accordance with the invention.

Referring now to the drawing a pump body **1** immersed in oil **2** has an inlet **3** and an exhaust valve generally indicated at **4**. The exhaust valve **4** comprises a flexible plastic or elastomer flap or sealing member **5** and a clamping plate **6** screwed to the pump body. An exhaust duct **7** gives communication between the interior of the pump and the exhaust valve. The pump is shown in a position near the end of a pumping cycle with a volume of sealing oil **8** in front of the pump blade **9** and partially filling the exhaust duct or passage **7**. This is the stage of the pumping cycle associated with the "oil knock" described above.

FIGURE 1 shows the duct **7** having part of its wall consisting of an insert **10** of a closed cell foam plastic or foam rubber which provides a multiplicity of gas filled cells behind light flexible walls. In the presence of a pressure surge the insert **10** will act as a cushion to the shock and will absorb part of the energy associated with the noise due to "oil knock."

The embodiment shown in FIGURE 2 is provided with a modified valve flap **5** which contains a compartment **11** within its thickness and which is filled with air. Thus in cooperation with the flexible wall comprising the lower part of the flap **5**, a low inertia shock absorbing system is provided. The top portion **12** of the exhaust duct **7** is enlarged to increase the area of the exhaust flap in communication with the pressure surge.

In FIGURE 3 the flexible valve flap **5** contains no pockets within itself but is sufficiently extensive and suitably shaped so that a gas pocket **13** is confined between its upper surface and the clamping plate **6**. The underside of the flap in this region is in communication with the compression side of the pump through suitable passages **14** communicating with a recess either indented in the underside of the flap or, as shown in the figure, provided in the pump face against which it is clamped. In this example there may be a danger that the gas pocket **13** becomes gradually filled with oil due to seepage between the valve flap and its top clamping plate. Any risk of oil accumulation in the gas pocket **13** can be prevented by the provision of a vertical vent pipe **15** from the

clamping plate which extends above the oil level in the pump. It has been found that the sudden movement of the flexible diaphragm at the instant of pressure surge throws any accumulated oil up such a pipe and maintain the gas space substantially empty of oil.

In the case of all these systems if the rotary vane pump illustrated is imagined with one blade at top dead centre then the space on the compression side (when the pump is pumping high vacuum) is itself at a substantial vacuum (usually within a few torr of absolute) causing the flexible membrane(s) of any of the devices described to sag or bulge towards the pump internal space. In the case of an elastic membrane a certain amount of stretch or strain will occur in the material. As the rotor rotates there comes a time when the trapped volume in front of the outlet valve becomes suddenly filled with almost incompressible oil. Instead of the almost instantaneous pressure surge which would normally occur, the flexible membrane(s) yields easily in a sense which removes any strain and compresses or displaces the gas retained behind them. This process carries on until the pressure within the exhaust duct **7** is sufficiently above atmospheric pressure for the exhaust valve to open and any surplus oil in the space in front of the valve to be ejected. Pressure build-up is sufficiently slow for the valve to have time to open before an intensely high pressure surge develops and the loud knock associated with this stage in the operation of the pump is, to a great extent, suppressed. This is achieved without any release of gas into the compression side of the pump and therefore without any risk of gas penetration to the high vacuum side to the detriment of the vacuum produced.

The invention is not, of course, limited to any particular construction of oil sealed high vacuum pump nor to any of the particular valve arrangements which have been described as illustrative of a number of alternative constructions suitable for carrying out the invention.

I claim:

1. A liquid sealed mechanical vacuum pump including in combination:

(a) an oil reservoir;

(b) an outlet passage;

(c) an outlet valve closing said outlet passage and immersed in said reservoir;

(d) a gas filled chamber; and

(e) a flexible member providing permanent separation between media flowing along said outlet passage and the interior of said chamber.

2. A pump according to claim **1**, in which there are a plurality of said gas filled chambers, said chambers being defined by the individual cells of a closed cell foamed rubber member situated in said outlet passage.

3. A pump according to claim **1** in which said outlet valve is provided with a closure member which comprises a flexible flap, a part of which flap covers said outlet passage when said valve is closed and is provided with a

closed gas pocket within its thickness to define said chamber.

4. A pump according to claim **1** in which said outlet valve includes a flexible valve flap and a valve plate constraining a first part of said flap normally to close said outlet passage, said flap having a second part having an inner side and an outer side opposite said inner side, and in which said valve plate is provided with a recess in the region of said outer side whereby said recess and said outer side define said gas filed chamber and a fluid duct is provided to give communication between said inner side and the interior of said outlet passage.

5. A pump according to claim **4** in which said chamber is provided with means connecting it to the ambient atmosphere outside said reservoir.

6. A liquid sealed mechanical vacuum pump having a pump body, an oil reesrvoir, an outlet passage from said pump body for the pumped medium and an outlet valve normally closing said passage, which said outlet valve is attached to said pump body, is immersed in said reservoir and includes:

(a) a flexible valve flap having a first part which normally covers said outlet passage and a second part which has an inner side and an outer side; and

(b) a valve plate rigidly attached to said pump body whereby said second part of said valve flap is compressed between said plate and said pump body, said plate being provided with a recess which, together with said outer side of said second part, defines a gas filled chamber;

and in which a duct is provided through said pump body between the interior of said outlet passage and said inner side of said second valve flap part.

7. A pump according to claim **6**, including an air vent pipe extending from said recess in said valve plate to a point above the oil in said reservoir.

References Cited

UNITED STATES PATENTS

2,118,356	5/1938	Money	230—232
2,928,588	3/1960	Sudmeier	230—228
2,929,550	3/1960	Sadler	230—228
3,042,292	7/1962	Lorenz	230—232
3,053,439	9/1962	Brill	230—228
3,130,902	4/1964	Brown	230—232
3,151,808	10/1964	Saath	230—232
3,355,095	11/1967	Hollenberg	230—232
3,360,193	12/1967	Harris et al.	230—232

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