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2,565,077

VARIABLE VOLUME ROTARY PUMP

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Fig. 1.

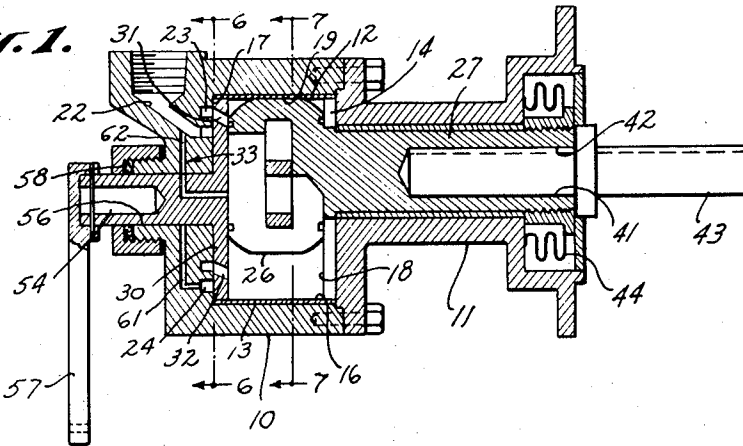


Fig. 2.

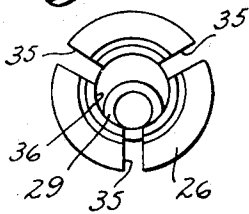


Fig. 3.

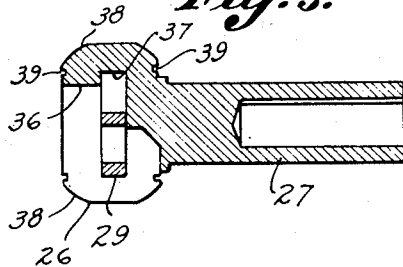


Fig. 4. Fig. 5.

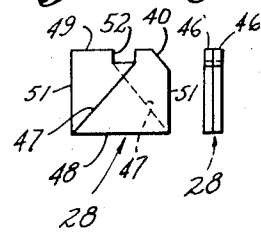


Fig. 6.

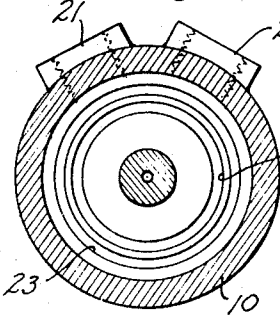


Fig. 7.

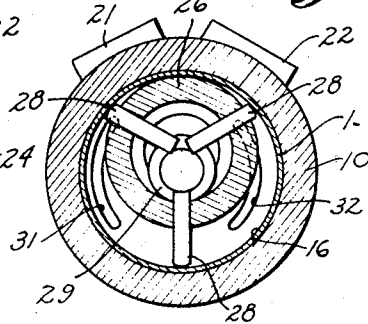


Fig. 8.

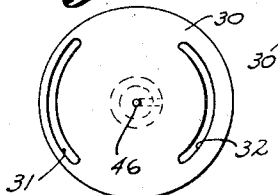
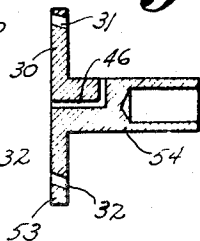


Fig. 9.



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VARIABLE VOLUME ROTARY PUMP

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10 Claims. (Cl. 103—3)

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My invention relates to rotary pumps, and a primary object thereof is the provision of a variable volume rotary pump including simple and effective means for varying the delivery rate of fluid therefrom.

Another object of my invention is the provision of a variable volume rotary pump including a rotatable ported member for varying the delivery rate thereof.

I contemplate a pump which includes a housing having a pumping chamber therein and which includes an eccentrically mounted rotor disposed in the chamber, the rotor including radially movable blades which are adapted for engagement with the peripheral wall and the end walls of the chamber. Another object of my invention is to provide a pump wherein the housing is provided with inlet and outlet ports therein and wherein an end wall of the chamber is provided with annular grooves therein which communicate with the inlet and outlet ports in the housing. A related object is to provide a pump wherein the ported member is disposed in the chamber and is provided with inlet and outlet ports therethrough which communicate with the chamber and with the annular grooves in the end wall of the chamber, the ported member being rotatable to vary the positions of the inlet and outlet ports therethrough relative to the rotor to vary the delivery rate of the pump.

Another object of my invention is the provision of a pump wherein the direction of fluid flow therethrough may be reversed by rotating the ported member through 180°. A related object is the provision of a pump wherein the delivery rate thereof may be varied from zero to full output by rotating the ported member.

Still another object is to provide a pump wherein the pressure of the fluid discharged therefrom is employed to urge the blades of the rotor outwardly into engagement with the peripheral wall of the chamber, thereby compensating for wear and differential thermal expansion and permitting the pump to operate efficiently at low rotational speeds. A related object is to provide resilient means for urging the blades outwardly, thereby permitting the pump to operate efficiently at low speeds and pressures.

A further object is the provision of blades for the rotor which are adapted to engage the end walls of the pumping chamber when urged outwardly by the resilient means or by fluid acting thereon. Another object in this connection is the provision of blades having slits therein to

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define edges which are inclined with respect to the axis of rotation of the rotor so that the inclined edges cooperate to urge the sides of the blades into engagement with the end walls of the pumping chamber when the blades are urged outwardly into engagement with the peripheral wall thereof.

The foregoing and various other objects and advantages of my invention may be realized by means of the embodiment thereof which is illustrated in the accompanying drawing and is described in detail hereinafter. Referring to the drawing, which is for illustrative purposes only:

Fig. 1 is a longitudinal sectional view of a variable volume rotary pump which embodies the fundamental concepts of my invention;

Fig. 2 is an end view of a rotor which forms one component of the pump;

Fig. 3 is a longitudinal sectional view of the rotor;

Fig. 4 is an elevational view of a blade for the rotor;

Fig. 5 is an end view of the blade;

Fig. 6 is a transverse sectional view taken along the line 6—6 of Fig. 1;

Fig. 7 is a transverse sectional view taken along the line 7—7 of Fig. 1;

Fig. 8 is an end view of a ported member for varying the delivery rate of the pump; and

Fig. 9 is a longitudinal sectional view of the ported member.

Referring particularly to Fig. 1, the variable volume rotary pump includes a housing 10 having a bearing member 11 eccentrically mounted thereon, the bearing member being bolted or otherwise removably attached to the housing. The housing 10 is provided with a cylindrical recess 12 therein, the recess being provided with a liner or sleeve 13 and an end plate 14 of wear resistant material to provide a pumping chamber 16 which is defined by end walls 17 and 18 and a peripheral wall 19. The housing 10 is provided with ports 21 and 22 therein which communicate with the pumping chamber 16 and which include concentric annular grooves 23 and 24, respectively, which are formed in the end wall 17 of the chamber 16 as best shown in Fig. 6, the ports 21 and 22 being usable interchangeably as either inlet or outlet ports as will be described in detail hereinafter.

A rotor 25 is eccentrically disposed in the chamber 16 and is secured to or formed integrally with a shank 27, the shank being journaled in the bearing member 11. The rotor 25 includes a plurality of spaced, radially movable blades 28

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as best shown in Fig. 7, the blades being urged outwardly into engagement with the peripheral wall 19 of the chamber 16 by resilient means 29. A rotatable ported member 30 is disposed in the chamber 16 between the end wall 17 and the rotor 26, the ported member being provided with arcuate ports 31 and 32 therethrough which are concentric with and communicate with the annular grooves 23 and 24 in the housing 10, respectively. The delivery rate of fluid from the pump and the direction of fluid flow therethrough are determined by the position of the ports 31 and 32 through the ported member 30 relative to the rotor 26 as will be described in detail hereinafter. The housing 10 and ported member 30 are also provided with means 33 for bleeding fluid from the high pressure or outlet port of the pump into the chamber 16 for the purpose of urging the blades outwardly into engagement with the peripheral wall 19 as will be described hereinafter.

As best shown in Fig. 2, the rotor 26 is provided with a plurality of spaced, radial slots 35 which receive the blades 28, the blades being radially movable in the slots. The rotor 26 is recessed as indicated at 36 and is provided with an annular groove 37 therein at the base of the recess 36 for the resilient means 29, as best shown in Fig. 3. The rotor 26 is provided with rounded peripheral portions 38 which register with beveled portions 40 (Fig. 4) of the blades 28 to provide restricted fluid communication between the adjacent spaces included between adjacent pairs of blades when the blades are in the position indicated by the lowermost blade of Fig. 7, thereby providing some fluid carryover between the spaces when the blades are in the position indicated by the lowermost blade of Fig. 7. The end surfaces of the rotor 26 are provided with annular grooves 39 therein as best shown in Figs. 2 and 3, the grooves 39 being adapted to retain fluid therein to provide a seal between the rotor 26, the end plate 14, and the ported member 30.

As best shown in Fig. 1, the rotor shank 27 is preferably provided with a bore 41 therein which is splined as indicated at 42, the splined bore being adapted to receive a complementary driving member 43. The driving member 43 may be attached to any suitable driving means (not shown) to rotate the shank 27 and rotor 26. A seal 44 is provided at the outer end of the bearing member 11 to prevent fluid leakage between the shank 27 and bearing member, the seal 44 being of conventional construction.

As best shown in Figs. 4 and 5, the blades 28 preferably includes a plurality of relatively thin strips 46 which may be formed of a material such as metal, fiber, etc. Each strip 46 is provided with an angular slit 47 therein which is inclined at an angle with respect to the axis of rotation of the rotor 26, the slits 47 in successive strips 46 being inclined in opposite directions. When an outward force is exerted on the inner end 48 of the blade 28 to urge the outer end 49 thereof into engagement with the peripheral wall 19 of the chamber 16, the edges of the blades adjacent the slits 47 cooperate to cause the blades to expand longitudinally, thereby causing the sides 51 thereof to engage the end plate 14 and ported member 30 to provide a seal therebetween. This feature of the blades 28 permits automatic compensation for wear and for differential thermal expansion of various components of the pump. Since the slits 47 in successive strips 46 are oppositely inclined, leakage through the blades 28 is prevented.

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The inner end 48 of each blade 28 is centrally notched as indicated at 52 to receive the resilient means 29, the resilient means preferably being an annular ring of resilient material which is disposed in the annular groove 37 in the rotor 26. The ring 29 retains and is retained by the blades 28 and serves to urge the outer ends 49 of the blades into engagement with the peripheral wall 19 of the chamber 16, thereby expanding the blades longitudinally so that the sides 51 thereof engage the end wall 18 of the chamber and the ported member 30. The resilient ring 29 also serves to compensate for wear and differential expansion as previously described.

The ported member 30 includes a plate or plate member 53 having a shank 54 extending therefrom through an opening 56 in the housing 10 as best shown in Figs. 1 and 9, the plate having the arcuate ports 31 and 32 therethrough as best shown in Fig. 8. The arcuate ports 31 and 32 are concentric with and register with the annular grooves 23 and 24 in the end wall 17 of the chamber 16 as best shown in Fig. 1, and provide fluid communication between the chamber and the ports 21 and 22 in the housing 10. The shank 54 is provided with a lever or arm 57 for rotating the ported plate 53, the arm being formed integrally with or being suitably secured to the shank. A packing gland 58 is provided to prevent leakage between the shank 54 and the wall of the opening 56 therefor.

The bleeding means 33 includes a passage 59 through the ported member 30 which communicates with the chamber 16 and with the outlet port through a passage 61 or a passage 62 in the housing 10. As shown in Fig. 1, fluid communication is provided between the chamber 16 and port 22 through the passage 59 and the passage 62, the port 22 being the high pressure or outlet port in this case. If the port 21 were the outlet port, it would merely be necessary to rotate the ported member 30 until the passage 59 communicates with the port 21 through the passage 61. The high pressure fluid bled into the chamber 16 in this manner acts on the inner ends 48 of the blades 28 to urge the outer ends 49 thereof into engagement with the peripheral wall 19 of the chamber and to expand the blades as previously described. When the rotor 26 is operating at relatively high speeds, the centrifugal force applied to the blades 28 is ordinarily sufficient to urge the blades outwardly with the desired force. However, since the centrifugal force may be insufficient at lower operating speeds, the fluid pressure acting on the blades 28 cooperates with the resilient ring 33 to urge the blades outwardly into sealing engagement with the end wall 18 and peripheral wall 19 of the chamber 16 and into sealing engagement with the ported member 30 to provide efficient operation even at low operating speeds and pressures.

As best shown in Fig. 7, the volumes of the spaces included by adjacent blades 28 alternately increase and decrease as the rotor 26 rotates, the volume of the space included by any pair of adjacent blades being a maximum when the space is at the point where the rotor is farthest from the peripheral wall 19 of the chamber 16, and the volume thereof being a minimum when the space is at the point where the rotor is closest to the peripheral wall. The maximum pressure of the fluid in the space between any pair of adjacent blades is attained when the volume of the space is at its minimum value, and the minimum pressure is attained when the vol-

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ume is at its maximum value. Thus, the maximum rate of delivery of fluid by the pump in one direction may be attained by rotating the ported member 30 until the ports 31 and 32 there-
through are disposed at the points of maximum
and minimum pressure, respectively, the flow
from the pump being reversed upon rotating the
ported member through 180° whereby the ports
31 and 32 are disposed at the points of minimum
and maximum pressure, respectively. Zero out-
put may be obtained by rotating the ported
member 30 until the ports 31 and 32 are at points
of equal pressure being located at diametrically
opposite points where the rotor 26 is equidistant
from diametrically opposite portions of the pe-
ripheral wall 19 of the chamber 16. It will be
apparent that any intermediate rate of delivery
in either direction may be obtained by rotating
the ported member 30 until the ports 31 and
32 are in a suitable intermediate position.

Thus, my invention provides a variable volume rotary pump which provides a simple and effective means for varying the delivery rate of a fluid. Although I have described an embodiment of my invention which incorporates the fundamental concepts thereof, I do not intend to be limited to the specific disclosures contained herein since these concepts may be incorporated in embodiments which include various changes, modifications, and substitutions without departing from the spirit of the invention, and I hereby reserve the right to all such changes, modifications, and substitutions as properly come within the scope of my appended claims.

This application is a division of my application Serial No. 361,063, now Patent No. 2,359,558.

I claim as my invention:

1. In a rotary pump, the combination of: a housing having a chamber therein which is defined by walls, one of said walls having annular grooves therein, said housing having inlet and outlet ports therein each of which communicates with one of said annular grooves; and a rotatable ported member disposed in said chamber adjacent said one wall thereof, said ported member having inlet and outlet ports therethrough each of which communicates with said chamber and communicates with one of said annular grooves for any position of said ported member throughout a range of 360° of rotation.

2. In a rotary pump, the combination of: a housing having a chamber therein which is defined by a peripheral wall and a pair of end walls, one of said end walls having annular grooves therein, said housing having inlet and outlet ports therein each of which communicates with one of said annular grooves; a rotatable ported member disposed in said chamber adjacent said one end wall thereof, said ported member having inlet and outlet ports therethrough each of which communicates with said chamber and communicates with one of said annular grooves for any position of said ported member throughout a range of 360° of rotation; and means for rotating said ported member.

3. In a rotary pump, the combination of: a housing having a chamber therein which is defined by a peripheral wall and a pair of end walls, one of said walls having annular grooves therein, said housing having inlet and outlet ports therein each of which communicates with one of said annular grooves, and said housing having passages therein each of which communicates with one of said ports therein; and a rotatable ported member disposed in said chamber adjacent said

one wall thereof, said ported member having inlet and outlet ports therethrough each of which communicates with said chamber and communicates with one of said annular grooves for any position of said ported member throughout a range of 360° of rotation, and said ported member having a passage therethrough which communicates with said chamber and is adapted to communicate with one of said passages in said housing.

4. In a rotary pump, the combination of: a housing having a chamber therein which is defined by a peripheral wall and a pair of end walls, one of said end walls having annular grooves therein, said housing having inlet and outlet ports therein each of which communicates with one of said annular grooves, and said housing having passages therein each of which communicates with one of said ports therein; a rotatable ported member disposed in said chamber adjacent said one end wall thereof, said ported member having inlet and outlet ports therethrough each of which communicates with said chamber and communicates with one of said annular grooves for any position of said ported member throughout a range of 360° of rotation, and said ported member having a passage therethrough which communicates with said chamber and is adapted to communicate with one of said passages in said housing; means for rotating said ported member whereby said passage therethrough communicates with the said passage in said housing which communicates with said outlet port in said housing; a rotor disposed in said chamber between and engaging said rotatable member and the other of said end walls of said chamber, said rotor including radially movable blades each having an outer end engaging said peripheral wall of said chamber and each having an inner end; and means for rotating said rotor whereby fluid flows through said outlet port in said housing, through the said passage in said housing which communicates with said outlet port therein, through said passage in said ported member, and into said chamber wherein the fluid acts on said inner ends of said blades to urge said blades outwardly.

5. A rotary pump as defined in claim 4, said rotor being mounted eccentrically in said chamber whereby the volumes included between adjacent blades and said peripheral wall of said chamber are variable as said rotor rotates, rotation of said ported member varying the positions of said inlet and outlet ports therethrough relative to said rotor to vary the rate of delivery of fluid from said rotary pump.

6. In a rotary pump, the combination of: a housing having a chamber therein which is defined by a peripheral wall and a pair of end walls, one of said end walls having annular grooves therein, said housing having inlet and outlet ports therein each of which communicates with one of said annular grooves; a rotatable ported member disposed in said chamber adjacent said one end wall thereof, said ported member having inlet and outlet ports therethrough each of which communicates with said chamber and communicates with one of said annular grooves for any position of said ported member throughout a range of 360° of rotation; means for rotating said ported member; a rotor disposed in said chamber between and engaging said rotatable member and the other of said end walls of said chamber, said rotor including radially movable blades each having an outer end engaging said peripheral wall of said chamber, said rotor being mounted

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eccentrically in said chamber whereby the volumes included between adjacent blades and said peripheral wall of said chamber are variable as said rotor rotates, rotation of said ported member varying the positions of said inlet and outlet ports therethrough relative to said rotor to vary the rate of delivery of fluid from said rotary pump; and means for rotating said rotor.

7. In a device of the character described, the combination of: a housing having a chamber therein and having first and second port means therein which communicate with said chamber; a rotatable, ported member disposed in said chamber and provided with third and fourth port means therethrough which communicate with said chamber and which respectively communicate with said first and second port means for any position of said ported member throughout a range of 360° of rotation; and means for rotating said ported member.

8. In a device of the character described, the combination of: a housing having a chamber therein and having first and second port means therein which communicate with said chamber; a rotor eccentrically mounted in said chamber; a plurality of radially movable blades carried by said rotor; a rotatable ported member in said chamber and provided with third and fourth port means therethrough which communicate with said chamber and which respectively communicate with said first and second port means for any position of said ported member throughout a range of 360° of rotation; means for rotating said rotor; and means for rotating said ported member.

9. In a device of the character described, the combination of: a housing having a chamber therein which is defined by a peripheral wall

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and a pair of end walls, one said end wall having concentric, first and second annular grooves therein, and said housing having inlet and outlet ports therein each of which communicates with one of said annular grooves; a ported member in said chamber adjacent said one end wall thereof and rotatable about the axis of said annular grooves, said ported member having first and second ports therethrough which communicate with said chamber and which respectively communicate with said first and second annular grooves for any position of said ported member throughout a range of 360° of rotation; and means for rotating said ported member.

10. A device as set forth in claim 9 including a rotor eccentrically mounted in said chamber between said ported member and the other end wall of said chamber, and including a plurality of radially movable vanes carried by said rotor.

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