April 29, 1958 | C. E. ADAMS ET AL | 2,832,293

VANE PUMP

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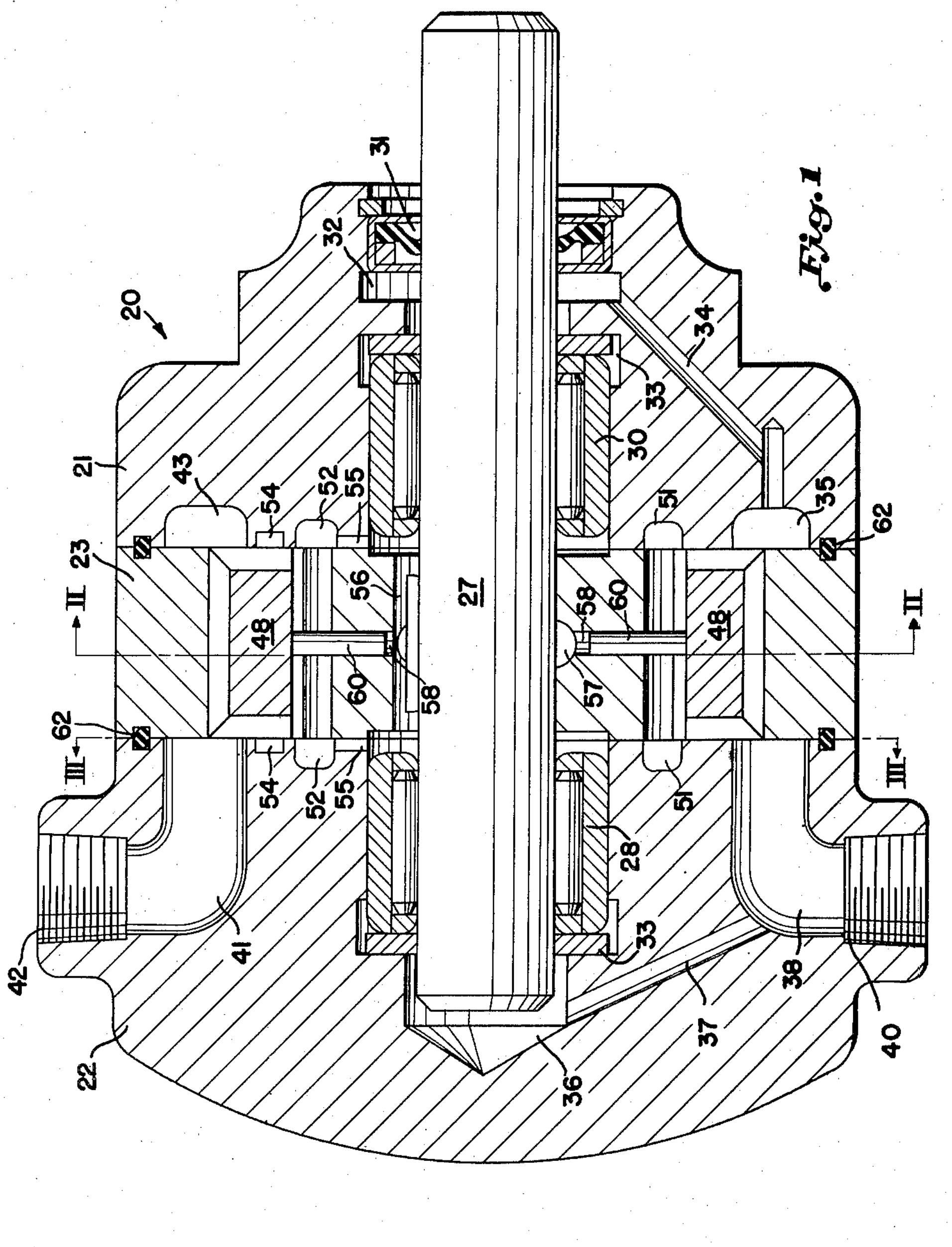

Fig. 1

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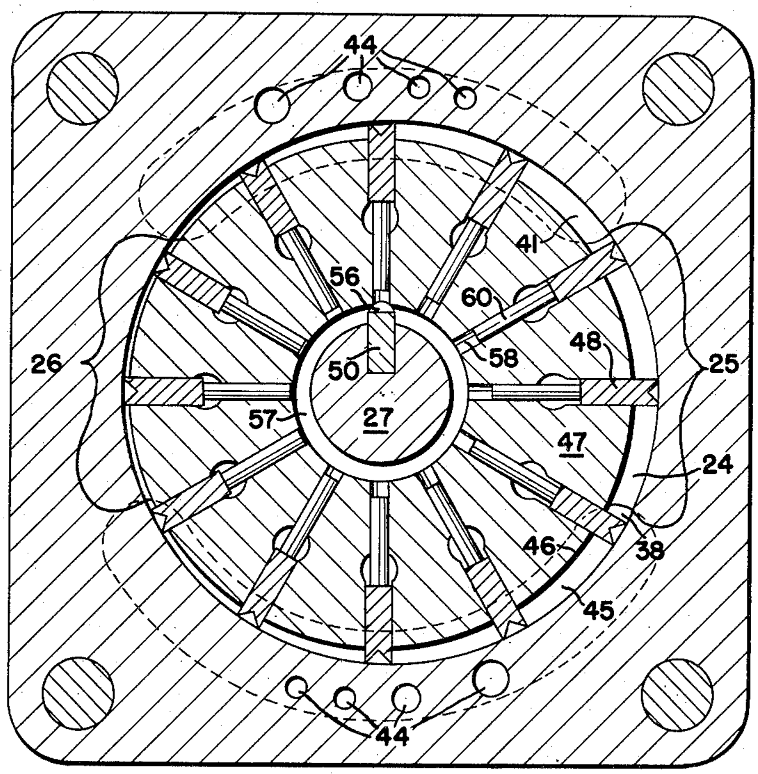

Fig. 2

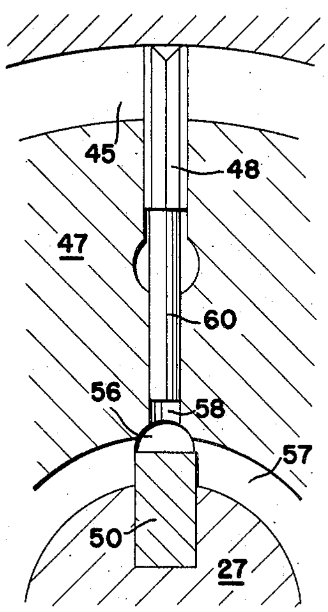

Fig. 4

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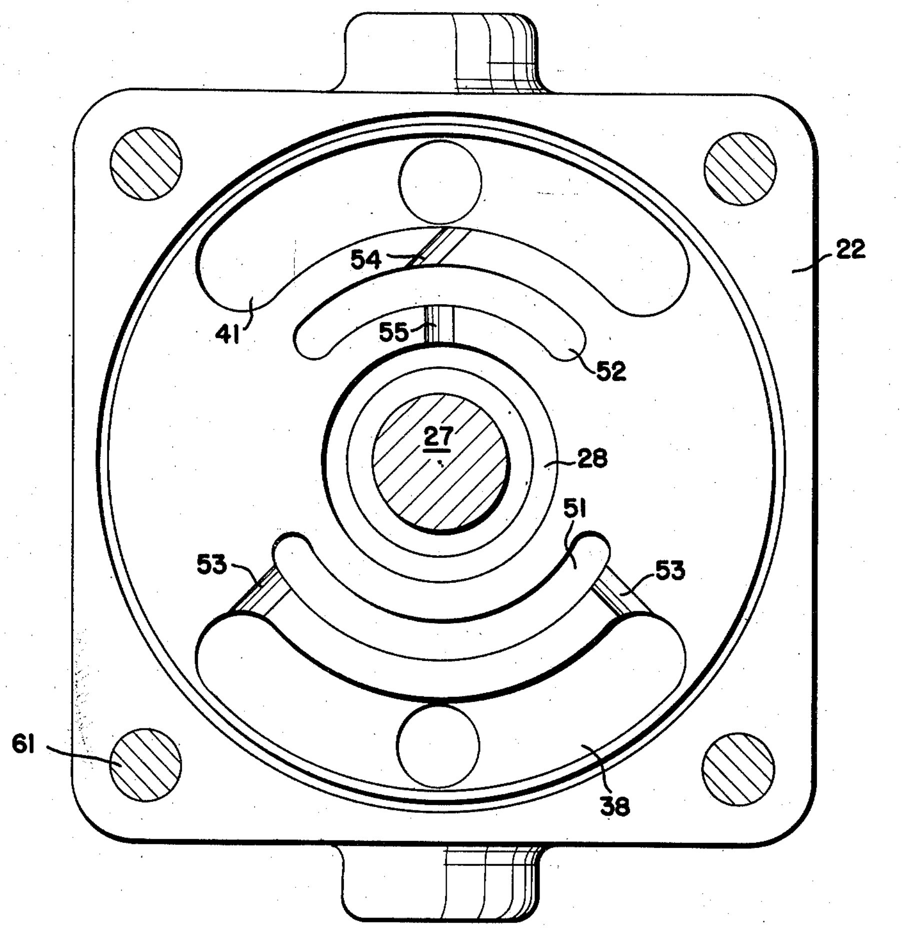

Fig. 3

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VANE PUMP

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This invention relates generally to hydraulic apparatus and is more particularly directed to fluid pressure energy translating devices frequently designated as pumps and motors. Still more particularly, the invention is directed to fluid pressure energy translating devices of the vane type.

An object of this invention is to provide a vane type pump which will be particularly suited for operation at high pressures, the pump having means for urging the vanes into contact with parts of the pump casing under low forces so that the vanes will not engage the casing to such an extent as to mar the casing but will engage the same with sufficient force to prevent the flow of fluid under pressure from one side of the vanes to the other side.

Another object of the invention is to provide a fluid pressure energy translating device having vanes of relatively great thickness, the vanes having a pair of sealing edges for engaging the casing and the pump having means for substantially balancing the fluid pressure at the radially spaced ends of the vane, means also being provided for applying a low force to the vanes to urge them toward the casing wall to effect a double seal between the fluid transfer pockets formed by the vanes and the rotor and casing walls.

A still further object of the invention is to provide a hydraulic pump having a plurality of circumferentially spaced radially extending vanes, the pump casing, the rotor and the vanes having means for conducting fluid under the same pressures to the inner and outer ends of the vanes, the rotor being provided with piston chambers under the vanes and piston pins in the piston chambers, the casing and rotor also being provided with passages for supplying fluid under pressure to the inner ends of the piston pins to cause them to apply a low force to the vanes to urge them in an outward direction.

A still further object of the invention is to provide a vane type fluid pressure energy translating device having a casing forming a rotor chamber, a rotor supported for rotation in the chamber by needle bearings carried by the casing, the casing also being provided with means for applying fluid under pressure to the needle bearings and with means for confining the fluid pressure to the regions containing the needle bearings, the casing being further provided with means for conducting fluid escaping past the confining means back to the inlet port to prevent excessive leakage from the pump.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of embodiment of the invention is clearly shown.

In the drawings:

Fig. 1 is a vertical longitudinal sectional view taken through a fluid pump formed in accordance with the present invention.

Figs. 2 and 3 are vertical transverse sectional views taken on the planes indicated by the lines II—II and III—III, respectively, of Fig. 1.

Fig. 4 is a detail sectional view taken through the pump and rotor to show the vane and piston pin construction employed in the pump.

Referring more particularly to the drawings, the numeral **20** designates the pump in its entirety. In the form of invention selected for illustration, a vane type pump of the unbalanced type has been employed. This pump includes a casing having end sections **21** and **22** and a spacer or cam section **23**. The latter section has an opening **24** extending therethrough to form a rotor chamber when the sections **21**, **22**, and **23** are assembled. An unbalanced type of pump is employed in the present illustration and its opening **24** is substantially circular although the peripheral wall of the opening includes two parts **25** and **26** which are arcuate and have different radii struck from the axis of rotation of the pump shaft. These two parts **25** and **26** are interconnected by wall parts which are arcuate and have equal radii struck from center off-set from the axis of rotation of the shaft **27**.

The casing sections **21** and **22** are provided with needle bearings **28** and **30** for rotatably supporting the shaft **27** in the casing. The section **21** has an opening for the shaft which extends completely through the section **21** so that the end of the shaft may project exteriorly of the casing to receive a pulley, a coupling or any other device for transmitting rotary motion from a prime mover to the pump. The section **21** has a sealing member **31** surrounding the shaft adjacent the outer end of the shaft opening. Between this sealing member and the needle bearing in the section **21**, the casing is provided with an annular recess **32** for collecting fluid which may flow along the shaft or seep between a sealing member **33** and the shaft or casing. A passage **34** extends from the groove **32** to another recess **35** formed in the surface of the section **21** which engages the spacer **23**.

A second sealing member **33** is provided in the section **22** to also confine fluid to the needle bearing **28** and the space around the shaft and center portion of the rotor. The section **22** has a recess **36** into which the inner end of the shaft **27** projects. This recess is connected also by a passage **37** with an inlet passage **38** formed in the section **22**, the inlet passage **38** having a threaded port **40** to which fluid is supplied from a reservoir or any other suitable source in the operation of the pump. Section **22** has a second passage **41** which constitutes an outlet passage, this passage being threaded at its outer end, as at **42**, for connection with a conduit leading to the point of use of the fluid delivered by the pump.

Section **21** has a recess **43** which registers with the passage **41**, the recess and the passage being connected by holes **44** formed in the spacer **23**. The recess **35** and passage **38** are also disposed in registration with one another and are connected by similar holes **44** formed in the spacer **23**. The recesses **35** and **43** are provided so that, in the operation of the pump, fluid will have unimpeded access to fluid transfer pockets **45** formed by the casing walls, the exterior wall **46** of a rotor **47** and vanes **48** carried by the rotor and engaging the casing walls.

The rotor **47** is keyed to the shaft **27**, as at **50**, to rotate therewith, the rotor being disposed in the opening **24** formed in the spacer **23**. The vanes **48** are of such width that they will have only a slight degree of clearance with the adjacent end faces of the sections **21** and **22**; the vanes must form a sliding seal with the faces of the sections. In the form of the invention shown, the vanes are relatively thick and have V-shaped recesses formed in the side edges and the outer end. These V-shaped recesses provide spaced sealing edges in engagement with the peripheral wall of the rotor chamber and with the side walls of such chamber, the spaced sealing edges providing a chamber at the outer end of each vane. This chamber is connected by the grooves in the side edges of the vanes with the inner ends of the slots formed in the rotor 47 to receive the vanes. These slots are precisely formed so that a close sliding fit is provided between the vanes and the rotor. By connecting the spaces at the inner and outer ends of the vanes, these members will be substantially pressure balanced, that is, the fluid pressures at the inner and outer ends will be equal and will be applied to end surfaces on the vanes which are also substantially equal; thus, when the fluid pump is exposed to fluid pressure in operation, these fluid pressures will not tend to urge the vanes in either direction.

As shown in Figs. 1 and 3, the end surfaces of the sections 21 and 22 have arcuate recesses disposed for registration with the inner ends of the vane slots in the rotor. These recesses, 51 and 52, are located adjacent and register with the inlet port 38 and outlet port 41, respectively, and extend throughout the same angle of rotation as such ports. Recess 51 is connected with the inlet port by slots 53 while recess 52 is connected with outlet port 41 by a slot 54. Recesses 51 and 52 will receive fluid at the pressures contained in the adjacent ports. The inner ends of the vane slots and the vanes will thus be exposed to the same pressures as the outer ends thereof when the vane slots register with the inlet and outlet ports. The sections 21 and 22 are further provided with grooves 55 for conducting fluid under outlet port pressure to the openings for the shaft and the needle bearings. This pressure is conducted through a groove 56 from one end to the other of the rotor, this groove 56 connecting with an annular groove 57 formed in the wall of the central opening in the rotor. The groove 57 is provided to conduct fluid under pressure to the inner ends of piston chambers formed in the rotor 47. These piston chambers extend radially from the groove 57 to the inner ends of the vane slots and slidably receive piston pins 60, these pins being employed to abut and urge the vanes, under a low force, toward the peripheral wall of the rotor chamber. In the form of the invention shown, one piston pin is provided for each vane. It is obvious that more piston pins could be employed if found desirable, also that the diameters of the piston pins could be varied from that shown when more or less force is required to urge the vanes in an outward direction. The pins selected for illustration are of a diameter less than the width of a vane and have been picked to exert a force which has been calculated to give the desired action; the size of the pins may be changed if more or less force is required to maintain the vanes in sealing engagement with the peripheral wall of the rotor chamber.

As previously pointed out, sections 25 and 26 of the peripheral wall are arcuate having their centers in the axis of rotation of the shaft 27. The sealing edges of the vanes will thus both engage the peripheral wall at these points and prevent or minimize the escape of fluid pressure from one side of the vane to the other. It is obvious that, when the vanes are adjacent the inlet and outlet ports, the pressures of these ports will exist on both sides of the vanes as well as within the recesses between the sealing edges of the vane. This pressure will also exist in the vane slots at the inner ends of the vanes since such slots register with the recesses connected with the inlet and outlet ports and the recesses at the outer ends of the vanes are also connected with the inner ends of the vane slots by the grooves in the ends of the vanes. As the vanes move across the sealing sections 25 and 26, the pressure in the space between the sealing edges of the vanes might vary due to some leakage of fluid across the sealing edges. If this pressure varies, the pressures at the inner ends of the vanes will also vary due to the connection of the inner and outer ends of the vanes through the slots formed in the side edges thereof.

The meeting faces of the sections 21 and 22 and the spacer 23 have annular grooves formed therein for the reception of sealing gaskets 62. These gaskets are compressed in these sealing grooves and serve to prevent the escape of fluid between the casing sections. The casing sections are clamped together by fastening devices 61 extending through aligned holes in the sections.

In the operation of the device as a unit, the rotor turns counter-clockwise as viewed in Fig. 2. The fluid transfer pockets increase in size during movement in the lower half of the rotor chamber, due to the eccentricity of the opening 24 relative to the rotor 46, and fluid is drawn through the inlet port 38 into the fluid transfer pockets. The continued rotation of the rotor carries the fluid in the transfer pockets across the sealing section 25 of the peripheral wall causing the transfer pockets to register with the outlet port and recess 41 and 43, respectively. As the transfer pockets continue to move, they decrease in size due to the eccentric relation of the rotor and chamber and fluid is expelled from the transfer pockets into the outlet port. Since this port is connected by groove 54, recess 52 and groove 55 with the space around the shaft, the outlet port pressure will exist in the space around the shaft and will be applied through grooves 56 and 57 to the inner ends of all of the piston pins 60.

When the apparatus is operating, pins 60 will be urged radially outwardly by fluid under pressure while the vanes 48 traverse the cam ring or opening 24 (counterclockwise as seen in Fig. 2) between the 10 and 2 o'clock positions and when said vanes travel between the 2 and 10 o'clock positions and across the outlet passage 41 they will be urged outwardly only by the centrifugal force of themselves and the pins 60. When the pins 60 are urged outwardly hydraulically they are transmitting the force of the fluid pressure to the vanes and causing the spaced sealing edges at the outer ends thereof to firmly engage the peripheral wall of the rotor chamber. Since the fluid pressures at the inner and outer ends of the vanes are substantially balanced at all times, the forces urged by the piston pins will be the only forces employed to urge the vanes in an outward direction in addition to the centrifugal force. By limiting the size of the piston pins, the force exerted thereby may also be limited. Since the force urging the vanes into engagement with the cam wall is thus restricted, the pressures developed by the pump may be increased to high values without deleterious effect.

While the form of embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adapted, all coming within the scope of the claims which follow.

We claim:

1. In a fluid pressure energy translating device, a casing having side and peripheral walls forming a rotor chamber with circumferentially spaced inlet and outlet ports; a rotor supported for rotation in said chamber; vane elements projecting from said rotor and engaging said side and peripheral walls to form fluid transfer pockets; spaced sealing edges on the parts of the vane elements engaging said side and peripheral walls, the spaced edges providing each vane with a pressure chamber at its outer end connected with the space at the inner end of the vane; a piston pin disposed in said rotor in registration with each vane element; and means for applying fluid pressure from one of said ports to the inner ends of said piston pins to urge said vanes outwardly toward said peripheral wall.

2. In a fluid pressure energy translating device, a casing having side and peripheral walls forming a rotor chamber with circumferentially spaced inlet and outlet ports; a rotor supported for rotation in said chamber; spaced substantially radially extending vanes carried by

said rotor and slidably engaging the peripheral wall of said chamber, said peripheral wall having sealing portions between said ports, said sealing portions being concentric with the axis of rotation of said rotor; spaced sealing edges on said vane elements for engaging said side and peripheral walls, the spaced sealing edges providing each vane with a pressure chamber at its outer end connected with the space at the inner end of the vane; a piston pin disposed in said rotor in registration with and at the inner end of each vane; and means for applying fluid pressure from one of said ports to the inner ends of said piston pins to urge said vanes toward said peripheral wall.

3. In a fluid pressure energy translating device, a casing having side and peripheral walls forming a rotor chamber with circumferentially spaced inlet and outlet ports; a rotor supported for rotation in said chamber; vane elements projecting from said rotor and engaging said side and peripheral walls to form fluid transfer pockets; spaced sealing edges on the parts of the vane elements engaging said side and peripheral walls, the spaced edges providing each vane with a pressure chamber at its outer end connected with the space at the inner end of the vane; a piston pin disposed in said rotor in registration with each vane element, each of said piston pins having a cross-sectional area equal to a fractional part of the area of the inner end of the vane element registering therewith; and means for applying fluid pressure from one of said ports to the inner ends of said piston pins to urge said vanes outwardly toward said peripheral wall.

4. In a fluid pressure energy translating device of the vane type, structure for hydraulically urging the vanes of said device radially outwardly at least while said vanes traverse the low pressure port of said device, said fluid pressure energy translating device including a casing having a rotor chamber and low and high pressure ports; a rotor supported for rotation in said chamber, said rotor being disposed relative to the peripheral wall of the chamber to provide a fluid transfer section between said low and high pressure ports, said rotor having substantially radially extending vane slots; vanes disposed for reciprocatory movement in said slots independently of each other, each of said vanes having sealing means on its radially outer end engaging the peripheral wall of said chamber and surface means on the radially outer end of each vane presenting a first area to hydraulic pressure which urges said vane radially inwardly in its slot; means on each of said vanes presenting a second area to hydraulic pressure for urging said vane hydraulically outwardly radially in its slot; means for supplying pressure from said high pressure port to said second area while said vane traverses said high pressure port; means presenting a third area to hydraulic pressure for urging said vane hydraulically outwardly radially in its slot; means for conducting hydraulic fluid at equal pressures to said first and second areas, and means for conducting hydraulic fluid from said high pressure port to said third area, the hydraulic forces on said third area overbalancing the hydraulic forces on said first area and urging said vane radially outwardly in its slot and against the peripheral wall of said chamber at least while said vane traverses said low pressure port.

5. In a fluid pressure energy translating device of the vane type, structure for hydraulically urging the vanes of said device radially outwardly at least while said vanes traverse the low pressure port of said device, said fluid pressure energy translating device including a casing having a rotor chamber and low and high pressure ports; a rotor supported for rotation in said chamber, said rotor being disposed relative to the peripheral wall of the chamber to provide a fluid transfer section between said low and high pressure ports, said rotor having substantially radially extending vane slots; vanes disposed for reciprocatory movement in said slots independently of each other, each of said vanes having sealing means on its radially outermost end engaging the peripheral wall of said chamber and hydraulically operated means for urging each of said vanes radially outwardly in its slot, said hydraulically operated means including surface areas on opposite ends of the vane; means for conducting pressures substantially equal to those at said low and high pressure ports to said opposite surface areas successively while said rotor and vane rotate in said chamber for at least partially balancing inward radial hydraulic thrusts on said vane; another hydraulically operated means for urging said vane radially outwardly against the peripheral wall of said chamber, and means for conducting fluid pressure from said outlet port to said other hydraulically operated means, said other hydraulically operated means urging said vane radially outwardly whenever the pressure on said opposite surface areas is less than the pressure in said outlet port.

6. In a fluid pressure energy translating device of the vane type, structure for hydraulically urging the vanes of said device radially outwardly at least while said vanes traverse the low pressure port of said device, said fluid pressure energy translating device including a casing having a rotor chamber and low and high pressure ports; a rotor supported for rotation in said chamber, said rotor being disposed relative to the peripheral wall of the chamber to provide a fluid transfer section between said low and high pressure ports, said rotor having substantially radially evtending vane slots; vanes disposed for reciprocatory movement in said slots independently of each other, each of said vanes having sealing means on its radially outermost end engaging the peripheral wall of said chamber and hydraulically operated means for urging each of said vanes radially outwardly in its slot, said hydraulically operated means presenting opposed surface areas to hydraulic fluid for causing opposite thrust forces to be applied radially to said vanes; means for conducting pressures substantially equal to those at said low and high pressure ports to said opposed surface areas successively while said rotor and vane rotate in said chamber for at least partially balancing inward radial hydraulic thrusts on said vane; another hydraulically operated means for urging said vane radially outwardly against the peripheral wall of said chamber, and means for conducting fluid pressure from said outlet port to said other hydraulically operated means, said other hydraulically operated means urging said vane radially outwardly whenever the pressure on said opposite surface areas is less than the pressure in said outlet port.

7. In a fluid pressure energy translating device of the vane type including a rotor having radial slots and a rotor chamber having low and high pressure ports, that improvement comprising vanes mounted for reciprocation in said slots and mechanism for hydraulically urging each of said vanes outwardly in its radial slot at least while each vane traverses the low pressure port of said device, each of said vanes provided at its outer end with sealing means having sealing contact with the peripheral wall of said chamber and said outer end also having a first surface presenting a surface area to hydraulic pressure for urging said vane radially inward in its slot, a second surface on each of said vanes presenting a surface area to hydraulic pressure urging said vane radially outward in its slot, means for supplying hydraulic pressure from said high pressure port to said second surface area while each of said vanes traverses said high pressure port, a third surface presenting a surface area to hydraulic pressure for urging said vane radially outward in its slot, means for conducting hydraulic fluid at equal pressures to said first and second surface areas, and means for conducting hydraulic fluid from said high pressure port to said third surface area, the hydraulic fluid supplied to said third surface area over-balancing the hydraulic pressure of said first surface area and urging said vane radially outward in its slot and against the peripheral wall of said

rotor chamber at least while said vane traverses said low pressure port.

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