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Foley

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[54] **VACUUM PUMP**

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[52] **U.S. Cl.** **418/98,** 418/85, 418/100

[51] **Int. Cl.** **F01c 21/04,** F01c 21/06, F04c 15/00

[58] **Field of Search** 418/100, 85, 98

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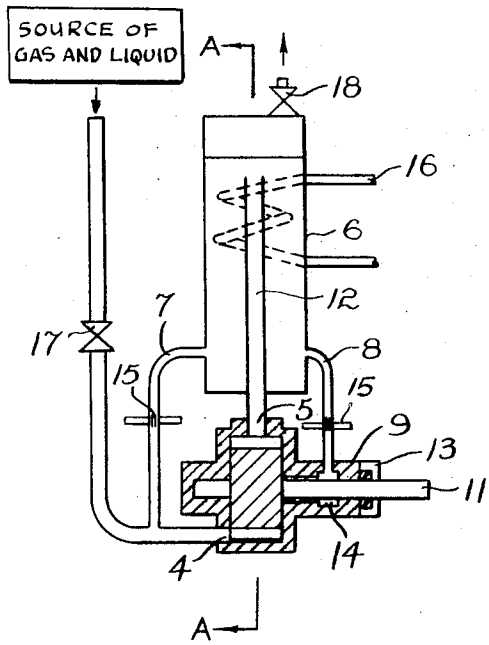
[57] **ABSTRACT**

A gaseous pump capable of producing a high vacuum or delivering to a high pressure, the pump being a normal gear pump with sealing means to seal the gaps between the gear faces, gear teeth and the casing, and to seal the bearing supporting the drive shaft. Sealing liquid is recirculated from a liquid trap at the outlet to the inlet of the pump and to the bearing supporting the drive shaft.

2 Claims, 2 Drawing Figures



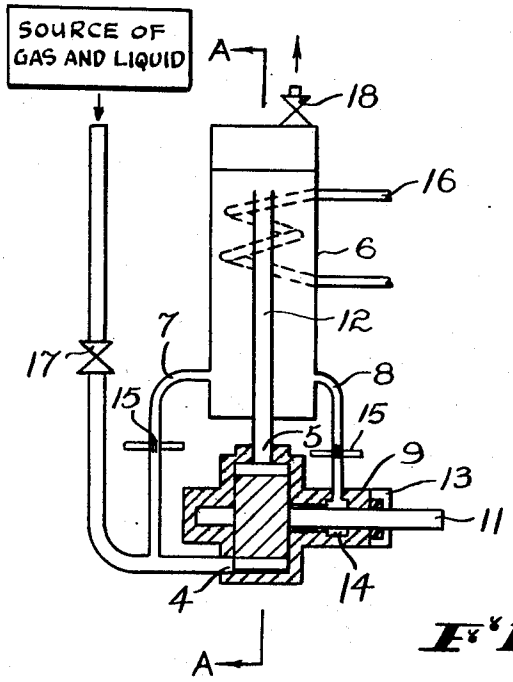

SOURCE OF GAS AND LIQUID
A
18
16
6
12
7
8
17
15
15
5
9
13
11
4
14
A

FIG 1

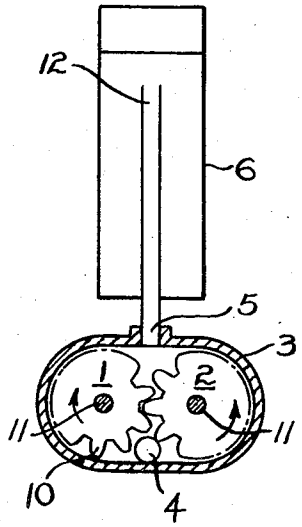

12
6
5
3
1
2
11
11
10
4

FIG 2

VACUUM PUMP

This invention relates to an improved vacuum pump and in particular it relates to a pump which can draw off air or a gas to produce a very high vacuum, or be used as a compressor to deliver high pressure air or gas, without the need of supplying intricate and costly mechanism to achieve this.

It is customary in vacuum pumps to go to considerable expense to enable the pumps to draw the required vacuum, and certain problems exist with this not only in relation to tolerances within the pump itself, but also to exclude leakage of air into the pump due to the drive which must be applied to the pump.

In refrigeration therefore it has been the practice to provide completely sealed units so arranged that the inflow of air to the system was impossible under all normal conditions, but in the case of vacuum pumps which can not be sealed from their driving means there has always been the problem of preventing an inflow through the seals of the drive shaft and independently of the type of packing used there has been a tendency for the pump to leak at this locality particularly where the pump has periods of inactivity such as in refrigeration or similar equipment.

It will be realized therefore if it were possible to provide a simple and effective pump in which sealing problems were removed, that there would be a great advance in the art, and it is the object of this invention to provide such a vacuum pump and to do this in a simple and effective manner and to provide a novel form of seal which will overcome the problems regarding the drawing of a vacuum which have existed heretofore with simpler pumps.

The objects are achieved according to the present invention by providing a gear pump or the like in which rotors have teeth or gaps which are adapted to carry the air out of the system but using as a sealant a liquid or wetting agent which is present at those areas where sealing is required, such as at the teeth or other members which form the air carrying gaps and the bearing through which the shaft to the pump passes.

Such a pump can have particular application in water desalination plants but can also be used for refrigeration systems or the like, and act as either a vacuum pump or a compressor.

In order however that the invention will be fully appreciated an embodiment will now be described with reference to the accompanying drawings, but it is to be clear that the invention need not necessarily be limited to this embodiment, the scope being defined in the claims herein.

In the drawings:

FIG. 1 is a cross-sectional view of the pump, and

FIG. 2 is a view along the section A—A of FIG. 1.

The pump according to this invention can conveniently be of the gear type in which a pair of gear wheels 1, 2 inter-mesh and are disposed within a housing 3, the housing 3 being provided on one side of the inter-meshing teeth with an inlet 4 and on the top side with an outlet 5, this then forming a normal type of gear pump in which the spaces between the teeth 10 carry the air or gas or the like from the inlet 4 to the outlet 5.

Such a pump however without effective sealing means would allow heavy leakage of air between the teeth 10 and the ends of the teeth and the housing 3 as well as the drive shaft 11 and its bearing 9 and to overcome this problem the pump and bearing 9 are kept wet with a liquid, which we have found will then allow a very high vacuum to be drawn due to the liquid seal.

For the purpose of maintaining a liquid seal, the pump must be provided with a certain amount of liquid as well as vapor or gas for it to pump, and at the outlet of the pump is a liquid trap 6 so arranged that a body of liquid is maintained in this trap from which recirculation tubes 7, 8 lead to the inlet 4 of the pump and to the bearing 9 so that liquid is constantly circulated from the trap 6 through the pump and also through the bearing 9 to form the seal.

In the case for instance of a vacuum pump used in a water desalination unit, the pump can be used both to draw the vacuum and to remove the condensate from the heat exchanger of the unit, and in this case it will be realized that as the pump is handling both vapor and air and water the necessary seal will be provided at all times, thus enabling the pump to draw the required vacuum without any problems, the liquid trap at the outlet ensuring that there is at all times a circulation of liquid through the pump to maintain the necessary seal.

Thus in the case of a vacuum pump arranged for a water desalinization plant or the like a normal type of gear pump would be used with an inlet at the base from a reservoir which could be a heat exchange reservoir and with a gas space above the reservoir also leading to the inlet so that gas or air could be drawn into the pump as well as liquid.

As the gear pump rotates air carried between the teeth 10 is carried round to the outlet 5 but as it also carries liquid, the liquid forms a seal between the edges of the teeth 10 and the housing 3 and also because of its movement from the inlet 4 to the outlet 5 has the effect of assisting in the trapping and carrying of air to the outlet, so that the gears 1 and 2, even if these are not of a particularly good fit but simply in accordance with normal gear pump practice, will be sufficiently sealed to draw high vacuum because of the presence of the sealing liquid.

At the outlet there is an upwardly projecting pipe 12 which is encircled by the liquid trap 6, the upper space of this liquid trap serving to release the air and vapor to discharge same to the required locality, but as the pipe 12 projects upwardly within the liquid trap 6 there will be an amount of liquid held in the space between the pipe and the inner wall of the liquid trap and it is from this space that the recirculation tubes 7 and 8 lead, one tube 7 to the inlet of the pump and the other tube 8 to the bearing 9 housing the shaft 11 by means of which the pump is driven.

The action of course is that so far as the recirculation tube 7 which feeds the pump is concerned there is at all times a flow of water to wet the pump and this wetting is sufficient to form the seal, while on the other side, the bearing 9 which is disposed between a stuffing gland 13 and the pump rotors is also fed with water through its recirculation tube 8 so that there is a water seal between the shaft 11 and the hollow in the bearing 9 through which the shaft 11 passes, this water seal being sufficient to prevent an inflow of air to the rotor for the reason that the recirculation tubes 7 and 8 open into the liquid trap and in the case of the bearing 9 this opens into a very small space 14 between the shaft and

the housing so that the supply from the recirculation tubes is at all times sufficient to maintain a liquid seal of the required volume of liquid.

This flow can however be controlled by having restrictors **15** in the recirculation tubes **7** and **8**, particularly in the tube **7** which leads to the low pressure side of the pump where otherwise a heavy bleed from atmosphere would take place with resultant excess flow of liquid from the liquid trap, but in the case of the recirculation tube **8** leading to the pump shaft this problem does not exist in the same way because the bleed can be taken to a locality at or adjacent the bearing **9** in which there is only a very narrow liquid space **14** so that the flow of liquid into this area is restricted by the narrow gap between the shaft **11** and the bearing **9**.

A normal stuffing or packing gland **13** may be provided for the shaft also but the effective seal is made by the liquid. Instead of a stuffing or packing gland, the bearing may be lengthened and the packing gland dispensed with. In this case the clearance between the bearing **9** and shaft **11** in this lengthened area may be 0.0005 inch, while the clearance between the liquid space **14** and the rotors may be in the vicinity of 0.004 inch.

Alternatively instead of the gear pump having a single drive shaft, a pair of timing gears may be used, and thus both gear shafts will be driven by the timing gears, a similar bearing being provided on both gear shafts. In this instance the pump has an exceptionally long life as the gear teeth **10** of the rotors **1** and **2** do not contact each other.

As stated earlier the type of pump used for this purpose can of course vary because any pump having spaces which move to carry air or vapor and liquid from an inlet to an outlet can be suitably used for this purpose, the principle of course being in each case to have sufficient liquid present to form a seal which would prevent the back flow of air passed the teeth or the like, and it will also be realized that the actual gaseous medium which is being pumped by the gear or other pump can be widely varied provided there is some liquid with it for the purpose of ensuring a liquid seal for the pump.

To allow the pump to be stopped whilst still maintaining the seal a non-return valve **17** can be fitted to the inlet **4** of the pump. The liquid trap at the discharge side can be of such proportions that it will feed back sufficient liquid to completely fill the pump and suction reservoir with liquid while the pump is stopped. A similar non-return valve **18** may also be provided at the outlet of the liquid trap **6**.

A suitable cooling coil **16** can be incorporated in the liquid trap **6**, to cool the recirculating liquid, when it is desired to do so, especially when the pump is operating under high vacuum or high pressure.

Thus the invention can also be used in refrigeration or the like where a simple gear pump or the like can then be used in place of the compressor in any required circuit. A supply of oil could be used which could be circulated to provide the sealing means for the pump and shaft and this could be trapped and returned repeatedly to the liquid trap to recirculate as required without actually being carried over with the gas which is being pumped.

Thus this simple and effective unit is provided which can be a relatively standard pump with tolerances no better than those normally provided, but because of the presence of sealing liquid such a pump has been found to be able to produce a very high vacuum.

What I claim is:

1. In a gaseous pump for pumping gas and liquid fluids from a source thereof, the pump being capable of producing a high vacuum and having:

a. a housing including the chamber for containing gears serving as rotors;

b. positive displacement inter-meshing gears serving as rotors and disposed within said chamber for pumping said fluids;

c. a lower inlet connected with said chamber;

d. an upper outlet connected with said chamber; and

e. power input shafts drivingly connected with said rotors;

the improvement comprising:

f. a liquid trap communicating with said outlet so as to be continuously supplied with liquid therefrom in normal operation; said liquid trap having a storage capability for storing said liquid;

g. bearing means for sealingly and rotatably receiving said shafts; said bearing means having a first means for effecting a liquid seal about said shafts when supplied with said liquid from said liquid trap; said bearing means being provided with a substantially cylindrical wall disposed about said shafts and each having an annular recess intermediate its ends; a first clearance between the wall and the drive shaft being greater between the recess and the gears of the gear pump than a second clearance between the wall and drive shaft over the remainder of the portion of the bearing exteriorly of said recess; said first clearance being sufficient to allow inward passage of a sufficient quantity of said liquid to block the flow of any other fluid longitudinally of said shaft; said second clearance serving as at least a portion of a seal to block outward passage of said liquid longitudinally of said shaft exteriorly of said recess;

h. conduit means for conducting said liquid to said bearing means by gravity flow; said conduit means communicating with said liquid trap and with said bearing means;

i. second means for supplying by gravity flow a controlled volumetric rate of flow of said liquid from said liquid trap to said inlet; said second means communicating with said liquid trap and with said inlet; said controlled volumetric rate of flow being sufficient to effect the liquid seal intermediate said gears and intermediate each said gear and the internal surface of said chamber adjacent thereto; said controlled volumetric rate of flow being less than the pumping capacity of said pump;

said conduit means and said second means for supplying a controlled volumetric rate of flow comprising recirculation tubes extending from the liquid trap to the inlet of the pump and the bearing means supporting the drive shaft; one of said recirculation tubes serving as said conduit means being in communication with said recess of said bearing means for supplying the sealing liquid; said liquid trap being disposed adjacent said outlet and above said chamber and said shaft and bear-

ing means such that simple, dependable gravity flow is effected from said liquid trap to said chamber and to said shaft and bearing means and retains said pump ready for immediate pumping even against a high vacuum or under a high load condition.

2. A gaseous pump as defined in claim 1 wherein said bearing means has a liquid impermeable seal disposed exteriorly of said first means; and wherein, when said pump is stopped, said liquid trap contains sufficient liquid and is connected such that said liquid will flow from said liquid trap into and fill said chamber and said bearing means and effect a liquid seal such that said pump is immediately ready for pumping service upon re-starting.

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