May 26, 1953 W. T. DANIELS 2,639,855

VARIABLE VACUUM AND PRESSURE ROTARY PUMP

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Fig. 1.

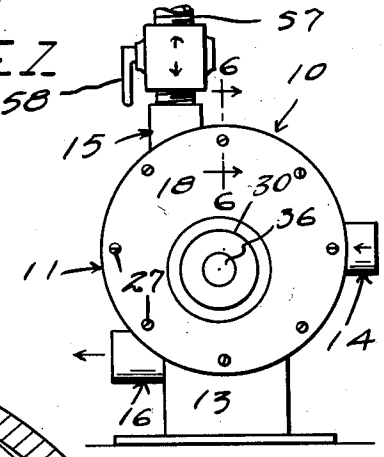


Fig. 2.

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Fig. 3.

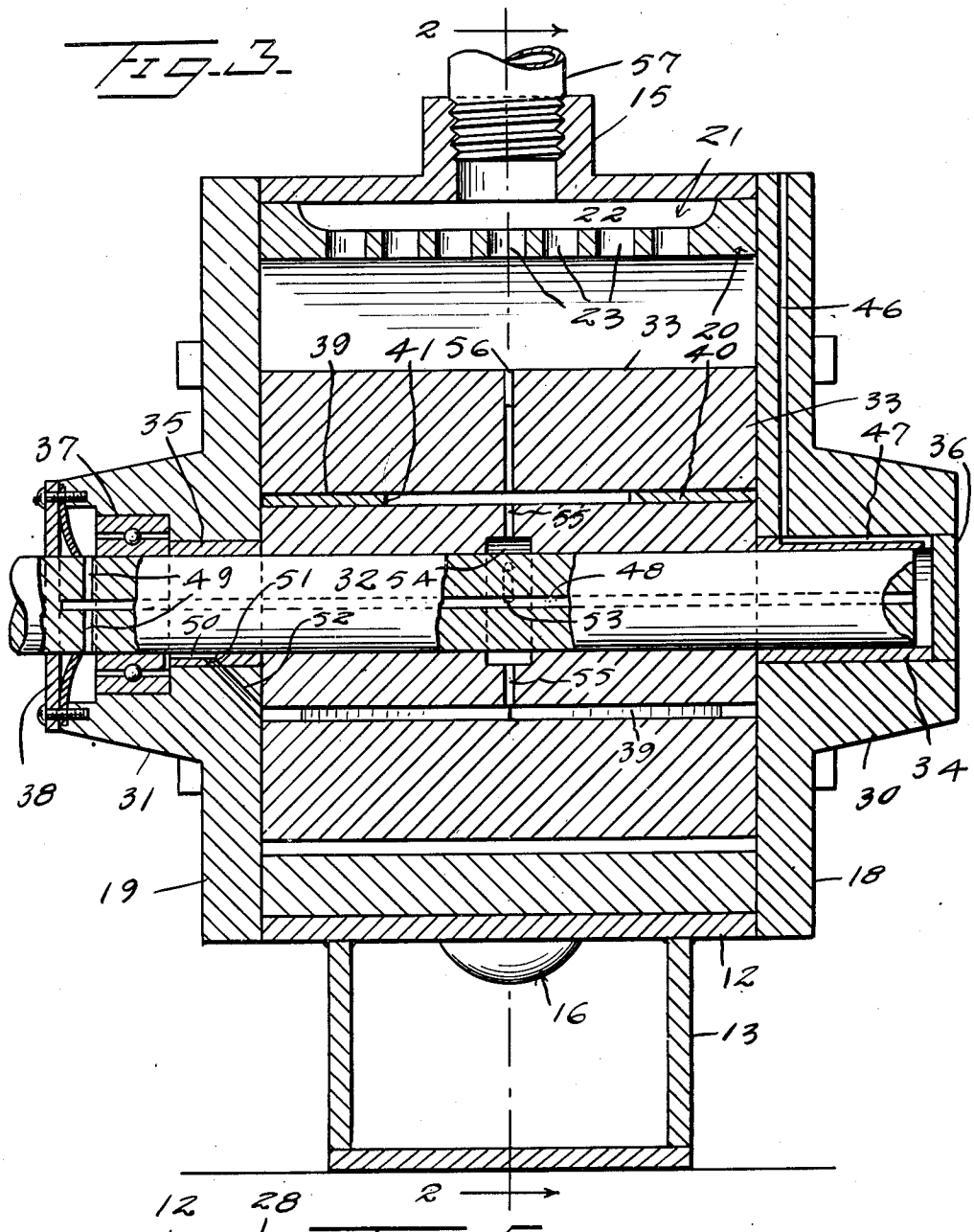
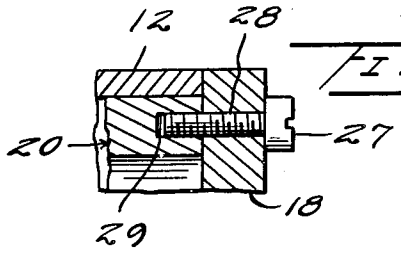


Fig. 6.



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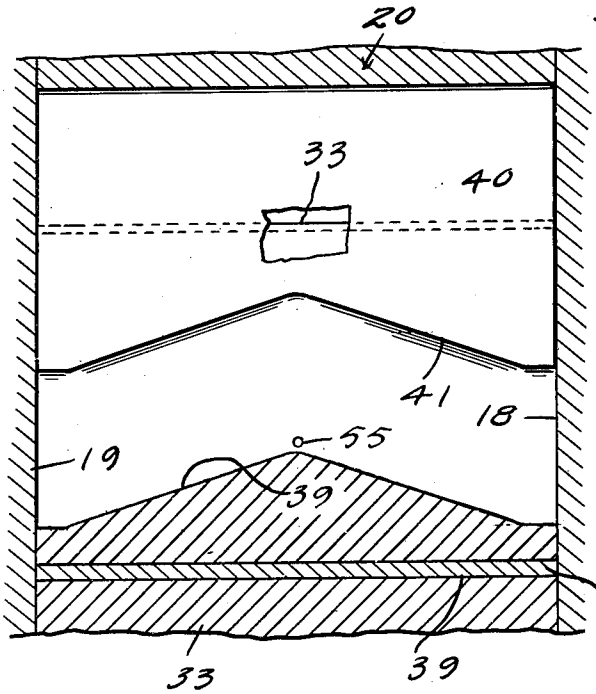


FIG. 4.

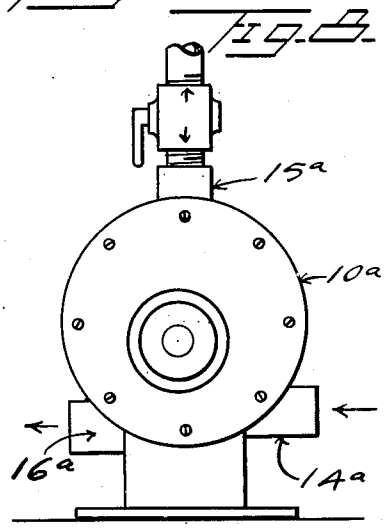


FIG. 6.

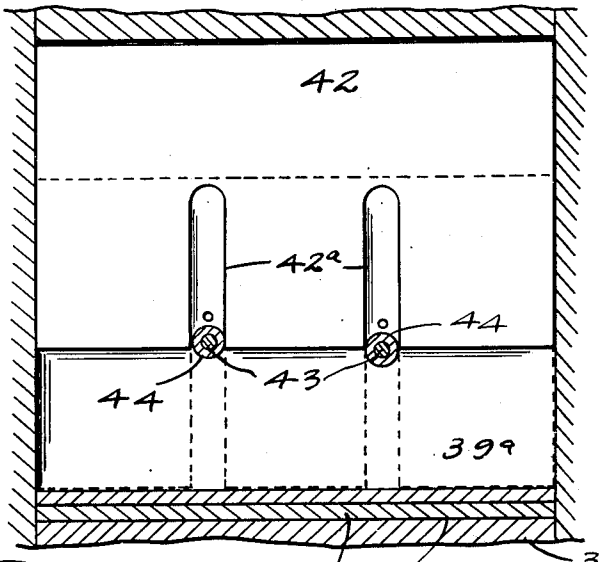


FIG. 7.

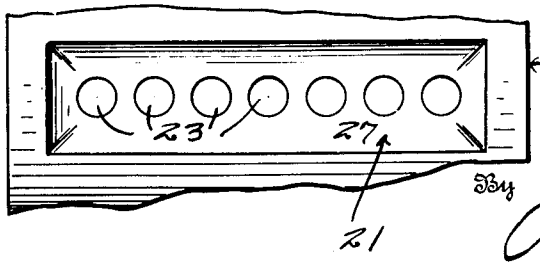


FIG. 5.

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VARIABLE VACUUM AND PRESSURE ROTARY PUMP

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Application February 6, 1948, Serial No. 6,603

5 Claims. (Cl. 230—47)

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This invention relates to a novel construction of vacuum pump having means whereby the vacuum and pressure of the pump may be varied at the will of the user to afford a pump capable of operating under a number of conditions such as to produce a relatively high pressure at the outlet of the pump with a medium vacuum pull at the inlet side thereof; a very high pressure with a very strong vacuum; two stages of vacuum with a constant pressure or two different pressures with a constant vacuum.

More particularly, the present invention aims to provide an improved construction of pump utilizing three ports in lieu of the two ports normally provided for vacuum pumps and having a novel manifold structure associated with each of said ports to facilitate the intake and exhaust of the pumped medium.

A further object of the invention is to provide a novel construction of pump enabling the ready assembly and disassembly thereof and permitting the replacement of the wearing surfaces of the pump without requiring replacement or reboring of the pump casing and which can be accomplished without special skill to produce a substantially rebuilt pump.

A further object of the invention is to provide a rotary-type vacuum pump having the rotor located adjacent the bottom thereof to reduce the wear on the moving parts.

Another object of the invention is to provide an improved construction of rotor wherein the weakening of the rotor body by the provision of the rotor blade slots will be reduced to a minimum.

Still a further object of the invention is to provide a rotary pump having a lubricating system fed from a common inlet for lubricating all moving parts of the pump.

Various other objects and advantages of the invention will hereinafter become more fully apparent from the following description of the drawings, illustrating presently preferred embodiments thereof, and wherein:

Figure 1 is a side elevational view of one embodiment of the pump;

Figure 2 is an enlarged sectional view thereof taken substantially along a plane as indicated by the line 2—2 of Figure 3;

Figure 3 is an enlarged transverse vertical sectional view taken substantially along a plane as indicated by the line 3—3 of Figure 2;

Figure 4 is a sectional view of the pump taken substantially along a plane as indicated by the line 4—4 of Figure 2;

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Figure 5 is a fragmentary plan view of a portion of the inner cylinder or liner of the pump, shown removed;

Figure 6 is a radial sectional view taken substantially along a plane as indicated by the line 6—6 of Figure 1 and on an enlarged scale;

Figure 7 is a view similar to Figure 4 and illustrating a modification of the pump, and

Figure 8 is a view similar to Figure 1 illustrating another modification of the pump.

Referring more specifically to the drawings, the novel variable rotary vacuum pump comprising the invention is designated generally 10 and includes a pump housing, designated generally 11 having a cylindrical outer wall 12 which is formed integral with or suitably secured to a supporting base 13, the bottom portion of which is adapted to be secured to any suitable supporting surface for mounting the pump in an upright position as illustrated in the drawings. The cylindrical wall 12 is provided with circumferentially spaced ports 14, 15 and 16 each of which includes an outwardly projecting internally threaded nipple 17. The housing 11 also includes end walls 18 and 19 which are detachably secured to the cylindrical wall 12, in a manner hereinafter to be described, and which close the open ends of said cylindrical wall.

The pump housing 11 also includes a detachable inner cylinder or liner, designated generally 20 which fits snugly within the cylinder 12 and which is provided with circumferentially spaced manifold passages 21, one of which is adapted to register with each of the ports 14, 15 and 16. The manifold passages 21, as best seen in Figure 5, each includes a recess 22 which is formed in the exterior of the liner 20 and which extends transversely thereof to adjacent the side edges of said liner, and a plurality of radially extending ports 23 which are spaced longitudinally of the recesses 22 and which have their outer ends opening into said recesses and their inner ends opening into the interior of the liner. As best seen in Figure 2, the cylinder 12 is provided with at least one tapped radially disposed opening 24 for receiving a setscrew 25 the inner end of which engages in a recess 26 in the periphery of the liner 20, when said setscrew is in an advanced position, as seen in Figure 2, for fixedly securing the liner relatively to the cylinder 12 and with the manifold passages 21 thereof in proper registry with the ports 14, 15 and 16.

A plurality of screw fastenings 27 extend through unthreaded openings 28 in each of the end walls 18 and 19 and into tapped recesses 29

which open outwardly of the side edges of the liner 20, as best seen in Figure 6, for detachably securing said end walls to the liner and for thereby securing the end walls to the cylinder 12 through connection of the liner 20 and cylinder 12 by setscrew 25.

As best seen in Figure 3, the end walls 18 and 19 are provided with downwardly offset outwardly projecting bosses 30 and 31, respectively, which are deposited in alignment for journaling a shaft 32 which is fixed to a rotor 33 which is thereby disposed eccentrically within the housing 11 and so that said rotor contacts the inner surface of the liner 20 adjacent the bottom of the housing 11, as best seen in Figure 2. The bosses 30 and 31 are provided with bushings 34 and 35, respectively, in which the shaft 32 is journaled and one end of said shaft terminates in the boss 30, spaced from the outer end thereof which is sealed by a closure or plug 36. The shaft 32 projects outwardly from the boss 31 and is adapted to be connected to suitable driving means, not shown, for revolving the rotor 33 within the pump housing 11. Said boss 31 is recessed to accommodate an anti-friction ball bearing unit 37 and outwardly thereof and spaced therefrom is provided with a removable seal 38 through which the shaft 32 rotatively extends.

As best seen in Figures 2 and 4, the rotor 33 is provided with four corresponding blade slots 39 each of which has an outer end opening into the periphery of the rotor 33 and an inner end terminating in spaced relationship to the intermediate portion of another, adjacently disposed slot 39 and which is disposed substantially at a right angle thereto so that the inner portions of the slots 39 are each disposed substantially at right angles to the two other slots located adjacent thereto and substantially parallel to the remaining slot 39. The inner ends of slots 39 are each defined by corresponding outwardly inclined surfaces as best seen in Figure 4 to increase the solid portion of the rotor between said slots. The slots 39 extend from side to side of the rotor 33 and are each adapted to slidably receive a blade 40 having a recessed inner edge 41 which fits flush against the inclined inner end or bed of its slot 39 for substantially filling the slot when the blade 40 is disposed in a retracted position therein.

Figure 7 illustrates a slightly modified form of the rotor vane, designated generally 42 and the rotor 33a thereof is shown provided with vane slots 39a which are straight across their beds to receive the straight inner ends of the vanes 42. The rotor 33a has two screw fastenings 43 extending through each slot 39a thereof and each of which carries a spacing washer 44. The fastenings 43 and their guide washers 44 extend through parallel slots 42a which extend from the inner edge of each blade 42 and said fastenings 43 are threaded into the rotor 33a to prevent spreading of the rotor body adjacent the slots 42a. The spacing washers 44 prevent the slots 39a being restricted by the fastenings 43 to prevent binding of the vanes therein. As in connection with the rotor slots 39, the slots 39a are adapted to be disposed substantially parallel to a tangent of the rotor and the inner ends thereof are spaced from the intermediate portions of an adjacent slot to provide a solid wall portion therebetween and which prevents undue weakening of the rotor body as frequently occurs with rotors having vane slots disposed in a conventional manner.

The vanes or blades 40 are urged outwardly by centrifugal force and as said blades and the slots are disposed parallel to tangents of the rotor the effect of centrifugal force thereon will not be as great as if said blades were disposed more nearly radial of the rotor and which is desirable in order to prevent excessive wear on the outer edges of the vanes and on the inner wall of the liner 20, due to the fact that the rotor 33 is adapted to revolve at a high speed within the range of 1,000 to 1,800 R. P. M.

Accordingly, this disposition of the slots and vanes may be varied depending upon the speed of rotation of the rotor and for pumps having rotors operating at a slower speed the vanes would be disposed more nearly radially thereof.

As best seen in Figure 3, the housing wall 18 is provided with a lubricating passage 46 which opens into a channel or groove 47 of the bushing 34 and which provides a passage for a lubricant, not shown, into the space between the closure 36 and the adjacent end of the shaft 32 and which is defined by a portion of the bore of the boss 30. The shaft 32 is provided with a longitudinal passage 48 communicating with said aforementioned end and having an opposite end extending to beyond the portion thereof which is journaled in the bearing 37 and which in turn communicates with the radial passages 49 of the shaft 32 and which opens into the bore of the boss 31 between the anti-friction unit 37 and the seal 38 and by means of which said bearing 37 is lubricated and through which the lubricant passes to a groove 50 in the interior of the bushing 35 and which has a port 51 communicating with said groove and with a passage 52 formed in the end wall 19 and which opens at its opposite end into the rotor chamber of the housing for lubricating the rotor. As best seen in Figures 2 and 3, the shaft 32 is provided with a radial passage 53 which communicates at its inner end with the passage 48 and which opens at its outer end into an annular recess 54 of the rotor 33 and which in combination with the shaft 32 defines a lubricating chamber having passages 55 extending radially therefrom and opening into the slots 39. The passages 55 are formed by drilling alternate passages through from the periphery of the rotor to form the two opposed passages 55 and said passages which are drilled from its periphery are preferably sealed by plugs or inserts 56.

As seen in Figure 1, the port 14 is shown located substantially midway of the top and bottom of the housing 11 and the port 16 is shown disposed on the other side of the vertical center thereof but adjacent the bottom of said housing. The intermediate port 15 is shown located adjacent the top of the housing but to the side thereof, relatively to the vertical center of the housing, in which is located the port 16. In Figure 1 the nipple of the port 15 is shown connected to a conduit 57 provided with a conventional manually controlled shutoff valve 58 and it will be readily obvious that the nipple 17 of the ports 14 and 16 could likewise be connected to like conduits, not shown.

Assuming that the outlet port 16 is connected to suitable means, not shown, for receiving compressed air and that the inlet port 14 is open to the atmosphere and the port 15 is closed by the valve 58, when the rotor 33 is revolved by suitable driv-

ing means, not shown, counterclockwise as seen in Figure 2 or as indicated by the arrow 59, each of the vanes or blades 40 as rotor 33 moves out of contact with the inner wall of the liner 20, adjacent the bottom thereof, will begin to pull a vacuum in the space between the rotor and liner and behind said vane until the vane passes the manifold 21 of the inlet port 14 at which time the air will be drawn into this increasing space and will continue to enter said space until the next vane in a trailing position, with respect to said aforementioned vane, passes the inlet port 14. Likewise, after each vane 40 passes the inlet port 14 and approaches the port 15 it will begin to compress the air located in the chamber in advance thereof or between said vane and the next vane spaced therefrom in a counterclockwise direction as seen in Figure 2, and this chamber is diminished for compressing the air until it is of the size of the space as seen between the outlet port manifold and the vane 40 which is disposed adjacent thereto and in a direction approaching said manifold. As this space comes into communication with the manifold 21 of the outlet port 16 the compressed air is released therefrom through said outlet port 16. The previously described operation is substantially conventional in rotary type air compressors and the amount of air compressed is limited by the amount of vacuum created in the initial stage of movement of the vane toward the inlet port and in the subsequent stage of movement of the vane beyond said inlet port and before the next trailing vane passes the inlet port together with the quantity of air which can enter the vacuum chamber while it is in registration with the inlet port. With the rotary pump or compressor 10 as disclosed in Figures 1 to 6 and as previously described, the amount of the medium compressed may be increased and accordingly the extent to which the pumped medium is compressed increased by opening the intermediate port 15. When the port 15 is open or partially open a vane 40 will draw air into the space behind it from the inlet port 14 and will continue to draw air after passing the intermediate port 15 from said port and until the next trailing vane has passed said intermediate port 15 thereby increasing the volume of air in each of the chambers between adjacent vanes 40 and accordingly the volume and pressure of the air released from the outlet port 16. Due to the eccentric disposition of the axis of the rotor 33 relatively to the axis of the casing 11, the size of each chamber continues to increase until the leading vane 40 thereof is a considerable distance beyond the port 15. Since the trailing vane of each chamber passes the port 14 before the leading vane thereof passes the port 15, and since the rotor is revolving so fast that neither port can completely relieve the vacuum as rapidly as it is created, a vacuum will still exist in each chamber after it has begun to diminish in size so that air will still be drawn into each chamber through port 15 until its trailing vane passes said port. To insure this, the valve 58 can be adjusted to regulate the amount of air admitted to the casing through port 15 in a given time and at any given vacuum. It will be readily apparent that the lubricating system, previously described, will maintain all moving parts of the pump 10 properly lubricated.

Figure 8 is a view similar to Figure 1 illustrating a slightly modified form of the pump designated generally 10*a* and differing from the pump 10 in that the intermediate port 15*a* is located

at substantially the top center thereof and the inlet port 14*a* is located at the bottom and to one side of the center and practically opposite to the outlet port 16*a*. Accordingly, with the pump 10*a* only a slight vacuum chamber will be formed by each vane between the time that it passes the outlet 16*a* and the time that it passes the inlet port 14*a*. Thereafter said vane will continue to draw a vacuum for drawing air through the inlet port 14*a* until the next trailing vane has passed the port 14*a*. Subsequently thereto and assuming that the intermediate port 15*a* is open, the aforementioned vane 40 will draw a vacuum in the space behind it for drawing air into said space from the port 15*a* after passing said port and until the next trailing vane passes said port to thereby provide a greatly increased amount of compressed air between adjacent vanes and which is compressed to a great degree before being discharged from the outlet port 16*a*.

Accordingly, from the foregoing it will be seen that when the intermediate port is closed the amount of air which is admitted through the inlet port will be limited and accordingly a relatively low pressure will exist at the outlet port. With the intermediate port open a high vacuum is created at the inlet port together with a full volume and high pressure at the outlet port, or the highest vacuum can be obtained with the port 14 closed and port 15 open.

As previously noted, the rotor 33 is eccentrically mounted so as to contact the liner 20 adjacent the bottom of the housing 11 to thereby reduce wear on the periphery of the rotor and on said liner and as previously described, the rotor and liner may be quickly and easily removed and replaced without requiring re-boring of the pump housing and without requiring the services of a specially skilled worker or the use of special equipment thereby producing a pump which can be maintained in good working order and for efficient operation for an indefinite period of time and at a minimum of maintenance cost.

Various modifications and changes are contemplated and may obviously be resorted to, without departing from the spirit or scope of the invention as hereinafter defined by the appended claims.

I claim as my invention:

1. A rotary pump comprising a housing having an inlet port and an outlet port disposed in the periphery thereof, a driven rotor rotatably mounted eccentrically within the housing chamber and having a plurality of vanes reciprocally disposed in the body thereof for contact with the end walls and periphery of said housing, said housing including a removable liner forming an interior section of the periphery thereof, said liner being provided with manifold ports communicating with the inlet and outlet ports and with said housing chamber, said manifold ports each including a groove formed in the exterior of said liner and extending transversely thereof and a plurality of spaced ports communicating with said groove and with the housing chamber and formed in said liner in transversely spaced relationship to one another, the length of each groove, transversely of the liner, being substantially greater than the width of the groove, circumferentially of the liner.

2. A rotary pump comprising a housing having an inlet port and an outlet port disposed in the periphery thereof, a driven rotor rotatably mounted eccentrically within the housing chamber and having a plurality of equally spaced vanes

reciprocally disposed in the body thereof for contact with the end walls and periphery of said housing, said rotor being disposed to contact the periphery of the housing adjacent the bottom thereof and adjacent said outlet port and more remote to the inlet port, and an intermediate port separate from the inlet port formed in the periphery of said housing and forming a second inlet port thereof, said intermediate port being spaced a greater distance from the periphery of the rotor than the inlet port, said three ports being circumferentially spaced substantially equal distances apart and greater distances apart than the outer edges of adjacent vanes.

3. A rotary pump as in claim 2, said intermediate port being disposed between said inlet and outlet ports, in the direction of rotation of the rotor, and being spaced a slightly greater distance from the inlet and outlet ports than said last mentioned ports are spaced from one another.

4. A rotary pump as in claim 2, said intermediate port being disposed between said inlet port and outlet port in the direction of rotation of the rotor, said rotor being provided with four of said vanes, all of said ports being spaced circumferentially of one another a distance greater than one-fourth the internal circumference of the housing.

5. A rotary pump as in claim 2, and a valve associated with said intermediate port for regulating the amount of fluid admitted to the pump housing therethrough.

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