

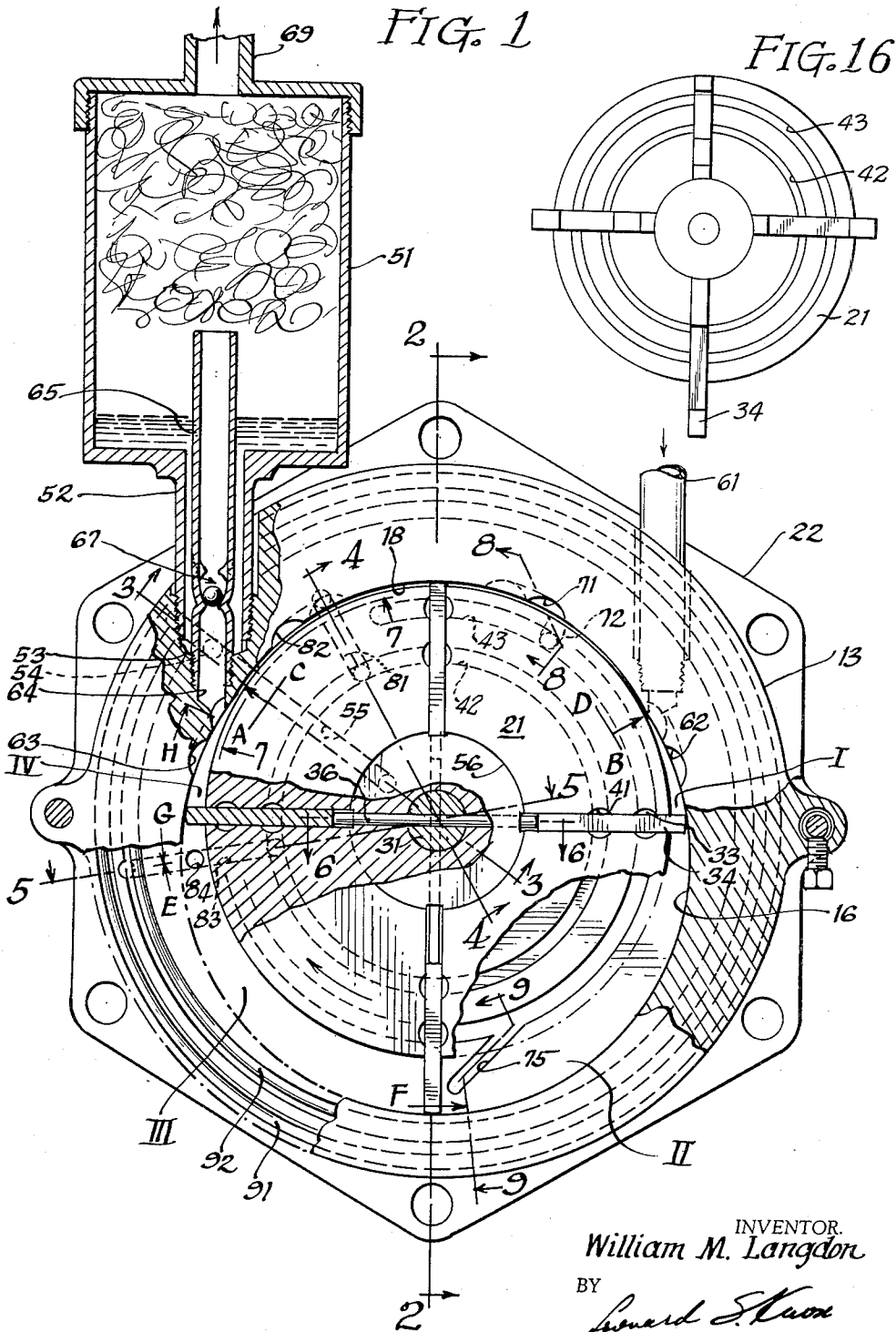
June 26, 1962

W. M. LANGDON
ROTARY VACUUM PUMPS

3,040,974

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4 Sheets-Sheet 1



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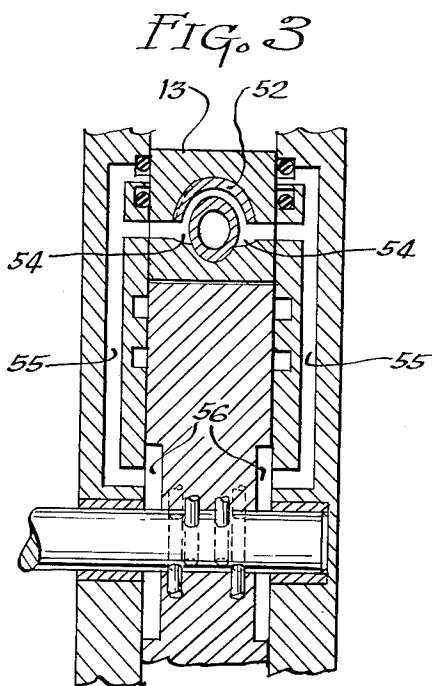
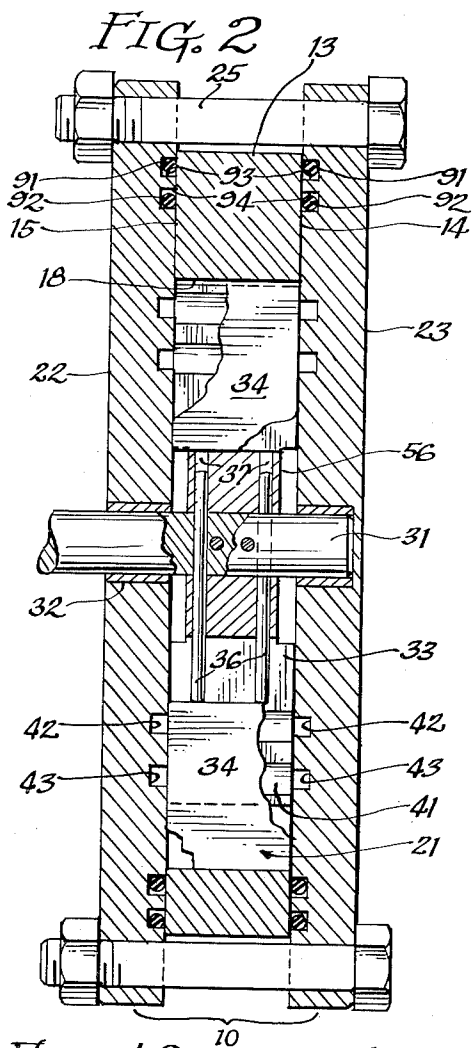


FIG. 10

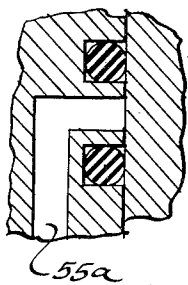
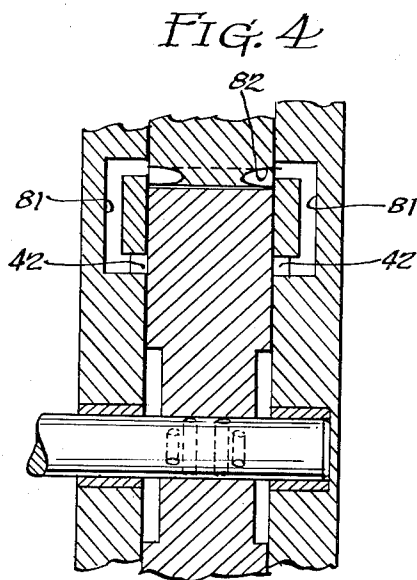
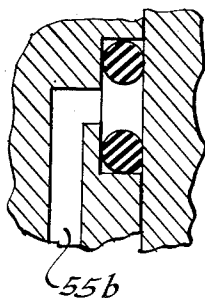


FIG. 11



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FIG. 5

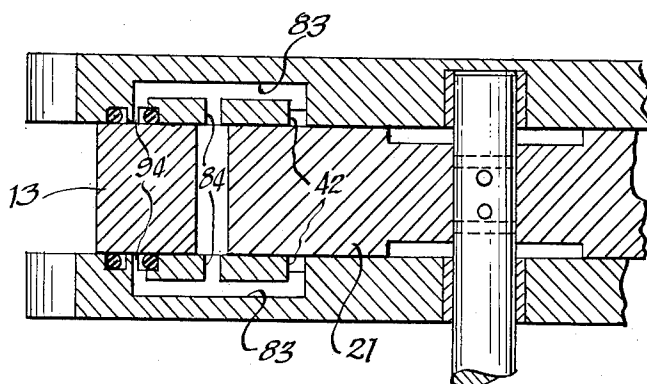


FIG. 6

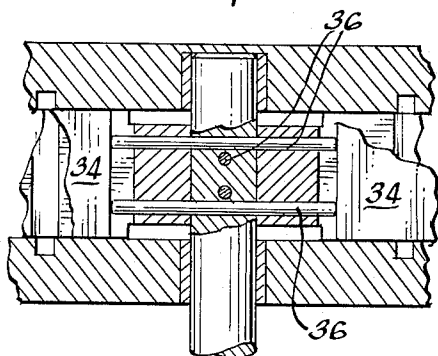


FIG. 7

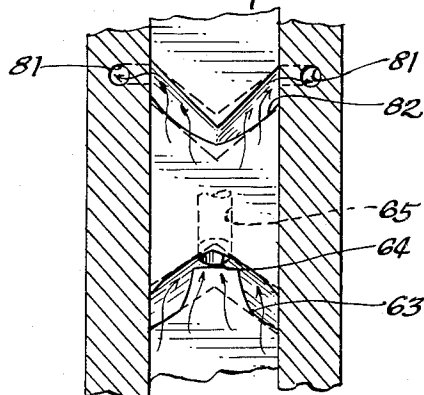


FIG. 8

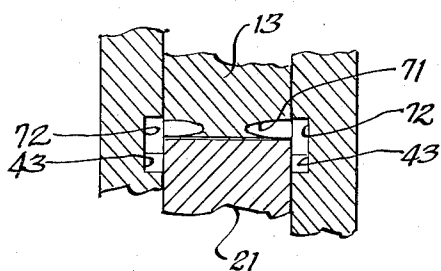
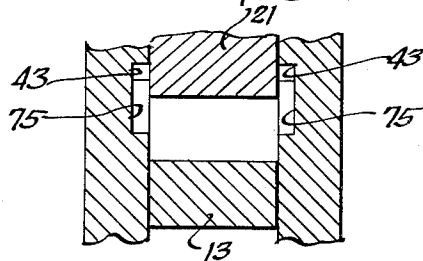


FIG. 9



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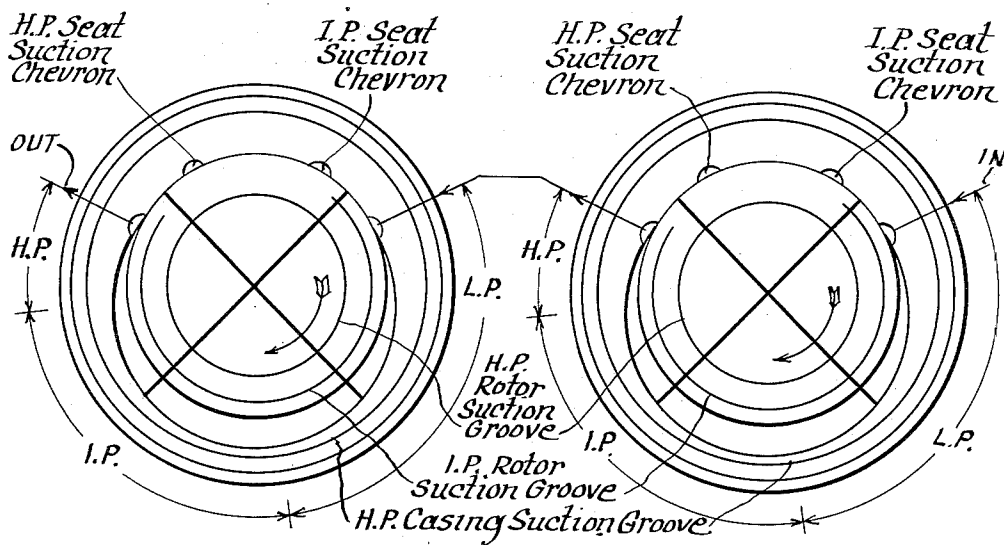
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ROUGH STAGE FINE STAGE
FIG. 12 TWO STAGE PUMP

FIG. 15

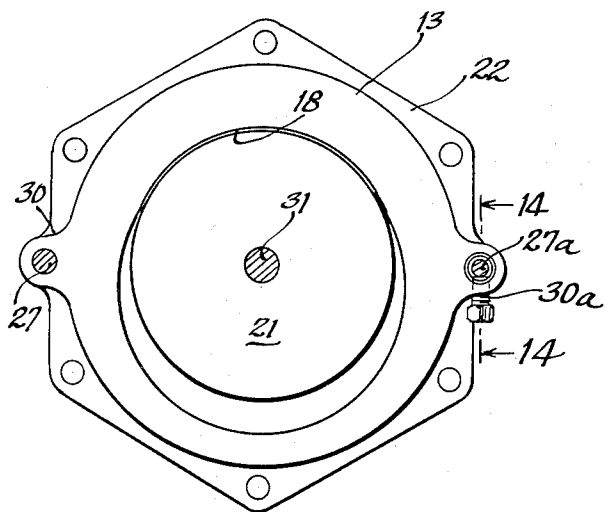
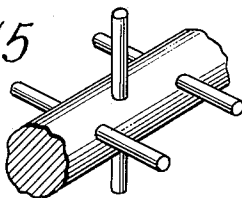


FIG. 13

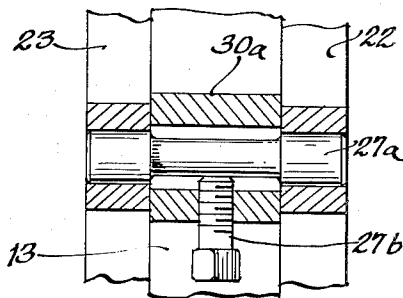


FIG. 14

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ROTARY VACUUM PUMPS

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Filed Dec. 11, 1956, Ser. No. 627,697
12 Claims. (Cl. 230—205)

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.

Heretofore pumps of this character have been limited in rotational velocity by a violent rattling or hammering caused by collapse of gas-oil bubbles in the exit passages as the outlet port is traversed by the successive vanes. This behaviour cannot be allocated to specific designs of pumps but has been generally exhibited in most prior pumps which have been operated at high speed, say 1200 to 1750 r.p.m. However, the phenomenon is distinguished from a force hammer, and has always been encountered in a rough stage exhausting to atmosphere.

Rattle is generally absent in the fine stage of a mechanical pump since, due to the vacuum on the exhaust port, the oil froths and the pressure is too low to cause this froth to collapse completely and instantly.

Since reduction in speed minimizes the undesirable rattle to a tolerable level the remedy has been to lower the speed at the sacrifice of pumping rate. While this expedient eliminates the rattle, slow speed operation requires very close running tolerances which, in turn, seriously limits the quantity of oil which may be circulated.

In the field of organic distillation wherein the vacuum is on the order of 1 to 10 mm. Hg no acceptable pump has been available. For example in processing certain noxious organic compounds mechanical oil displacement pumps fail rapidly when the oil becomes contaminated by the light ends. Extensive trapping systems are merely a palliative. For example, they are ineffective for hydrogen chloride. Gum deposits form on the working surfaces necessitating frequent shutdowns for maintenance. The invention pump has been employed in this type of service and has been found free of these difficulties.

It has been found that the provision of a restricted outlet to atmosphere, the use of rather larger running clearances than have hitherto been employed and the provision of means for circulating comparatively massive volumes of oil through and about the pump have resulted in a pump which may have three to six times the capacity of corresponding available pumps, but which is free of rattle.

To this end the invention pump employs a restricted outlet from the pumping cavity, followed by a check valve, preferably a ball check, and a restricted exit following the check valve which opens above the level of the oil in the main oil reservoir. Prior pumps utilized an outlet which was as large as possible followed by a flap check. Additionally the exit opened below the oil level of the reservoir.

As alluded to hereinabove it has been found extremely difficult to define the condition which results in the presence or absence of hammer. However, a pump with a free air capacity of 70 liters per minute is free of hammer if the outlet from the pumping cavity and the following exit line beyond the check valve have an inside diameter of from $\frac{1}{8}$ " to $\frac{3}{16}$ ". This compares with $\frac{3}{4}$ " for most vacuum pumps or the equivalent ratio of 36 to 1 in terms of area. Considered in the light of the foregoing it is probable that hammer is due to the issuance from the exit line of an oil-gas bubble mixture which, under a high vacuum, contains a small amount of bubbles. If the

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space, up to the check valve, is sufficiently large there is a separation of the gas from the oil with the gas rising to the valve seat and the oil, as a mass, tending to return. The oncoming stream opposes the returning fluid, resulting in oscillation of a mass of liquid against the approaching vanes. The intermittent physical contact thus resulting evidences itself audibly as a hammering or rattling noise. On the other hand, and as brought out in connection with the present invention, a restricted outlet tends to prevent separation of the bubbles and these therefore act to cushion the oscillating mass of oil. It must be noted that the check valve is not necessary to prevent hammer. It does, however, result in improved pumping action by maintaining a vacuum in the pumping cavity bounded in part by the next approaching vane. Stated otherwise, in the absence of a check valve, the passage of the vane past the outlet would subject the post-vane space to atmosphere and with consequent decrease in vacuum. A restricted outlet passage provided with a check valve and terminating below a mass of oil sufficient to allow separation of the froth near the exit will frequently cause hammer.

Another object of the invention is to provide for the continual introduction of oil at atmospheric pressure from the main reservoir to the rotor shaft and about the inner end of the radially disposed vanes for feed outwardly along the clearance space between the adjacent faces of the rotor and vanes as well as the adjacent end faces of the rotor and stator.

Another object is to provide annular grooves at both faces of the rotor in communication with the suction side of the pumping cavity to facilitate flow of oil from the axis of rotation toward the periphery of the rotor and more effective degassing of the oil.

Another object is to provide axially-extending grooves in the faces of the vane slots having their ends aligned with the annular grooves for degassing of the oil flowing radially outwardly along the side faces of the vanes.

Another object is to provide at least two annular concentric grooves on at least one of the respective abutting faces of the stator end plates and stator ring and to introduce oil at atmospheric pressure into the outer groove to assist in sealing the joint. The inner groove is in communication with the suction side of the pumping cavity to degass the oil passing thereby.

Another object is to provide a single stage, vane type, vacuum pump having three or more vanes, an oil degassing port opening at the seat and which port is connected to another port opening into the stator bore at a point removed from the first port an angular distance

$$\frac{360^\circ}{n}$$

where n is the number of vanes.

Another object is to provide sealing means between the stator ring and the adjoining stator end plates comprising gaskets, such as O-rings set into grooves, and a connection between the grooves and oil reservoir to supplement the sealing action of the gaskets.

Another object is to obtain positive rubbing contact of the vanes with the stator ring by supplementation of centrifugal force by hydraulic pressure.

Another object is to provide a rotary, vane-type, vacuum pump which incorporates a greater rate of circulation of oil than prior pumps thereby allowing the pump to be run at higher temperatures without degradation of the oil.

Another object is to provide a pump as aforesaid which requires a comparatively smaller oil supply circulated at a higher rate thereby to result in an augmented rate of degassing.

Another object is to provide a pump as aforesaid the parts of which need not be closely fitted thereby consider-

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ably reducing machining and hardening costs and grinding of parts to close tolerances.

Inasmuch as springs are corroded by many gases and liquids taking passage through a vacuum pump and may therefore fail another object resides in the elimination of springs for forcing the vanes radially outwardly whereby an overload condition may relieve itself by forcing of the vanes into their slots and whereby the need for a relief valve is eliminated.

Another object lies in elimination of scoring of the parts due to foreign matter or grit due to wear.

Another object is to provide an oil-sealed, rotary, vane-type pump which utilizes low cost oil.

Another object is to provide a pump of this character having low starting torque thereby permitting the use of a direct-connected, split phase A.C. motor.

Another object is to provide a pump in accordance with the foregoing in which the vacuum will release automatically practically instantaneously without the hazard of oil being drawn into the evacuated vessel.

Other objects and advantages of the invention will become apparent from the ensuing description which, taken with the accompanying drawings, discloses certain preferred forms which the invention may assume in practice.

In these drawings:

FIG. 1 is a side elevational view, with certain parts broken away, of a pump in accordance with the invention;

FIGS. 2 to 9 are cross sections taken on the lines 2—2 to 9—9 respectively of FIG. 1;

FIGS. 10 and 11 are details of alternative modes of sealing the joints between the stator ring and stator end plates;

FIG. 12 is a diagram of a tandem arrangement of pump in accordance with the invention;

FIG. 13 is a detail of means for taking up wear between the rotor and rotor seat;

FIG. 14 is a cross section on the line 14—14 of FIG. 13, somewhat enlarged;

FIG. 15 is a detail of a modified vane-pin assembly; and FIG. 16 is a side elevation of a modified rotor construction.

Turning now to the drawings there is shown a vacuum pump comprising a stator 10 and a rotor 21 arranged for rotation therein. Stator 10 may, for example, comprise a stator ring 13 having flat end faces 14 and 15 and an eccentrically located bore 16. This latter is substantially cylindrical comprising two cojoined segments of cylindrical surfaces of different diameters for ease of manufacture. One segment extends over an arc A—B and the other over an arc C—D. The latter forms a seat 18 for the cylindrical rotor 21. The axis of the larger cylindrical surface may be regarded as the principal axis of the bore 16.

The stator also comprises end plates 22 and 23 abutting the faces 14 and 15 of the stator ring to complete the pumping chamber. Bolts 25 or any equivalent, conventional fastening means are utilized to maintain the parts of the stator assembly in operative relation. A dowel 27 fitted through an ear 30 may be used for facilitating alignment.

The rotor 21 comprises a cylindrical body secured to a shaft 31 journaled in bearings 32 in the end plates 22 and 23. The shaft is sealed in any acceptable manner. A driving motor (not shown) is coupled to the shaft 31 for direct drive thereby as will be understood. As is well known the rotor axis is offset from the axis of the bore and osculates therewith, except for running clearance, over a region defined by the seat 18.

Rotor 21 is provided with a plurality of radial slots 33 each slidably receiving a vane 34 adapted to bear on the wall of the bore 16 and of width equal to the axial length of the bore minus any desired endwise running clearance. Inasmuch as the rotor is eccentric with respect to the bore of the stator a crescent-shaped cavity will be defined therebetween and which cavity is interrupted in its periph-

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eral extent by the several vanes 34. As will appear subsequently much more liberal tolerances may be allowed in the invention pump than with known prior designs. The inner end of the slots 33 will sometimes be referred to herein as the root of the slot.

Each opposite pair of vanes is provided with a pair of cylindrical pins 36 inserted in suitable bores 37 in the rotor 21 and shaft 31. These pins are of the maximum length allowed by the most proximate position of a pair of diametrically opposed vanes. Thus, should a vane be retained in its slot by the surface tension of the oil, by gummy deposits or other cause, the opposite vane may, upon being thrust into its slot and against the pins 36 by its traverse against the curved wall of the stator, exert force on the bound vane to free it for normal movement. In order to avoid interference the pins 36 may be staggered in any manner consistent with balanced transmission of force therethrough. Even a single, centered pin may be used for one of the pairs (FIG. 15).

The faces of the slots 33 are provided with channels or grooves 41, e.g. two on each face, which open on the flat faces of the rotor for fluid communication with a corresponding plurality of concentric grooves 42 and 43 in the inside face of each of the stator end plates 22 and 23. In the illustrated example two such grooves are shown cut into the inner face of each end plate of the stator. If desired grooves 42 and 43 may be cut into the opposed end faces of the rotor 21 and at the same respective radial distance from the axis of rotation. In this case, however, the vanes should be provided with notches or bores aligned with the annular grooves in all positions of the vanes to provide communication between these grooves and vane slots.

An oil reservoir 51 is connected, by means of a combined pipe and support 52 to the stator ring 13 via a port therethrough preferably by a threaded joint. The initial bore therefor in the stator ring is carried down sufficiently to provide a chamber 53 with which axially-extending ports 54 are in communication (FIG. 3). Ports 54 are, in turn, connected to radial conduits 55 exiting into respective recesses 56 in the flat faces of the rotor 21. These recesses are of such diameter as to cause the same to intersect the vane slots 33 at the root or inner end thereof. A suitable supply of oil is maintained in the reservoir 51 below the exit of the outlet pipe to be referred to and feeds, in the first instance, through ports 54 and conduits 55 into recesses 56 wherefrom centrifugal force carries the oil radially outwardly along the juxtaposed faces of the rotor and stator to seal the clearance spaces therebetween and to lubricate the surfaces.

Intake of the pump is via a pipe 61 threaded into a port through the stator ring 13 and exiting in a so-called Chevron groove 62 of the customary type whereby the inlet is exposed to the entire effective face of the vanes and interference of the inlet with the vanes is avoided.

On the assumption that the pump rotates clockwise (FIG. 1) the successively developed pumping chambers, as defined between the bore, rotor and each pair of vanes may, for convenience of reference, be defined as I, II, III and IV. While a four vane pump is illustrated it is to be understood that the principles of the invention are equally applicable to any pump of n vanes where $n \geq 3$ and in which the angular spacing of the vanes is

$$\frac{360^\circ}{n}$$

The outlet of the pump is also via a Chevron groove, namely, 63 (FIG. 7) in communication with a bore 64 threadedly receiving a pipe 65 within the pipe 52. A ball check valve 67 of any common type is arranged in the pipe 65 below the level of the oil in the reservoir. Reservoir 51 is provided with an exit 69 to atmosphere.

Pumping action per se is conventional, insofar as concerns the simple intake of gases at 61 and their discharge at 65, each pair of vanes taking in and delivering up their

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quota of gases and oil as the rotor revolves. However, oil in copious quantities is also circulated about the working parts of the pump. Such phases will now be described.

The first and rough degassing of the oil flowing radially outwardly from the axis of rotation and over the seat 18 is accomplished by connecting the grooves 42 by means of a passage 81 (FIG. 4) to a chevron groove 82 located just beyond the point C measured in the direction of rotation. To this end grooves 42 are also connected to a point of rough suction via radial passages 83 (FIG. 5) and axial passages 84.

Second, there is the circulation of oil from the recesses 56 radially outwardly as explained.

Third, the oil passing outwardly between the juxtaposed flat faces of the rotor and stator and into the vane slots 33 is degassed through the medium of the grooves 43 in a manner which will shortly be explained.

At this juncture it is to be noted that in the case of a four-vane rotor there is always a vane 34 positioned between the ports 75 and 84 and also a vane positioned between the port 75 and the chevron 62. That is to say the point F, viz: the port 75 is displaced from the inlet port 62 by slightly more than the angular spacing of the vanes. In the present case since there are four vanes illustrated the pitch will be 90°. The point G, viz: the port 84 is displaced slightly more than 90° from the point F. The angular distance from the point G to the exhaust port 63 has not been found to be critical but the greater the angle the more improved is the operation. This may be explained by noting that if the space enclosed between the vane at point G and port 63 is too small gas leakage can adversely affect the available suction in the space. From the foregoing it will be apparent that the spacing of the ports 75 and 62 should be such in relation to the number of vanes that a vane is always interposed between them. Similarly as to the interposition of a vane between the ports 75 and 84. It will also be apparent that the angle of 90° just mentioned is obtained by dividing 360° by n where n in general is the number of vanes and in the example $n=4$. It will also be noted that the point F does not represent a critical region but an average point with respect to the port 75. If this port were a hole or truly radially disposed the point F may be established quite exactly. However, in order to provide the port 75 with sufficient area and to avoid mechanical interference between the vanes and the port the same is preferably a slot inclined as shown.

Essentially, the invention pump depends for its increased efficiency upon copious circulation of oil in passages intentionally made large enough to obtain increased degassing in the pumping chamber as contrasted to those pumps wherein the oil is degassed before being permitted to enter the pump.

Fourth, some raw oil from the high pressure or outlet port 63 will flow across the seat 18 to the low pressure or inlet port 62. A suction chevron 71 (FIG. 8) is connected by branches 72 to the grooves 43, which latter are subjected to suction, as will appear. Thus oil flowing past the seat 18 is degassed.

Fifth, the groove 43 is connected, via branches 75 (FIG. 9) to the pumping chamber at a point F which constitutes a region of so-called "fine" suction, while the port 84 is connected to the groove 42 and is therefore referred to as a region of so-called "rough" suction. Stated otherwise, those regions of the pump at which comparatively higher pressures exist are spoken of as "rough" suction regions, and those regions at which comparatively lower pressures exist are referred to as "fine" suction regions. For example, the suction port 62 is at the lowest pressure and the interior of the chamber 51 beyond the check valve 67 is at the highest, i.e. atmospheric pressure.

Assuming the vanes 34 are in the position shown in FIG. 1 and with the understanding that raw oil from the reservoir 51 begins its flow at the axis of rotation and

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then flows outwardly by centrifugal force and that a pressure differential exists between the axis and the periphery of the rotor and that, additionally, oil is flowing from the exhaust chevron 63 through the seat 18, the degassing action may be detailed as follows: Since the port 84 is located at a region of rough suction, i.e. highest pressure in the pumping cavity and is in communication, via passages 83, with the groove 42 as well as the chevron 82 via the passage 81 degassing of the oil occurs initially at the grooves 42 and the chevron 82 and between the O-ring grooves 93 and 94. Concurrently the oil in the grooves 43 is subjected to degassing suction via the ports 75 which, at the assumed point of rotation, is a region of fine suction. Degassing is also being effected at chevron 71 connected to grooves 43 via passages 72. The chevrons 72 and 82 are effective to degas the oil passing through the seat 18.

It is to be noted that, in the position of the vanes 34 shown in FIG. 1 the port 75 receives an oscillating suction and similarly as to port 84. Further, that the pressure subsisting at the port 84, during such time as a vane is approaching this port, is determined by the suction pressure within the check valve 67.

Desirably the ports 75 are vertical or inclined in the direction of rotation, as shown, to obtain the benefit of whatever increase in head may result from gravity. Thus, suction in the region of the branch 75, as for example, the region II, is effective to degas oil in the grooves 43 and the other passages in communication therewith.

In connection with the suction grooves 43 it is to be noted that the degassing function performed thereby employs passages not influenced by pressure drop due to liquid head. Thus degassing occurs at an optimum level.

It should be noted that suction grooves 43 are blanked out according to the formula

$$\frac{360^\circ}{n}$$

e.g., an angle of 90°, as shown, in order that the higher pressure existing coextensively with this zone of the groove may not cause leakage of gas therinto whereby to defeat the degassing function performed thereby. If it is desired to reduce manufacturing difficulties the groove 43 in each end plate may be complete through 360° in the same manner as the grooves 42 with insignificant reduction in efficiency.

The stator end plates 22 and 23 are sealed with respect to the stator ring by means of two gaskets 91 and 92 which will allow metal-to-metal seating. Commercial O-rings are suitable and are received in grooves 93 and 94 in the end plates. Inasmuch as the interior of the pump is at a high vacuum it is possible for oil to leak past the innermost gaskets 92, as for example, improper metal-to-metal contact due to imperfections in the surfaces, foreign matter, etc. Consequently, the grooves 94 are connected (FIG. 5) via the passages 83 to the suction at branches 84. Thus, any oil reaching the grooves 94 is degassed. A high degree of degassing is not necessary here as the pressure drop due to the surface tension of the oil will essentially eliminate all oil flow for any reasonably possible misfit.

To insure sealing of the joints between the stator ring and stator end plates raw oil is introduced into the outer gasket grooves 93 via passages 55 (FIG. 3) which are connected by branches and ports 54 to the reservoir, as heretofore described. Thus, any minor interstices not fully sealed by the compressive action of the gaskets is liquid-sealed by oil.

In FIGS. 10 and 11 there are shown two alternative modes of supplementing the sealing action of the O-rings. In FIG. 10 oil from the source, e.g. the reservoir 51 is simply led to the faces of the joint by means of a conduit 55a rather than to one of the grooves in which the O-rings are retained. In FIG. 11 the O-rings are of different diameters and are seated in a common groove with which

the conduit 55b connects. Other types of feed are possible within the concept of injecting oil between the juxtaposed faces of the parts constituting the stator. By supplying oil to these joints the prior practice of "canning" the entire pump assembly in order to provide a bath of oil enshrouding the pump has been eliminated together with the increased cost of manufacture and maintenance represented thereby.

The principles of the invention may be variously embodied. For example, and turning to FIG. 12 there are shown, schematically, two pumps utilizing the principles of the invention arranged in tandem. From the legend it will be apparent that a fine stage and a rough stage may each be constituted as a pump in accordance with FIG. 1. It will be noted that oil and gases exhausted from the fine stage are not returned to the fine stage but are delivered to the rough stage, namely to the axis of rotation thereof and degassing occurs in that stage as previously explained in connection with FIG. 1.

One of the important advantages of the invention lies in its low starting load. Inasmuch as the vanes are not spring biased they may be retracted in their slots by the pressure developed in the pumping cavity. Consequently, upon starting, the mass of oil ahead of the several vanes tends to by-pass the ends of the vanes which are free to return in their slots. Thus the fluid friction tending to prevent rotation of the rotor is reduced, with consequent easier starting.

It is desirable to provide means for reducing the running clearance at the seat 18 since the same may wear inordinately wide by reason of foreign matter forced therethrough. To this end I may incorporate an arrangement as shown in FIGS. 13 and 14. One of the ears in the stator ring, 30a, through which a fully fitted dowel, such as 27, is passed is modified by inserting a screw 27b therein. Also the dowel at this point is reduced for that portion of its length coextensive with the ear 30a but is tightly fitted in the stator end plates 22 and 23. Accordingly, as wear develops at the seat 18 the tie bolts 25 are loosened and the screw 27 is turned inwardly against the dowel 27a which will cause the stator ring 13 to move toward the rotor 21. Obviously, and as is customary the tie bolts will be a sufficiently loose fit in their respective holes to permit such adjusting movement of the stator.

While I have shown certain embodiments 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. In a rotary, vane type, positive displacement vacuum pump which includes a stator having a bore and a wall at each side of the stator, an eccentrically positioned cylindrical rotor in the bore, the rotor and bore having coextensive, circumferentially-extending osculating areas defining an arcuate seat, the remainder of the curved areas of the rotor and stator and the respective end walls thereof defining a crescentiform pumping chamber, the rotor having a plurality of slots each slidably receiving a pumping vane, a port providing an inlet to the pump from the vessel being evacuated, and a port providing for discharge from the pump, said ports being disposed on opposite sides of the seat, the vanes dividing the chamber into regions of fine suction and rough suction, the combination comprising: a reservoir for a supply of oil in fluid communication with the pumping chamber, means defining a first annular recess in one of the side walls of said stator and rotor concentric with the rotor axis, means defining a second recess concentric with said first recess and positioned radially outwardly of said first recess, said slots each having a pair of axially-disposed recesses in the walls thereof aligned with said annular recesses respectively, a passage providing communication between said first annular recess and a region of rough suction in the pumping

chamber, and a second passage providing communication between said second annular recess and a region of fine suction in the pumping chamber.

2. In a rotary, vane type, positive displacement vacuum pump which includes a stator having a bore and a wall at each side of the stator, an eccentrically positioned cylindrical rotor in the bore, the rotor and bore having coextensive, circumferentially-extending osculating areas defining an arcuate seat, the remainder of the circumferential areas defining a crescentiform pumping chamber, the rotor having a plurality of slots each slidably receiving a pumping vane, a port providing an inlet to the pump, and a port providing for discharge from the pump, said ports being disposed on opposite sides of the seat, the vanes dividing the cavity into regions of fine suction and rough suction, the combination comprising: a reservoir for a supply of oil for flooding the pump, means forming a first slot in the curved wall of the stator adjacent the margin of the seat nearest the inlet port, means forming a second slot in the curved wall of the stator adjacent the margin of the seat nearest the discharge port, means defining a pair of annular, concentric recesses in one of the side walls of said stator and rotor concentric with the rotor axis, means providing communication between the inner one of said annular recesses and said second slot, means providing communication between said inner annular recess and a region of rough suction, means providing communication between the outer one of said annular recesses and said first slot, means providing communication between said outer annular recesses and a region of fine suction whereby the differential of pressure between said regions is effective to degass oil circulating in the seat.

3. In a rotary, positive displacement, vacuum pump of the type in which massive quantities of oil are circulated and which includes a stator ring and end plates together defining a substantially cylindrical bore having a principal axis, a cylindrical rotor rotatably carried in the bore on an axis eccentric with respect to said principal axis, the rotor, stator ring and end plates defining a crescentiform pumping chamber, the rotor having a plurality of radial slots for slidably receiving a plurality of vanes adapted to contact the curved wall of the bore to subdivide the chamber into a plurality of sections, each of said sections defining regions of fine suction and rough suction during rotation of the rotor, said rotor and bore having respective osculating arcs defining a seat therebetween, an inlet port to said chamber at one side of said seat and an outlet port from said chamber at the other side of said seat, the combination comprising: a pair of annular, concentric recesses in one of the sides of said rotor and stator end plates, a first passage providing communication between a region of rough suction and the inner one of said recesses, a second passage providing communication between a region of fine suction and the outer one of said recesses whereby the differential of pressure between said regions is effective to degass the oil intermediate the adjacent end faces of the rotor and stator.

4. The combination in accordance with claim 3 further characterized in that each vane slot is provided with a pair of axially-extending recesses in a face thereof, said vane-slot recesses opening at their ends in alignment with said annular recesses for concurrent degassing of oil circulating in said slots.

5. In a rotary, positive displacement, vacuum pump of the type in which massive quantities of oil are circulated and which includes a stator ring and end plates together defining a substantially cylindrical bore having a principal axis, a cylindrical rotor rotatably carried in the bore on an axis eccentric with respect to said principal axis, the rotor, stator ring and end plates defining a crescentiform pumping chamber, the rotor having a plurality of radial slots each slidably receiving a vane adapted to contact the curved wall of the bore to subdivide the chamber into a plurality of sections, each of said sections defining regions of fine suction and rough suction during rotation of the

rotor, said rotor and bore having respective osculating arcs defining a seat therebetween, an inlet port to said chamber at one side of said seat and an outlet port from said chamber at the other side of said seat, the combination comprising: a reservoir for a supply of oil for flooding the pump, said rotor having a circular recess in an end face thereof of a diameter greater than the circle defining the root of the several vane slots in communication with said slots, a conduit interconnecting said reservoir and said circular recess for feeding oil in the first instance to said recess wherefrom the same may circulate radially outwardly, a pair of annular, concentric recesses in one of the sides of said rotor and stator end plates opposite the adjoining rotor end face, first passage means connecting the inner one of said annular recesses with a region of rough suction, second passage means connecting the outer one of said annular recesses with a region of fine suction, whereby a differential of pressure is created across a part of said adjoining faces for degassing oil in the space therebetween and the vane slots.

6. In a rotary, positive displacement, oil-flooded, vacuum pump which includes a stator, an inlet and an outlet for said stator, and rotary means in said stator for providing a variable volume chamber therein for displacing air from the inlet to the outlet, said rotary means having vane slots with vanes therein, the combination comprising a reservoir for a supply of raw oil at atmospheric pressure, a conduit providing communication between the supply and a region in the stator adjacent the axis of rotation of said rotary means whereby oil is fed in the first instance to said region and is circulated outwardly therefrom, an annular recess in the stator disposed outwardly of said region, degassing means in said pump connected to said recess for effecting degassing of the oil as it circulates in and about said recess, recesses in the walls of the vane slots opening at the end faces of the rotary means, the ends of the last mentioned recesses being in communication with said annular recess, an exit conduit for said oil adjacent the stator outlet for re-delivery of oil to said reservoir, and a check valve in said exit port for insuring only exit flow therethrough, said exit conduit opening in said reservoir above the level of the supply therein.

7. In a rotary, vane type, positive displacement, oil flooded, vacuum pump which includes a stator having a substantially cylindrical bore including an end wall at each side thereof, a cylindrical rotor in the bore positioned eccentrically with respect to the principal axis of the bore and having its end walls juxtaposed to the stator end walls, the curved surfaces of the rotor and bore having coextensive, circumferentially-extending, osculating areas of predetermined arcuate extent defining a seat, the remainder of the curved areas of the rotor and stator and the respective end walls thereof defining a crescentiform pumping chamber, the rotor having a plurality of n radial slots each slidably receiving a pumping vane for radial reciprocation therein, a port providing an inlet to the pump from the vessel being evacuated and a port providing for discharge from the pump, said ports being disposed on opposite sides of the seat, said vanes subdividing the chamber into regions of varying pressure from a region of fine suction adjacent the inlet port to a region of rough suction adjacent the outlet port, degassing means comprising: a pair of annular, concentric recesses coaxial with the rotor axis in one of the sides of the rotor and end walls of the stator in communication with the vane slots, a first passage providing communication between a region of rough suction and the inner one of said recesses, a second passage providing communication between the outer one of said recesses and a suction region intermedi-

ate said rough and fine suction regions, the ends of said passages opening into said chambers being spaced apart about the principal axis of the stator by an angle greater than

$$\frac{360^\circ}{n}$$

8. The combination in accordance with claim 7 further characterized by a reservoir for a supply of oil for flooding the pump, a conduit for feeding the oil therefrom to a point in the stator between the rotor axis and the root of the vane slots wherefrom the oil circulates outwardly past said annular recesses and is degassed thereat.

9. The combination in accordance with claim 7 further characterized in that the vane slots are provided on their walls with recesses in communication with said annular recesses for degassing oil intermediate the vanes and vane slots.

10. The combination in accordance with claim 7 further characterized by the provision of a recess in the curved wall of the stator in the area of the seat adjacent said port providing for discharge from the pump and a passage providing communication between the inner one of said annular recesses and said recess in the curved wall for degassing oil circulating in the seat.

11. The combination in accordance with claim 10 further characterized by a second recess in the curved wall of the stator in the area of the seat adjacent said port providing an inlet to the pump and a third passage providing communication between said second recess and the outer one of said annular recesses for degassing oil circulating in the seat.

12. The combination in accordance with claim 7 further characterized in that the outer one of the annular recesses is blanked out beginning at a radial line of the rotor passing substantially through that end of the first passage located at the rough suction region of the first passage and ending at a point removed from said radial line by an arc of

$$\frac{360^\circ}{n}$$

measured in the direction of rotation of the rotor.

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