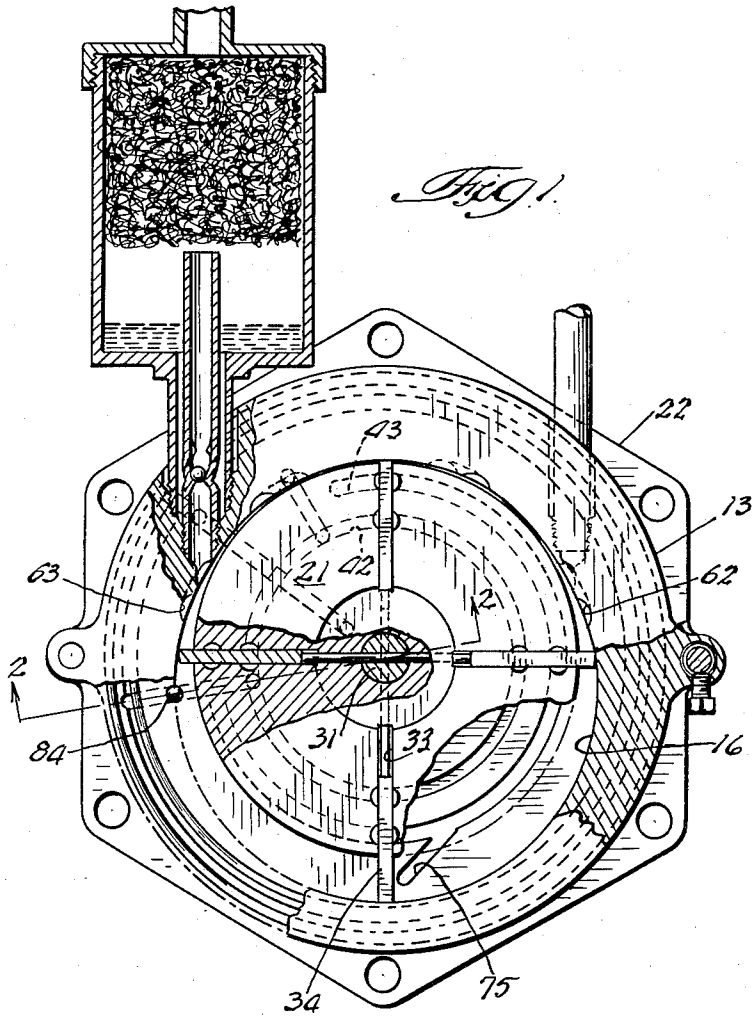
June 26, 1962 W. M. LANGDON 3,040,975

SEALING FLUID DEGASSING MEANS FOR ROTARY VACUUM PUMP

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Fig. 1.



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Fig. 2

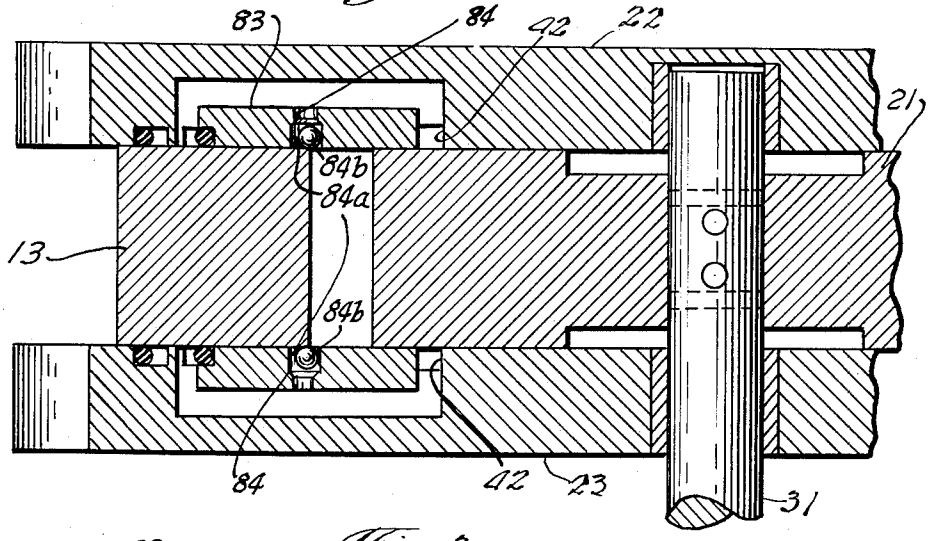
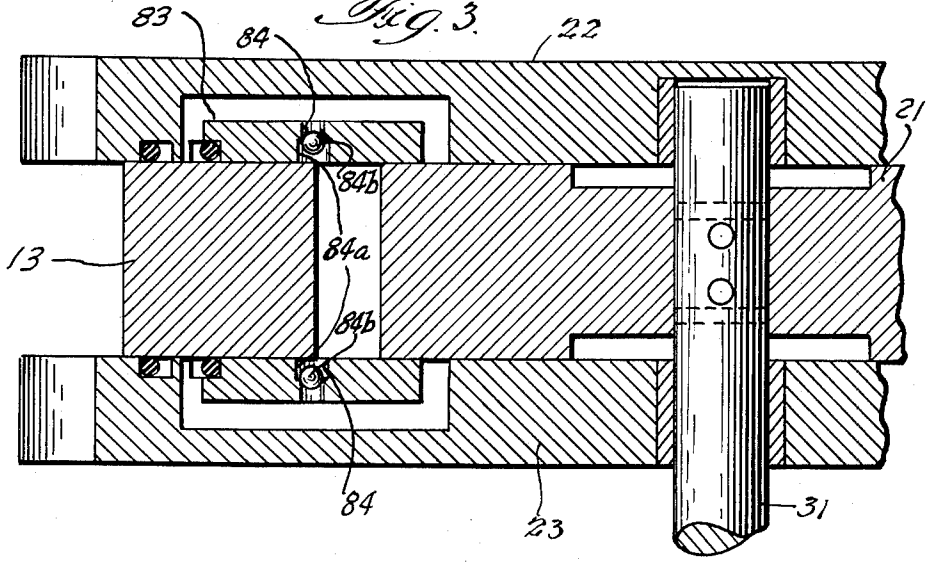


Fig. 3



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SEALING FLUID DEGASSING MEANS FOR ROTARY VACUUM PUMP

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This invention relates to rotary, vane-type vacuum pumps of the type which are oil sealed and exhaust to vacuum or comparatively higher gauge pressure but primarily to atmospheric pressure, and in which an arrangement of passages subjected to suction provide degassing of the oil.

In my co-pending application Serial Number 627,697 filed December 11, 1956, I disclosed a pump of the foregoing character in which a cylindrical rotor positioned eccentrically of a substantially cylindrical bore defines a crescentiform pumping cavity and in which the running clearance provided between the flat end faces of the rotor and the adjacent flat faces of the bore of the pump is intentionally larger than normal and also in which massive quantities of oil are circulated as a sealing medium. Moreover, the running clearance between the vanes and rotor and the vanes and stator may be also subject to larger-than-normal tolerances. By means thereof I have eliminated the friction and the concomitant wear which would otherwise occur where minute running clearances only are allowed, and many of the problems of manufacture attendant upon the production of accurately fitting parts are eliminated.

In my said prior application I also disclosed annular grooves concentric with the axis of the rotor connected by pairs of ports to a source of suction for degassing the oil circulating about the moving parts. One of these pairs of suction ports receives suction from a region of the pumping cavity just preceding the exhaust port, sometimes referred to as a "rough suction" region.

At the beginning of a pumping cycle the pressure in the pumping cavity in the region just preceding the exhaust port and the adjacent degassing port may rise to a level far above atmospheric pressure. For example, in one design of pump to which the invention has been found particularly adapted the rise in pressure has occurred when the vacuum at the inlet port is in the range from 2" to 1" Hg abs. This effect, which occurs only for a short period of time, can result in establishing air flow through the film of oil between the moving parts thereby to cause a corresponding undesired increase in pressure in the fine suction zone of the pump. In the absence of the improvement constituting the present invention the pump will operate at essentially its rated capacity down to approximately 25 mm. Hg absolute at which point the capacity (liters of air per unit of time at the suction pressure) will drop off to approximately 10 percent of the free air capacity at which point the pump will pull down at a greatly reduced rate to approximately 8 mm. Hg absolute. At this point the capacity will return practically instantaneously to its nominal value and the pump will then continue to pump down to about 50 microns whereafter the pumping rate gradually diminishes until its ultimate value is reached. Such behavior may, for purposes of this description, be described as a "short-circuiting" action from the "rough" suction zone to the "fine" suction zone to the exhaust port and cyclically about this path. Referring to the pump of my said co-pending application the air compressed in advance of the vane then approaching the exhaust port is forced through the pair of degassing ports just preceding the exhaust port, through the pair

of annular grooves in communication therewith, through the rotor-stator and vane-and-slot clearances to a preceding suction port operating at a lower pressure.

The present invention has for its object the provision of automatically functioning means to prevent the short-circuiting action and the concomitant drop-off in the pumping rate just described.

In the drawings which show one form in which the invention may be embodied in practice:

FIG. 1 is a vertical cross section taken through a pump in accordance with the invention with most of the end plate of the stator nearest the viewer and certain other parts broken away for clarity;

FIG. 2 is a cross section on the line 2—2 of FIG. 1 showing the automatic means of the invention in open position; and

FIG. 3 shows the same in closed position.

Turning now to the drawings there is shown a rotary, vane type, vacuum pump comprising a stator ring **13** having a bore **16** closed at both ends by end plates **22** and **23** (the near one of which is omitted from FIG. 1) and a rotor **21** supported for rotation with respect to the stator on a shaft **31** which is eccentrically positioned with respect to the axis of the bore **16** to define a pumping cavity, and as will be understood. The usual seat between the rotor and stator extends over an arc of contact intermediate an intake port **62** and an outlet port **63**. A plurality of vanes **34** are positioned for radial reciprocating movement in slots **33** in the rotor **21**. Inasmuch as the rotor is eccentric with respect to the bore of the stator a crescent shaped pumping cavity will be defined therebetween and which cavity is interrupted in its peripheral extent by the several vanes **34**.

Each of the end plates **22** and **23** is provided on its inner surface with at least two annular grooves **42** and **43** concentric with the shaft **31** as part of the passage means for circulating oil within the pump bore and for degassing the same. If desired, these grooves may be cut into the rotor.

For degassing the oil circulating in the spaces intermediate the rotor and stator and between the vanes and the rotor and stator several ports are provided and are connected by passage means to several points of suction. One of such ports, namely **84**, is located adjacent the outlet port **63** as shown. In practice the port **84** and its associated passages is duplicated on both sides of the stator but the function is the same. It will be understood that the pressure subsisting in the pumping cavity defined between the rotor and the stator ring and as subdivided by the vanes is graduated from one side of the seat between the rotor and stator ring to the opposite side of the seat, this latter being constituted by osculation of the cylindrical surface of the rotor with a congruent portion of the stator bore. The invention contemplates a pump in which the oil may be degassed at one or more points of the pumping cavity, for example, the degassing port **75** and the annular recesses **42** and **43**.

When the pump is operating during the middle and final part of a cycle the suction at ports **84** will be such as to degas the oil circulating in and about the groove **42** but at the beginning of the cycle, and as stated in the preamble above, superatmospheric pressure may be encountered in the region adjacent the suction ports **84** thereby resulting in pressure being applied to the spaces between the running parts and thence to the low pressure or suction regions. The net result is a sudden drop in the pumping rate. As pumping continues this temporary loss of capacity is recovered but the overall time of a pumping cycle is undesirably extended.

To counteract this adverse behavior the invention comprises the provision of automatically-functioning check

valve means now to be described. The entrance to the ports **84** is enlarged as seen in FIG. 2 to provide a valve chamber **84***a* in which there is loosely received a movable valve member, e.g. a ball **84***b*. At the initial part of the cycle, where the buildup of pressure heretofore noted is experienced, the ball is caused to close on the seat formed by the junction of the enlargement with the smaller, succeeding diameter of the port **84**. The weight of the ball is so determined that any pressure which is likely to result in the short-circuiting action heretofore referred to will cause closure of the valve and, when this excessive pressure has diminished, the ball will drop from its seat under the influence of gravity and/or suction when the vane has passed the degassing port **75** and the port **84** and the suction pressure has dropped below approximately ½" Hg abs. FIG. 3 shows the valve in closed position. It will be understood that, if desired, other forms of valve may be employed. For example, one in which the movable element is spring-biased.

In order that the rotating vanes may not interfere with the ball and also to retain the ball in operative relation with its chamber the enlarged entrance is located in a straddling relation with the curved wall of the bore **16**. Thus the ball is retained safely and out of interfering position but will leave exposed a sufficient area of the port for fluid communication with the pertinent adjacent section of the pumping cavity.

I have also found that the invention improvement improves the operation of so-called dry pumps namely, those in which the running clearances are as close as manufacturing methods will allow and oil is circulated in the pump primarily for lubrication.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made and, I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

I claim:

1. A rotary vane-type vacuum pump of the type in which the moving parts operate in massive quantities of oil comprising a stator having a substantially cylindrical cavity therein including flat end faces, a cylindrical rotor including flat end faces mounted for rotation in said cavity on an axis eccentric with respect to the principal axis of the cavity, means for rotating said rotor, respective portions of the periphery of the cavity and rotor being osculatory to provide a seat therebetween, the remainder of said peripheries defining a generally crescentiform pumping chamber, said rotor end faces being juxta-

posed to the respective said cavity end faces with running clearance therebetween, said rotor having a plurality of radially disposed slots, a like plurality of vanes one individual to each slot and reciprocable therein, the radially outer end of the vanes contacting the periphery of said cavity to subdivide said pumping chamber into suction and compression regions, said stator having an inlet port entering said pumping chamber at one side of said seat and an outlet port entering said pumping chamber at the opposite side of said seat, means for degassing the oil circulating about the moving parts comprising at least a pair of concentric recesses in at least one of the stator end faces, a third port opening in said pumping chamber adjacent said outlet port, passage means providing fluid communication between said third port and the inner one of said recesses, a fourth port opening in said pumping chamber at a point in advance of said third port measured in the direction of rotation of the rotor and separated from said third port at all times by one of said vanes, and passage means providing fluid communication between said fourth port and the outer one of said recesses, whereby suction at said ports acts to degas the oil circulating in and about said rotor, vanes and stator-rotor clearance, said third port having valve means therein adapted to close at some predetermined pressure adjacent said outlet port to prevent short-circuiting of air at said pressure from the region of said third port through said stator-rotor running clearance, vane slots and recesses to the region of said inlet port and adapted to open said valve at some predetermined lower pressure in the region of said third port.

2. The improvement in accordance with claim 1 in which said valve means comprises an annular seat in the said third port adjacent the entrance thereof and a ball loosely retained within the passage means between said third port and recesses adapted to close and open with respect to said seat.

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