May 5, 1959 J. DUBROVIN 2,885,143

VACUUM PUMP

Filed July 29, 1955 2 Sheets-Sheet 1

Fig. 1

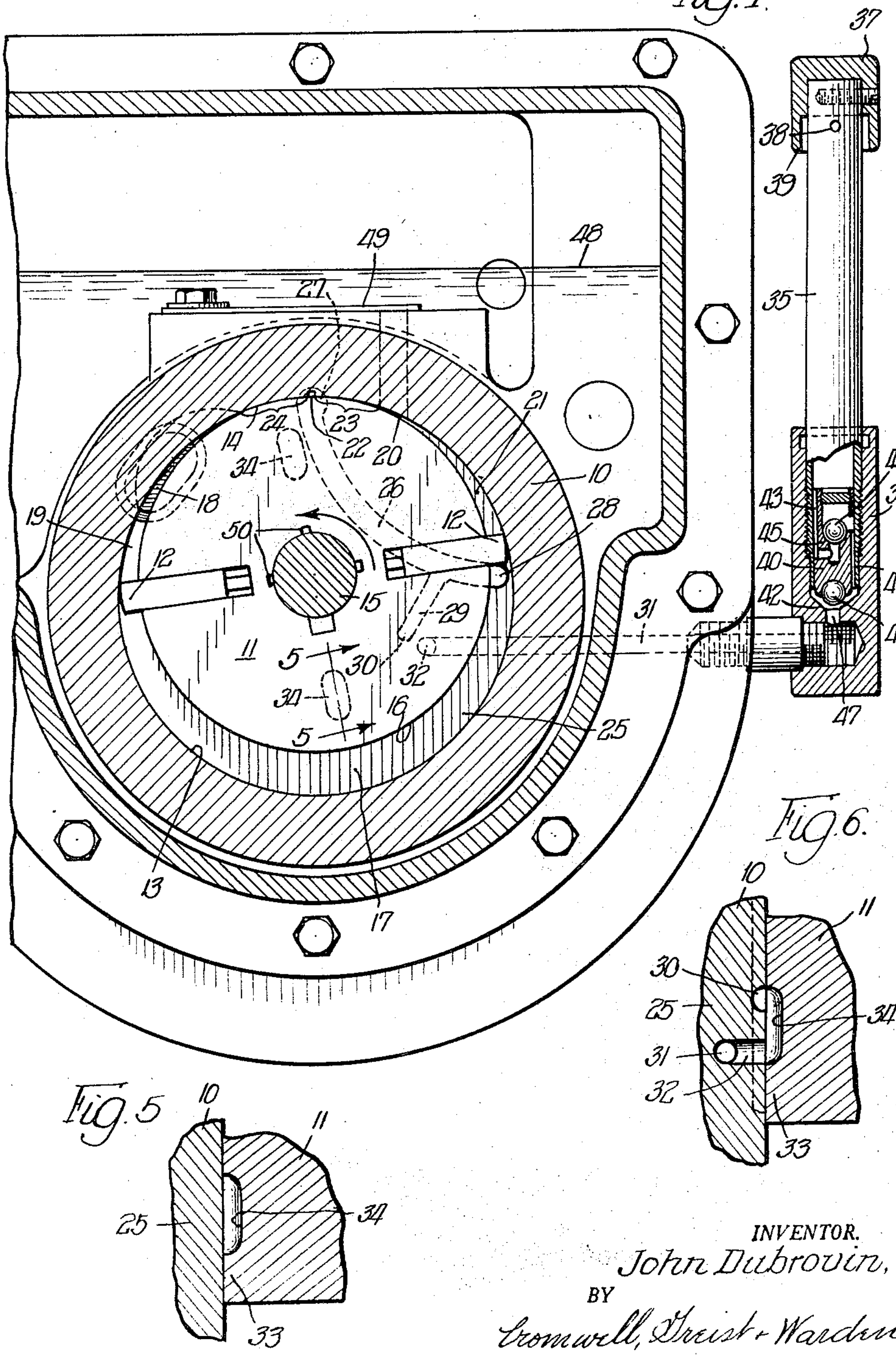


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Fig. 2.

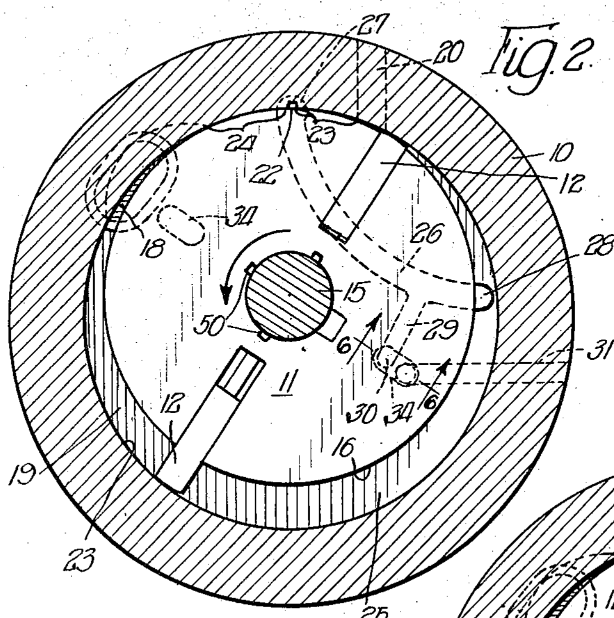



Fig. 3.

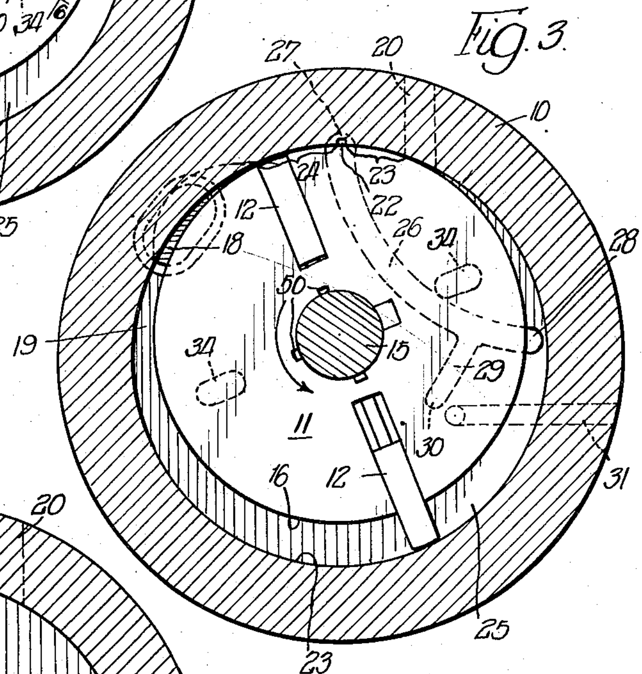
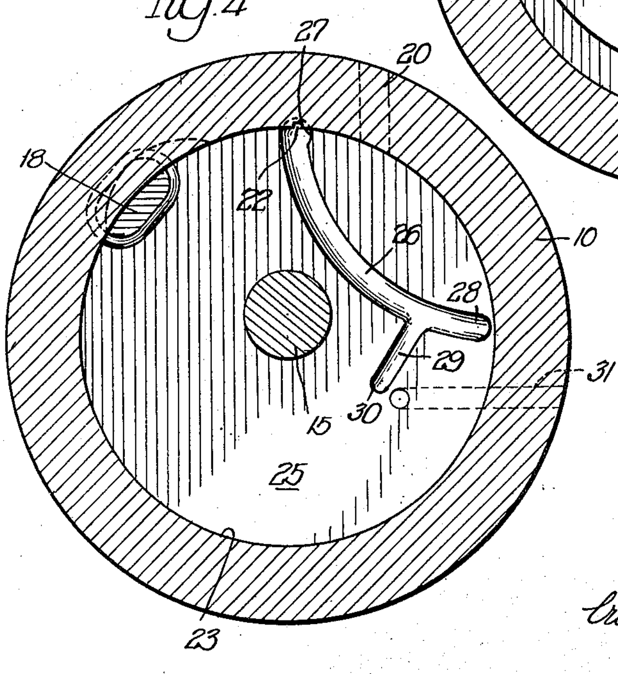



Fig. 4

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# VACUUM PUMP

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5 Claims. (Cl. 230—153)

The present invention relates to rotary oil sealed vacuum pumps for the production of extremely high vacuums, and has to do particularly with a pump of the type disclosed in my earlier Patent No. 2,337,849, wherein the rotor is provided with outwardly spring-pressed vanes in sliding engagement with the surrounding wall of the stator and wherein the rotor is eccentrically mounted in the stator and turns in an arcuate seat in the latter, which seat has the same radius of curvature as the rotor and is divided into two separate sealing areas.

The purpose of the invention is to increase the efficiency of a pump of this type by incorporating in the same new and improved means for preventing pressure-condensed vapors in the discharge or wet section of the pumping chamber from being carried over in the film of lubricating oil from that section into the intake section past the two-part seal present between those sections, also for coninuously volatilizing and removing from the discharge section of the pumping chamber the vapors which tend to condense and accumulate in the end of that section.

The invention resides in the provision for this purpose of novel venting means, in operative association with the two-part seal and also with the discharge section of the pumping chamber, which venting means permits of the introduction of air or other volatilizing fluid at such times and in such quantities as to eliminate in large measure the harmful effects of condensible vapors in the pump.

One specific object of the invention is to provide an intermittently operating air duct system of new and improved construction and operation for volatilizing and returning to the discharge section of the pumping chamber any condensed vapors which are carried over from that section with the film of lubricating oil past the first part of the two-part seal.

Another specific object is to provide an intermittently operating air duct system of new and improved construction and operation for volatilizing and removing from the discharge section of the pumping chamber the vapors which tend to condense and accumulate in that section.

While the foregoing statements are indicative in a general way of the nature of the invention other objects and advantages will be apparent to those skilled in the art upon a full understanding of the construction, arrangement and operation of the vapor volatilizing air admission means incorporated in the pump.

A preferred embodiment of the invention is presented herein for the purpose of exemplification, but it will of course be appreciated that the invention is susceptible of incorporation in other structurally modified forms coming within the spirit of the invention and the scope of the appended claims.

In the accompanying drawings,

Fig. 1 is a section view of a pump constructed in accordance with the invention;

Fig. 2 is a similar view, showing the rotor of the pump after it has advanced from the position shown in Fig. 1 into a position in which the air admission or venting means for the two-part seal and for the discharge section of the pumping chamber is in venting position;

Fig. 3 is a similar view, showing the rotor after it has passed the venting position;

Fig. 4 is a similar view, with the rotor removed in order to show the channels behind the same in the side wall of the stator;

Fig. 5 is a fragmentary radial section, taken on the line 5—5 of Fig. 1; and

Fig. 6 is a similar section, taken on the line 6—6 of Fig. 2.

Oil sealed vacuum pumps are vulnerable, particularly at low pressures, to the contaminating effects of condensible vapors, and it is therefore desirable in such a pump to create and maintain a condition in which the harmful effects of those vapors are substantially eliminated. Heretofore it has been proposed to do this by admitting a small amount of relatively dry air into the pumping chamber, which air upon admission will reduce the compression ratio required to open the exhaust port and will act as a vehicle above the dew point of most of the vapors being condensed to carry at least part of the same through the exhaust port in a vapor state. But no air introducing means has been devised for a pump of the type with which this invention is concerned which has given satisfactory results.

With the venting means of the present invention—which is characterized by a simple intermittently acting valve-like arrangement which affects through the air introduced not only the condition of the condensed vapors in the discharge or wet section of the pump chamber but also those in the seal as well—excellent results have been obtained.

The invention is shown incorporated in the roughing stage of a two-stage pump of the type disclosed in my earlier Patent No. 2,337,849, but the invention can also be used in a single-stage pump. The roughing stage illustrated in the drawings includes a hollow generally cylindrical stator 10 and a cylindrical rotor 11, which rotor is eccentrically positioned in the stator and is provided with two outwardly spring-pressed circumferentially spaced vanes 12 for sealing engagement with the surrounding wall 13 of the stator. The wall 13 of the stator is provided with an arcuate seat 14 of the same radius of curvature as the rotor 11 and the rotor turns in and seals with the seat 14. The rotor 11, which is mounted on a motor driven shaft 15, rotates in the direction indicated by the arrow.

The outer periphery 16 of the rotor 11 forms with the inner wall 13 of the stator 10 a crescent-shaped pumping chamber 17, which chamber terminates at opposite sides of the arcuate seat 14 and is in all positions of the rotor divided by the vanes 12 into two sections or segments. An intake port 18 is provided in the stator 10 at the vacuum end 19 of the pumping chamber 17, which intake port in a two-stage pump is connected with the discharge port (not shown) of the finishing stage and in a single-stage pump is connected by a nozzle (not shown) with the vessel to be evacuated. A discharge port 20 is provided in the stator 10 at the compression end 21 of the pumping chamber 17, which compression end is sometimes referred to as the wet segment of the pumping chamber because of the oil which tends to accumulate therein. The arcuate seat 14 between the stator and the rotor, which separates and seals off the confronting vacuum and compression ends of the pumping chamber 17, is provided with a narrow transverse groove 22, which groove divides the seat 14 into a first sealing area 23 at the compression end of the chamber and into a circumferentially separated second sealing area 24 at the vacuum end of the chamber.

One of the side walls 25 of the stator 10 is provided with a channel 26 which communicates at one end 27 with the transverse groove 22 which separates the sealing areas 23 and 24 and at its other end 28 with the pumping chamber at a point in the latter which is in all positions of the rotor sealed off from communication with the intake port 18 by at least one of the vanes 12. The channel 26 is provided intermediate its ends with a branch channel 29 which terminates at 30. A conduit 31 for air or other volatilizing fluid opens through the face of the side wall 25 of the stator 10 at 32, in closely spaced relation to the end 30 of the branch channel 29. This conduit 31 leads from a point outside the pump through the side wall 25 of the stator and its end 32 is normally sealed off by the closely mating side wall 33 of the rotor.

The side wall 33 of the rotor 11 is provided with two small circumferentially spaced cavities 34 which are of such shape and size as to span momentarily both the end 32 of the air conduit 31 and the end 30 of the branch channel 29 during the rotation of the rotor. When either one of the cavities 34 moves into register with the ends 32 and 30, as shown in Fig. 2, it places the branch channel 29 in communication with the air conduit 31, with the result that both the then relatively large section of the pumping chamber in which compression is progressively taking place and the groove 22 between the separated sealing areas 23 and 24 at the arcuate seat 14 are subjected to the air which is momentarily permitted to enter through the conduit 31.

The conduit 31 is connected, outside the pump, to an upstanding tube 35. The tube 35 is threaded at its lower end into a hollow fitting 36 and is provided at its upper end with a knurled cap 37 by means of which the tube can be turned in either direction to raise or lower the tube with respect to the fitting. Outside air enters the tube 35 through a hole 38 in the side of the tube, which hole is shielded by a skirt portion 39 of the cap, and passes downwardly through the center of the tube. A plug 40, which is secured in the lower end of the tube 35, is tipped with a centering ball 41, which ball is adapted to seal off a conical valve seat 42 in the fitting 36 when the tube is screwed all the way down. In normal operation the tube 35 is unscrewed far enough to raise the ball 41 off the seat 42. The air for the conduit 31 passes downwardly through a slot 43 in one side of the plug 40, then inwardly and upwardly past a check ball 44 on a valve seat 45, and then downwardly again through another slot 46 in the opposite side of the plug 40. After leaving the slot 46 the air continues downwardly past the raised ball 41 through a bore 47 in the center of the fitting 36, where it finally enters the conduit 31.

When the pump is at rest the tube 35 is preferably screwed down in order to close off completely the air conduit 31, whereby to prevent discharge through the tube 35 of any oil which has accumulated in the pumping chamber while the pump is standing. But after the pump has been in operation for a time the tube 35 is intended to be unscrewed to open up the conduit 31 to effect the desired venting. The extent to which the tube 35 is unscrewed will determine the amount of air which will enter, and any desired adjustment can therefore be made to conform with the conditions under which the pump is being operated.

The pump is immersed in a bath of oil to approximately the level 48, and the outer end of the discharge port 20, which is covered by a deflectable strip 49, which acts as a check valve, is submerged in the oil. The interior of the pump is supplied with oil by any suitable means, which means may include small grooves 50 in the rotor 11 about the shaft 15.

While the rotor 11 of the pump is illustrated and described as provided about its periphery with two vanes 12 for dividing the pumping chamber 17 into two sections, and as provided in its side wall with two cavities 34 for periodically placing the inlet conduit 31 in communication with the channel 26 in the side wall of the stator—it will be understood that more than two vanes may be employed, which will divide the pumping chamber into a corresponding number of sections, in which case a corresponding number of cavities will also be employed, with the vanes equally spaced about the periphery of the rotor and with the cavities located in the side wall of the rotor intermediate the vanes.



The pump and the venting means for the same operate as follows:

In Fig. 1 the rotor 11 is in a position in which both of the vanes 12 are at an angle of about 90 degrees with respect to a radius extending from the center of the shaft 15 to the center of the sealed seat 14. In this position of the rotor, the section of the pumping chamber or stator cavity between the front vane and the rear vane represents the largest volume that can exist between the vanes. And in this position, for each cycle (there being two cycles to each complete revolution of the rotor), the pressure in the section between the two vanes is at the lowest value that it will reach from this point on to the end of the cycle. In other words, as the rotor 11 continues to move the space in this section will progressively grow smaller, with a consequent increase in the pressure.

After the rotor leaves the position shown in Fig. 1 and before it arrives at the position shown in Fig. 2, the compression in front of the first vane will be in a very much more advanced state. Without the vented exhaust of the present invention the small and progressively decreasing size of the segment between the front vane and the seal 14, which segment contains condensible vapors in addition to the oil with which the pump is sealed, and which is known as the wet segment, would result in the occurrence of rapid condensation of those vapors. These liquids and all other condensates, under this compression stroke, would not only be forced out through the exhaust port but would also be forced into the seal by the impelling force of the vane and carried through the seal between the rotor and the stator. But with the venting means of the invention the amount of vapors condensing in this final or wet segment of the pumping chamber will be materially reduced and those which are carried over into the seal with the oil will be liberated between the two sealing areas of the seal and returned through the channel 26 to the compression section of the pumping chamber.

In Fig. 2 a more advanced position of the rotor is shown. In this position completion of the compression stroke of the first vane has been reached with the arrival of that vane at the discharge port, while the compression in the section of the pumping chamber, known as the compression section, in front of the second vane has increased but little, due to the but slight reduction in the size of that section, with the pressure in the section still below atmospheric pressure. While the compression stroke of the second vane is still at this extremely early stage, the air conduit 31 is momentarily placed in communication with the branch channel 29, whereupon air will rush in and will enter the compression section of the pumping chamber at a point approximately 180 degrees removed from the intake port. Some of the air will at the same time pass upwardly in the channel 26 into the transverse groove 22 between the sealing areas 23 and 24. Further rotation of the rotor will, of course, cut off the supply of air.

The air which enters the compression section will volatilize any then condensed vapors in that section, or an appreciable amount of the same, and will permit them to be evacuated as a mixture of vapor and air through the discharge port, the air becoming a vehicle to carry off such vapors.

The air which enters the vapor section may be ordinary outside air, at room temperature, but it will be appreciated that the drier and cooler the air the better the results. If desired, air which has been dried chemically, or cooled air which has been suitably treated, may be introduced.

After the rotor leaves the position shown in Fig. 2 and before it arrives at the position shown in Fig. 3, the front vane will sweep across the discharge port and enter the seal. Some of the oil in the final or wet segment of the pumping chamber will be forced into the seal with whatever condensed vapors remain and when these condensates reach the transverse groove 22 they will be liberated in the channel 26 and returned through that channel to the compression section of the chamber. In this way, volatile liquids are immediately recycled to the compression section of the chamber and again exposed to the drying air which has been permitted to enter that section.

In Fig. 3 a still more advanced position of the rotor is shown, in which the first vane has passed the transverse groove 22 in the seal and is about to begin the next cycle. In the travel of this vane beyond the transverse groove all that remains in front of the vane is a minimum quantity of dry oil, which is carried across the sealing area 24 by the mechanical motion of the rotor, since all of the condensate-wetted and excess oil in front of the vane will have been drawn back into the compression section of the pumping chamber in front of the next vane.

While, as previously indicated, the invention is especially applicable to a pump of the type disclosed in my earlier Patent No. 2,337,849, it can also be incorporated in pumps of other types.

I claim:

1. In an oil-sealed vacuum pump of the type characterized by a hollow generally cylindrical stator, a cylindrical rotor which is eccentrically positioned in the stator and is provided with a plurality of outwardly spring-pressed circumferentially spaced vanes for sealing engagement with the surrounding wall of the stator, an arcuate seat in said wall of the same radius of curvature as the rotor, in which seat the rotor turns, a crescent-shaped pumping chamber between the stator and the rotor, which chamber terminates at opposite sides of the arcuate seat and is in all positions of the rotor divided by the vanes into a plurality of sections, an intake port adjacent the vacuum end of the pumping chamber, a discharge port adjacent the compression end of the pumping chamber, a transverse groove in the arcuate seat, which groove divides the seat into a sealing area at the compression end of the chamber and a circumferentially separated sealing area at the vacuum end of the chamber, and a channel in one of the side walls of the stator, which channel has a portion which in all positions of the rotor is covered by the mating side wall of the rotor, and which channel communicates at one of its ends with the transverse groove which separates the two sealing areas, and communicates at its other end beyond said side wall of the rotor with the pumping chamber at a point in the latter which in all positions of the rotor is sealed off from the intake port by at least one of the vanes; the provision of an inlet conduit for air or other volatilizing fluid, which conduct leads from a point outside the pump through the said side wall of the stator and terminates in an end which in all positions of the rotor is covered by the said mating side wall of the rotor, and a plurality of circumferentially spaced cavities in the said side wall of the rotor, which cavities intermittently move into register with and span the end of said inlet conduit and a part of said covered portion of said channel during the rotation of the rotor.

2. In an oil-sealed vacuum pump of the type characterized by a hollow generally cylindrical stator, a cylindrical rotor which is eccentrically positioned in the stator and is provided with a plurality of outwardly spring-pressed circumferentially spaced vanes for sealing engagement with the surrounding wall of the stator, an arcuate seat in said wall of the same radius of curvature as the rotor,



in which seat the rotor turns, a crescent-shaped pumping chamber between the stator and the rotor, which chamber terminates at opposite sides of the arcuate seat and is in all positions of the rotor divided by the vanes into a plurality of sections, an intake port adjacent the vacuum end of the pumping chamber, a discharge port adjacent the compression end of the pumping chamber, and a channel in one of the side walls of the stator, which channel has a portion which in all positions of the rotor is covered by the mating side wall of the rotor and another portion which communicates with the pumping chamber at a point in the latter which in all positions of the rotor is sealed off from the intake port by at least one of the vanes; the provision of an inlet conduit for air or other volatilizing fluid, which conduit leads from a point outside the pump through the said side wall of the stator and terminates in an end which in all positions of the rotor is covered by the said mating side wall of the rotor, and means movable with the rotor for intermittently placing the end of said inlet conduit in communication with the first mentioned portion of said channel during the rotation of the rotor.

3. In an oil-sealed vacuum pump of the type characterized by a hollow generally cylindrical stator, a cylindrical rotor which is eccentrically positioned in the stator and is provided with a plurality of outwardly spring-pressed circumferentially spaced vanes for sealing engagement with the surrounding wall of the stator, an arcuate seat in said wall of the same radius of curvature as the rotor, in which seat the rotor turns, a crescent-shaped pumping chamber between the stator and the rotor, which chamber terminates at opposite sides of the arcuate seat and is in all positions of the rotor divided by the vanes into a plurality of sections, an intake port adjacent the vacuum end of the pumping chamber, a discharge port adjacent the compression end of the pumping chamber, and a channel in one of the side walls of the stator, which channel has a portion which in all positions of the rotor is covered by the mating side wall of the rotor and another portion which communicates with the pumping chamber at a point in the latter which in all positions of the rotor is sealed off from the intake port by at least one of the vanes; the provision of an inlet conduit for air or other volatilizing fluid, which conduit leads from a point outside the pump through the said side wall of the stator and terminates in an end which in all positions of the rotor is covered by the said mating side wall of the rotor, means movable with the rotor for intermittently placing the end of said inlet conduit in communication with the first mentioned portion of said channel during the rotation of the rotor, and means connected to the inlet conduit for regulating the effective size of the same.

4. In an oil-sealed vacuum pump of the type characterized by a hollow generally cylindrical stator having flat parallel side walls, a movable pumping member in the stator having flat parallel side walls which in all positions of said member are in flatly sealed engagement with the side walls of the stator, a pumping chamber between the stator and the pumping member, which chamber progressively increases and decreases in volume during the movement of the pumping member, an inlet port which communicates with the pumping chamber only while the latter is increasing in volume and is closed off from the pumping chamber while the latter is decreasing in volume, a discharge port which communicates with the pumping chamber only while the latter is decreasing in volume and is closed off from the pumping chamber while the latter is increasing in volume, and a channel in one of the side walls of the stator, which channel has a portion which in all positions of the pumping member is covered by the mating side wall of the pumping member and another portion which communicates with the pumping chamber only while the latter is decreasing in volume; the provision of a con-

duit for introducing air or other volatilizing fluid into the pumping chamber, which conduit extends from a point outside the pump through the said side wall of the stator and terminates in an end which in all positions of the pumping member is covered by the said mating side wall of the pumping member, and means movable with the pumping member for placing the end of said conduit in communication with said channel only while the pumping chamber is decreasing in volume.

5. In an oil-sealed vacuum pump of the type characterized by a hollow generally cylindrical stator having flat parallel side walls, a movable pumping member in the stator having flat parallel side walls which in all positions of said member are in flatly sealed engagement with the side walls of the stator, a pumping chamber between the stator and the pumping member, which chamber progressively increases and decreases in volume during the movement of the pumping member, an inlet port which communicates with the pumping chamber only while the latter is increasing in volume and is closed off from the pumping chamber while the latter is decreasing in volume, a discharge port which communicates with the pumping chamber only while the latter is decreasing in volume and is closed off from the pumping chamber while the latter is increasing in volume, and a channel in one of the side walls of the stator, which channel has a portion which in all positions of the pumping member is covered by the mating side wall of the pumping member and another portion which communicates with the pumping chamber only while the latter is decreasing in volume; the provision of a conduit for introducing air or other volatilizing fluid into the pumping chamber, which conduit extends from a point outside the pump through the said side wall of the stator and terminates in an end which in all positions of the pumping member is covered by the said mating side wall of the pumping member, and means movable with the pumping member for placing the end of said conduit in communication with said channel only while the pumping chamber is decreasing in volume, said means consisting of a cavity in the said mating face of the pumping member.

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