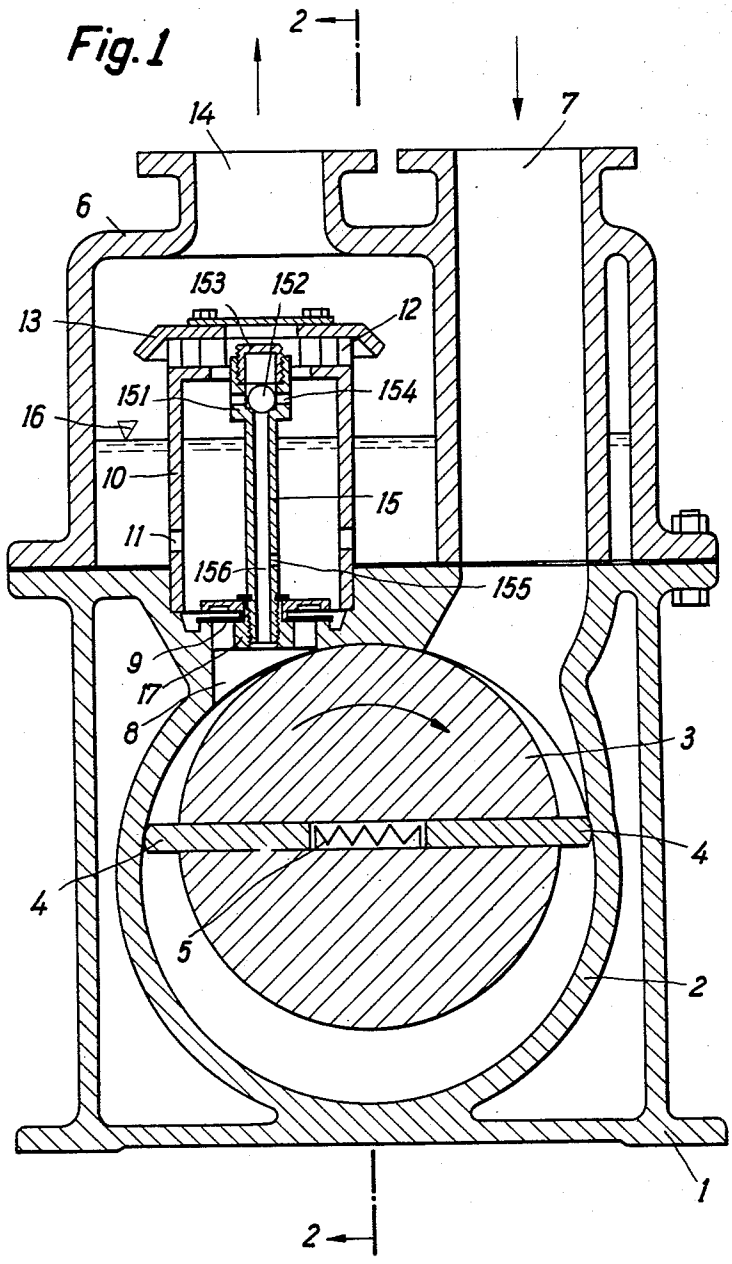
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Fig. 1



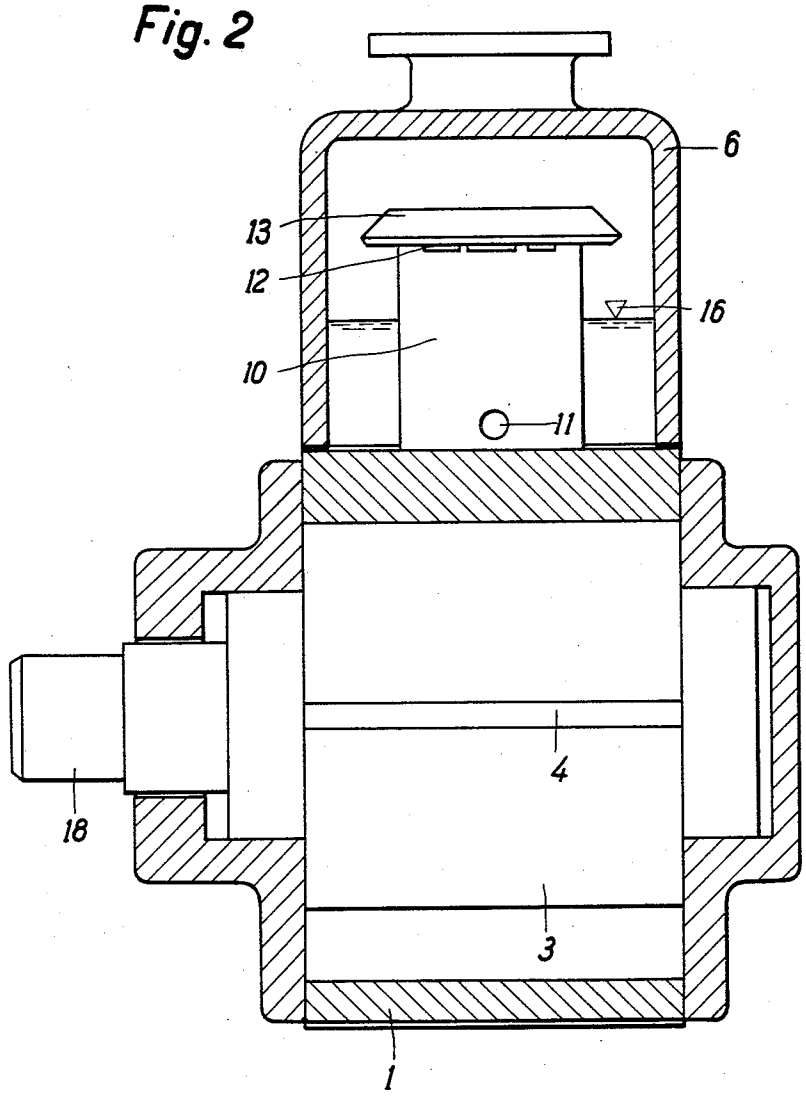
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Fig. 2



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5 Claims. (Cl. 230—205)

The present invention relates to pumps, particularly to high vacuum pumps.

When a mechanical high vacuum pump operates near a point at which the highest rated vacuum is obtained, certain disturbing striking noises will occur. The reason for this is the abrupt compression of the oil which is used for sealing the pump in that, due to the incompressibility of the oil, no pressure equalization can take place; instead, definite pressure zones will appear, as a result of which metallic striking noises are produced.

A certain noise reduction can be achieved by applying the gas ballast principle, i.e., by introducing atmospheric air into the pumping chamber portion closed off from the suction side so as to prevent vapor condensation. However, due to the large quantities of air needed to prevent condensation from occurring, the maximum obtainable vacuum is substantially reduced, so that this method of reducing noise is not practical, especially where high vacuums are required. One advance in the art was the discovery that if very small quantities of air are added periodically, such as $2 \cdot 10^{-3}$ mm. Hg 1/sec., a reduction of noise is achieved without unduly decreasing the maximum obtainable vacuum. Experiments have shown that this very small quantity of air introduced periodically already produced a substantial reduction of noise. However, in the case of pumps operating on the gas-ballast principle, the quantities of air required were higher by a factor of about 10^5, which markedly decreased the maximum obtainable vacuum.

One particular difficulty involves the supplying of relatively small quantities of air because care must be taken to avoid clogging the very small inlets which must necessarily be used, otherwise, the reliability and operability of the pump may be jeopardized. It has, therefore, been suggested to dose such small quantities of air by using a tubular supply element arranged above the outlet valve, through which element atmospheric air is brought into the space beneath the output valve by way of an air inlet opening of very small cross-section, this space beneath the outlet valve being in communication with the pumping space of the pump by way of throttling openings. However, such size limited air supply elements are difficult to keep free of dirt particles, so that under operating conditions where the entrance and accumulation of dirt particles and other small foreign bodies cannot be prevented, the size of the inlet opening is gradually made smaller by these dirt particles, as well as by deposited oil particles. Consequently, the quantity of air which can enter the pumping space is constantly reduced until, finally, there will be so little air supplied that there will no longer be any noise damping.

It is, therefore, an object of the present invention to provide an arrangement by means of which the very smallest quantities of air necessary for noise reduction can be supplied in a reliable manner.

The present invention is particularly applicable to a fluid-tight vacuum pump having a rotating pumping element, especially a rotary slide valve pump with oil seal, in which a very small quantity of a compressible medium, preferably atmospheric air, is periodically dosed into a portion of the pumping chamber which is not in communication with the intake or suction side of the pump. According to the present invention, this compressible medium is introduced in a mixture consisting of the compressible medium and the sealing fluid taken from the fluid reservoir of the pump. The advantage of this is that, instead of having to provide the very tiny opening necessary for introducing only a gaseous medium, it is now possible to use substantially larger openings through which the mixture of gaseous medium and liquid is introduced. These larger openings are less susceptible to clogging so that it becomes simple to provide an inexpensive and yet reliable pump.

As very small quantities of air are to be introduced, the proportion of liquid in the gas-liquid mixture will be substantially greater than the proportion of the gas. Thus, some way must be provided for obtaining a mixture of the sealing and the compressible gaseous medium which will be, generally, atmospheric air. This mixture is then introduced into the pumping chamber portion which is closed at the suction side, the introduction taking place near the beginning of the compression.

It is, therefore, another object of the present invention to provide means capable of carrying out the above task and to accomplish this, the present invention provides injector-like means for first mixing the gaseous medium with the sealing fluid and then introducing the mixture into the pumping chamber.

It is also possible to dissolve the gas in the oil and to introduce this oil containing the dissolved air into the pumping chamber in which a negative pressure prevails, whereupon the dissolved gas is freed from the liquid and thus becomes available to effect the desired noise reduction.

According to one embodiment of the present invention, the pump has a pump housing forming a pumping chamber within which a pumping rotor is arranged. An outlet provided with a liquid seal communicates with this pumping chamber, and there are provided means for mixing a compressible fluid medium with the liquid of the liquid seal and for introducing the thus obtained mixture into the pumping chamber. More particularly, the pumping rotor periodically divides the pumping chamber into portions, so that there will periodically come into existence a pumping chamber portion which is in communication with the outlet, but is out of communication with the inlet to the pumping chamber, and the mixing means are so arranged as to introduce the oil-gas mixture obtained into the last-mentioned pumping chamber portion.

Additional objects and advantages of the present invention will become apparent upon consideration of the following description when taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a longitudinal sectional view of a vacuum pump according to the present invention.

FIGURE 2 is a transverse sectional view taken along the line 2—2 of FIGURE 1.

Referring in detail to the drawings, there is shown a pump housing in the lower portion **1** of which there is provided a tubular body **2** forming a pumping chamber. A rotor **3** is mounted for rotation within the pumping chamber and is arranged eccentrically with respect to the tubular body **2**. The rotor **3** is provided with slots within which there are slides **4**, the latter being pressed outwardly against the interior surface of the tubular body **2** by suitable spring means **5**.

Above the lower portion **1**, there is an upper portion **6** containing the high vacuum intake or suction conduit **7**. The pumping chamber is provided at the outlet side with a channel **8** which is closed by a resilient plate-shaped outlet valve **9**. Above this valve **9**, there is an oil receptacle **10**, the interior of which communicates with the surrounding oil reservoir constituted by the interior of the upper portion **6** by way of equalizing bores **11**, while the slots **12** place this oil receptacle **10** in com-

munication with the surrounding atmospheric air above the deflection plate **13** which covers the upper end of the oil receptacle **10**. The outlet conduit of the pump is shown at **14**.

According to the present invention, an injector-like tubular supply element **15** is arranged interiorly of the oil receptacle **10**. The upper end of this element **15** is enlarged, as shown at **151**, and receives a freely movable ball valve **152**, the upward movement of which being limited by an abutement sleeve **153**, said sleeve being threaded into the enlarged portion **151** of the element **15** so as to be axially adjustable relative thereto. The enlarged portion **151** is provided with air inlet openings **154**, these inlets being above the liquid level **16** of the oil within the oil reservoir. The element **15** is also provided with an oil inlet bore **155** which is below the oil level **16** so that oil can flow into the free interior **156** of the element **15**. The lower portion of the element **15** extends through the outlet valve **9** and opens directly into the outlet channel **8**. As is shown in FIGURE 1, the lower portion of element **15** is in threaded engagement with a portion **17** forming part of the pump casing, thus securing the element **15** in place.

At one point during the rotation of the rotor **3**, the compression in the channel **8** will cause a part of the oil-air mixture present in the channel **8** from a previous cycle to be forced into the oil receptacle **10** around the upwardly yielding edges of the plate-shaped outlet valve **9**, while another part of the mixture will be forced through the open bottom end of the element **15** into the interior **156** thereof. This raises the ball valve **152** until the same abuts against the abutment sleeve **153**, thereby opening the bores **154** through which the mixture in the interior **156** can then pass.

Upon continued rotation of the rotor **3**, there will come into existence a pumping chamber portion which is in communication only with the outlet, i.e., with the channel **8**, but out of communication with the inlet conduit **7**. Since there is a substantial negative pressure in this pumping chamber portion the outlet valve **9** will close before the ball valve **152** has time to drop into its seat at the bottom of the enlargement **151**, in fact, the inertia of the ball valve causes a certain delay between the instant the valve **9** closes and the instant the ball valve closes the bores **154**. As a result, not only will oil in the interior **156** be sucked into the pump chamber, but a very small amount of air will, likewise, be sucked in through the bores **154**, this amount of air being dependent upon the stroke length of the ball valve, which stroke length, in turn, can be adjusted by turning the abutment sleeve **153** so as to produce an axial movement of the sleeve **153** with respect to the element **15**. By sucking air into the interior **156** of the element **15**, oil will be sucked from below the liquid level **16** through the oil inlet bore **155** and this oil will be mixed with the air since the element **15** acts as an injector. Thus, an oil-air mixture will be sucked in through the relatively large channel **156** which, in practice, is sufficiently large so that no problem of clogging will arise. The proportion of air in this oil-air mixture is determined by the dimensions of the air inlet bores **154**, as well as by the stroke length of the ball valve **152** which, as explained above, can be regulated or dosed by turning the abutment sleeve **153**. Thus, the amount of air necessary to damp noise can be selected.

In the case of a number of serially connected rotating pumps, the oil-air mixture can also be supplied in the connecting conduits between such pumps, the arrangement then being such that the air inlet is always at the outlet side of the previous pump. The tubular element **15** may then be made the same as described above, but the valve at the air intake side can be omitted.

Instead of atmospheric air, the oil-gas mixture may be obtained by mixing the oil with air under reduced pressure, i.e., it is possible to equip the pump with a pre-evacuator which feeds to the main pump air under negative pressure.

Under certain circumstances, a compressible gaseous medium other than air can be used as a noise prevention medium gas, for example, nitrogen.

It will be understood that the above description of the present invention is susceptible to various modifications, changes and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

I claim:

1. In a pump, the combination which comprises: a pump housing forming a pumping chamber; an inlet and an outlet communicating with said pumping chamber, at least said outlet being arranged so as to be generally above said pumping chamber; a liquid seal for sealing said outlet; pumping rotor means arranged in said pumping chamber for periodically dividing the same into portions so that there will periodically come into existence a pumping chamber portion which is in communication with said outlet but out of communication with said inlet; and injector means passing through said outlet for mixing a compressible fluid medium with the liquid of said liquid seal and for introducing the thus-obtained mixture below said outlet into said last-mentioned pumping chamber portion, said injector means comprising a tubular element having a compressible fluid medium inlet arranged above the level of the liquid in said liquid seal, a liquid inlet arranged below said level, and an outlet end communicating with said outlet of said pumping chamber and wherein the dosage of air introduced by said injector means into said pumping chamber portion being such as to damp pump noises without appreciably reducing the maximum obtainable vacuum.

2. The combination defined in claim 1 wherein said outlet is closed by a yieldable valve, and wherein said outlet end of said tubular element extends through said valve.

3. The combination defined in claim 2 wherein said injector means further comprises a valve member associated with said compressible fluid medium inlet, and adjusting means for adjusting said valve member, thereby allowing the quantity of compressible fluid medium entering said pumping chamber portion to be regulated.

4. A high vacuum pump comprising in combination: a pump housing forming a pumping chamber; an inlet and an outlet communicating with said pumping chamber at least said outlet being arranged so as to be generally above said pumping chamber; a yieldable outlet valve for closing said outlet; a liquid seal arranged above said outlet valve; pumping rotor means arranged in said pumping chamber for periodically dividing the same into portions so that there will periodically come into existence a pumping chamber portion which is in communication with said outlet but out of communication with said inlet; and injector means for mixing a compressible fluid medium with the liquid of said liquid seal and for introducing the thus-obtained mixture into said last-mentioned pumping chamber portion, said injector means having a tubular element extending through the liquid of said liquid seal as well as through said outlet valve, said element having a compressible fluid medium inlet above the level of the liquid, a liquid inlet below said level, and an outlet end in communication with said outlet of the pumping chamber, said compressible fluid medium inlet of said tubular element having associated therewith a valve member which closes more slowly than said outlet valve, whereby when said outlet of said pumping chamber is in communication with a pumping chamber portion within which a negative pressure prevails compressible fluid medium will be sucked in through said compressible fluid medium inlet of said tubular element, thereby causing liquid to be sucked into said liquid inlet of said tubular element and to become mixed with the sucked in compressible fluid medium, the thus-obtained mixture of

liquid and compressible fluid medium thereupon being introduced into said pumping chamber portion through said outlet end of said tubular element.

5. In a pump, the combination which comprises: a pump housing forming a pumping chamber; an inlet and an outlet communicating with said pumping chamber; a liquid seal for sealing said outlet; pumping rotor means arranged in said pumping chamber for periodically dividing the same into portions so that there will periodically come in existence a pumping chamber portion which is in communication with said outlet but out of communication with said inlet; and injector means for mixing a compressible fluid medium with the liquid of said liquid seal and for introducing the thus-obtained mixture into said last-mentioned pumping chamber portion, said injector means comprising a tubular element having a compressible fluid medium inlet arranged above the level of the liquid in said liquid seal, a liquid inlet arranged below said level, and an outlet end communicating with said outlet of said pumping chamber, said outlet being closed by a yieldable valve, said outlet end of said tubular element extending through

said valve, said injector means further comprising a valve member associated with said compressible fluid medium inlet, and adjusting means for adjusting said valve member, thereby allowing the quantity of compressible fluid medium entering said pumping chamber portion to be regulated, said valve member being a ball and said adjusting means comprising an adjustable abutment element against which said ball may abut.

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