Sept. 11, 1956 C. E. ADAMS ET AL 2,762,312

VANE TYPE PUMP

Filed May 17, 1951 3 Sheets-Sheet 1

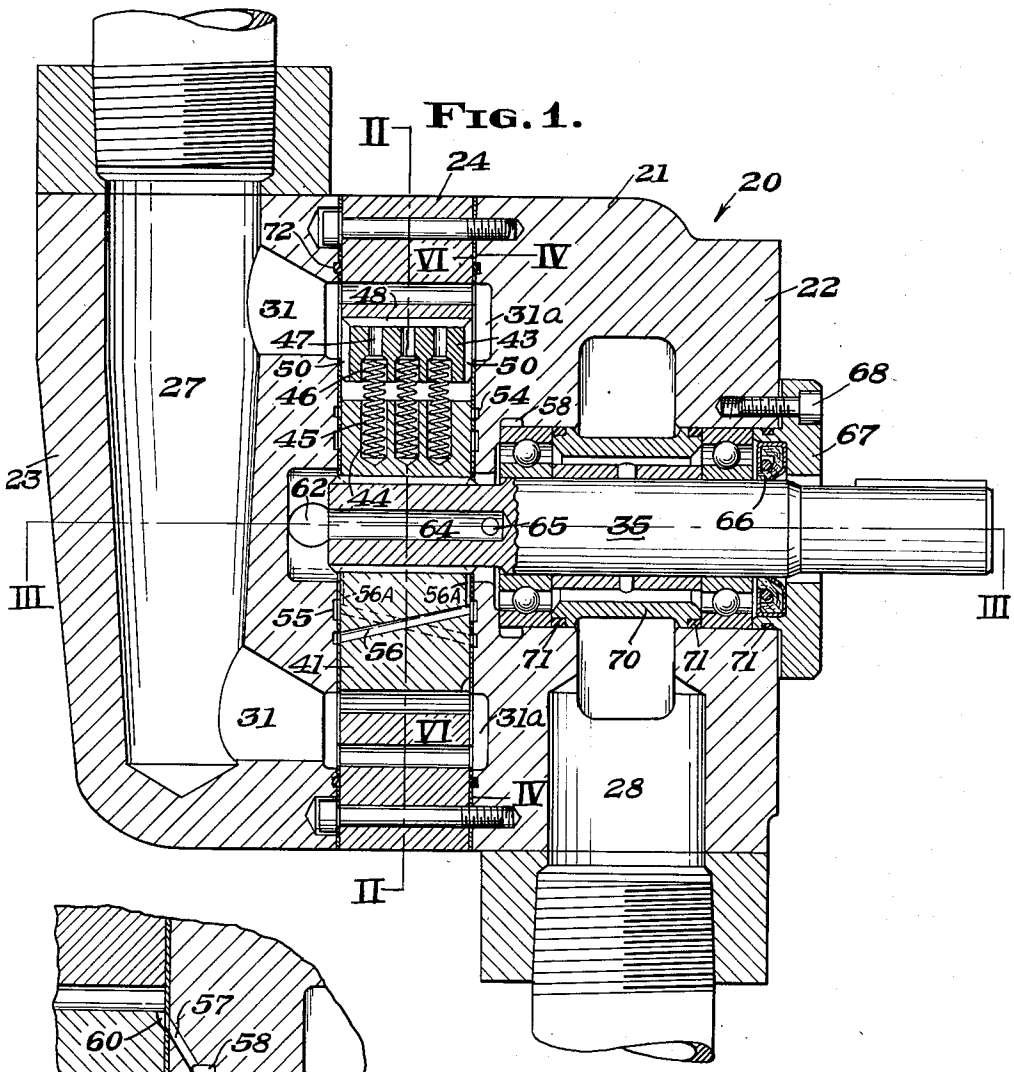


FIG. 1.

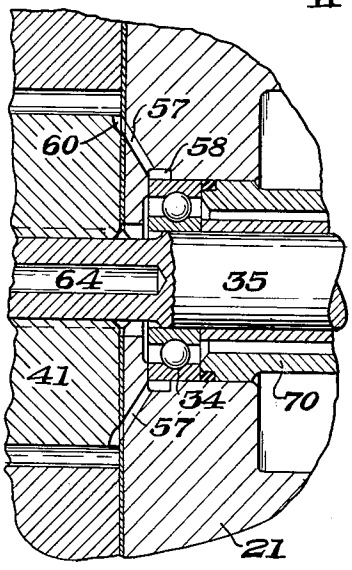


FIG. 5.

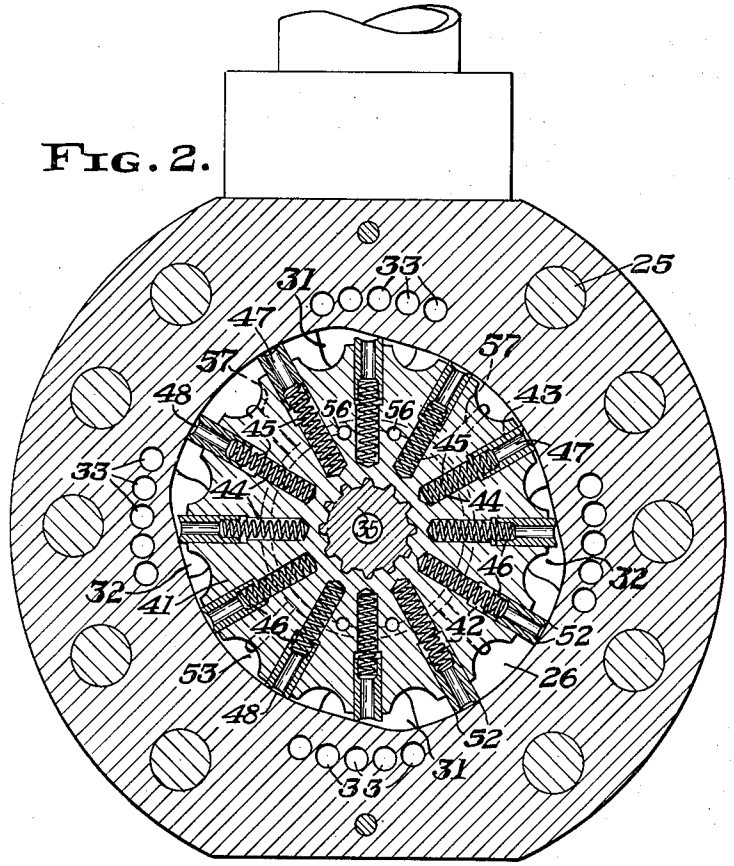
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VANE TYPE PUMP

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FIG. 2.



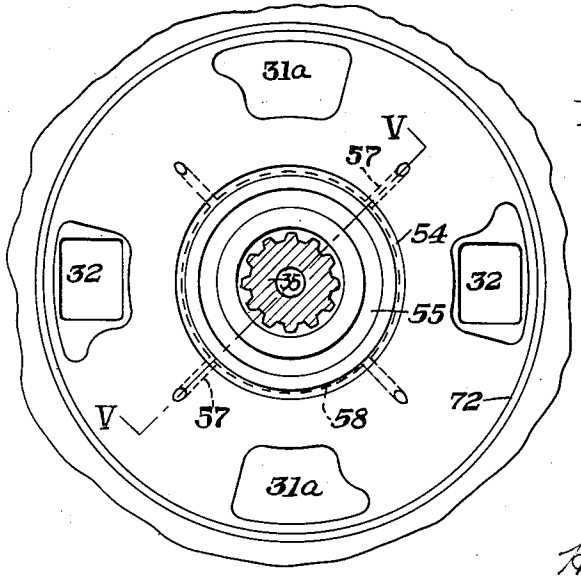


FIG. 4.

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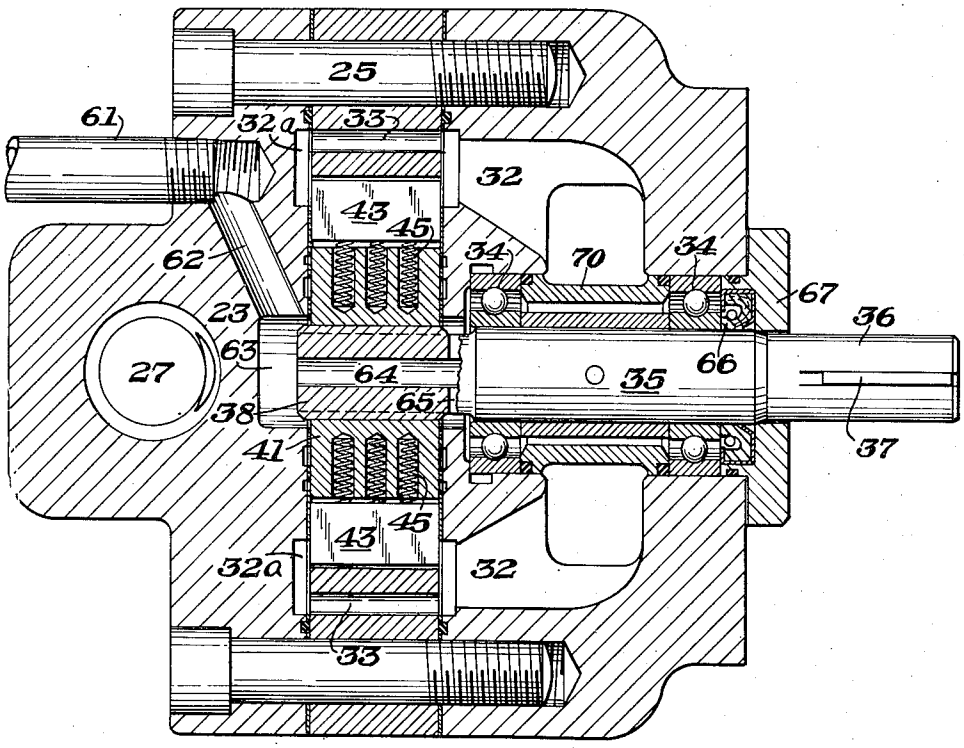
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VANE TYPE PUMP

Filed May 17, 1951 3 Sheets-Sheet 3

FIG. 3.



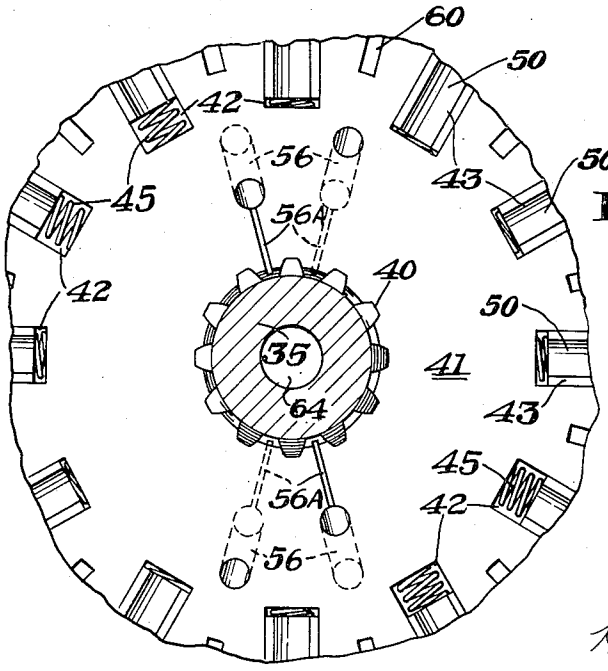


FIG. 6.

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2,762,312

VANE TYPE PUMP

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Application May 17, 1951, Serial No. 226,844

8 Claims. (Cl. 103—136)

This invention relates generally to hydraulic apparatus and is more particularly directed to an improvement in fluid pressure energy translating devices which may be used either as pumps or motors.

An object of this invention is to provide a fluid pump or motor of the vane type which will operate more efficiently than prior devices of this character and one which will give longer service with a minimum of attention.

Another object of this invention is to provide a vane type fluid pump or motor capable of generating, or being driven by fluid under relatively high pressures, the device being formed with means for creating an intermediate fluid pressure in the spaces defined by the vanes in their movement from the inlet to the exhaust port and vice versa whereby pulsation and consequent noise together with stresses on the vanes will be reduced, the life of the device thus being prolonged.

A further object of the invention is to provide a vane type fluid pump or motor having means for utilizing fluid pressure to reduce friction and consequently wear between the rotor and the casing of the device during its operation, thus increasing the efficiency of the device and lengthening its active life.

A still further object of the invention is to provide a vane type fluid pump or motor having a casing with a rotor chamber and a rotor with radial slots for receiving vanes, the latter having grooved outer edges for engaging a cam track having concentric portions of different radii connected by angular portions, the vanes also having passages extending from the grooved outer edges to the inner edges so that fluid pressures will be substantially balanced on the inner and outer ends of the vanes, springs being provided to urge the vanes outwardly into contact with the cam track surfaces, the grooved outer edges of the vanes providing two sealing engagements at each vane as it passes along the concentric portions of the cam track to decrease the leakage and to provide a valving action between the port opening and the bottom of the vanes when the vanes are moving across the angular connecting portions of the cam track.

Another object of the invention is to provide a vane type pump or motor having a casing with a rotor chamber and a rotor disposed therein, the sides of the rotor being disposed in close relationship to the sides of the chamber these members being provided with grooves and passages to prevent leakage of pressure fluid on either side from crowding the rotor against the other side.

An object also is to provide a vane type pump or motor having a casing with a rotor chamber and a rotor disposed therein, certain of the engaging side walls having leakage collecting grooves, the rotor having passages to connect predetermined grooves at opposite sides of the rotor so that pressure fluid leaking between the side walls at one side of the rotor will be conducted to the other side thereof, the grooves being of different areas in order to cause an increased force to be exerted at one side to quickly overcome the force on the other side. Since the rotor is symmetrical the end result will be the centering thereof in the rotor chamber with equal clearance on both sides.

It is also an object of the invention to provide a vane type pump having a rotor member with slots for the vanes and recesses between adjacent slots whereby increased communication area will be secured between the pockets formed by the rotor and vanes and the inlet and outlet ports when the pockets register therewith to the end that the lowest velocity of fluid flow from ports to pockets and vice versa will occur, the recesses in the rotor being so shaped that maximum support will be provided for the vanes.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings.

In the drawings:

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

Fig. 2 is a vertical transverse sectional view taken through the pump or motor on the plane indicated by the line II—II of Fig. 1.

Fig. 3 is a horizontal sectional view taken through the motor on the plane indicated by the line III—III of Fig. 1.

Fig. 4 is a fragmentary transverse sectional view taken on the plane indicated by the line IV—IV of Fig. 1.

Fig. 5 is a detail sectional view taken through the motor on the plane indicated by the line V—V of Fig. 4.

Fig. 6 is a vertical transverse sectional view taken through the device on the plane indicated by the line VI—VI of Fig. 1.

Referring more particularly to the drawings the improved vane type pump and motor is designated generally by the numeral **20**. This pump includes a casing **21** which is formed from a pair of end sections **22** and **23** and a central section **24**, these sections being bolted or otherwise secured together by members **25** to form a unitary casing having an internal rotor chamber **26**. As shown in Figs. 2 and 3, the chamber is formed primarily by the center section **24** which section is somewhat ring-like in form, the center opening, however, being substantially oval; the purpose of this shape will be apparent from the following description. The ends of this ring are closed by the end sections **22** and **23** to complete the chamber.

The sections **22** and **23** are provided as shown in Fig. 1 with inlet and outlet openings **27** and **28**, these openings each communicating with the chamber **23** at two diametrically opposite places **31** and **32**, the points of communication **31** and **32** being hereafter termed inlet and outlet ports. The inlet ports **31** extend from inlet opening **27**, while the outlet ports **32** extend from opening **28**. Ports **31** and **32** are disposed at 90° of revolution from one another. This arrangement provides alternate inlet and outlet ports spaced at 90° around the chamber **26**. Ports **31** are disposed at one end of the chamber **26** while ports **32** are disposed at the opposite end. Section **24** is provided with a plurality of openings **33** in registration with the ports **31** and **32**, these openings extending through the section **24** to establish communication between the ports **31** and **32** and recesses **31A** and **32A** formed in the other end section in registration with the ports.

Section **22** is provided with a central opening for the reception of bearing elements **34** which rotatably support a shaft **35**, one end of this shaft projecting through the chamber **26** and the other end to the exterior of the casing as at **36**. This end is provided with a key **37** to secure a pulley or other suitable element (not shown) for rotation with the shaft. The inner end **38** of the shaft is provided with splines which are received within keyways provided in a rotor body **41**, this body being substantially circular, when viewed from the end as in Fig. 2, and

having a diameter slightly less than the length of the minor axis of the oval chamber **26**.

The body **41** has a plurality of radially extending slots **42** formed therein, these slots receiving vane elements **43**. The vanes **43** closely fit the slots **42** but are movable in a radial direction therein. As shown in Figs. 1, 2 and 3, the body **41** is provided at the lower end of each slot with a plurality of sockets **44** for the reception of coil springs **45** which tend to urge the vanes in an outward direction, the springs also being received within sockets **46** formed in the vanes in registration with the sockets **44**. The vanes are further provided with passages **47** establishing communication between the inner ends of the slots **42** and the chamber at the outer periphery of the rotor body. The vanes also have grooved outer end and side edges **48** and **50**, the groove **48** being provided for a purpose which will be set forth later. It will be noted from Fig. 2 that the groove **48** in the outer edge of each vane provides such vane with spaced contact edges **52** which in certain positions of the vane engage the inner surface of the section **24** at spaced lines of contact. These edges and the groove thus provide a small chamber which is connected by the grooves **50** and ports **47** with the inner ends of the slots **42**. It will be obvious that the pressure existing in the slots **42** will also exist in the chamber formed by the groove **48** and vice versa.

Contrary to the true definition of an oval the chamber **26** has spaced portions which are truly concentric with the axis of the shaft **35** the portions of the surface at opposite sides of the inlet and the outlet ports being spaced at different distances from the axis of the shaft **35**. The portions spaced the greater distance from the axis extend between inlet and outlet ports and provide fluid transfer sections while the other concentric portions provide sealing sections; the purposes of these sections will be apparent from the following description.

It will be noted from Fig. 2 that the rotor body **41** is provided, between adjacent slots, with relieved portions **53**, these portions increasing the size of the pockets between adjacent vanes thus permitting the use of larger inlet and outlet ports whereby the velocity of the fluid flowing into and out of the pockets during the operation of the device will be materially reduced. This construction has been found desirable due to the rapid rate at which the rotor revolves during some periods of use of the motor. It also helps to prevent cavitation when the device is used as a pump. Fig. 2 shows also that when the vanes move along the angular portion of the cam surface connecting the sealing sections of the chamber and the transfer sections, the edges **52** of the vanes are alternately spaced from such surface depending upon whether the vanes are moving from the transfer section to the sealing section or vice versa.

During this time when one or the other edge is spaced from the chamber surface, which surface may be designated as a cam surface, the vanes are moving across either an inlet or an outlet port. At this time it is not necessary for the vane to provide a sealing action between adjacent pockets since fluid at the same pressure is disposed on each side of the vane.

The spacing of one or the other edge from the cam surface during the travel of a vane over the angular connecting portion is desirable and advantageous since it provides an avenue for the fluid to flow into and out of the passages leading through the vane to the inner end of the slot in the rotor. The spaced outer edges of the vanes thus serve as valves which are closed when the vanes are in engagement with the concentric portions of the cam surface and open when the vanes are in engagement with the angular connecting portions of the cam surface which causes the vanes to move in and out. As soon as the vanes reach the concentric surface of the transfer or sealing sections both edges will be engaged with the cam surface and a double seal will again be effected. At this time also the grooved outer edges of the vanes are sealed off from the pockets at either side thereof. The grooved outer edge of each vane then communicates with the inner end of the slot and the areas exposed to pressure will thus be substantially equal at the inner and outer edges of the vane except for the small portions of the vane in actual contact with the cam surface. The vanes will, therefore, be substantially balanced, being urged outwardly into engagement with the cam surface only by the force of the springs and the centrifugal force. A minimum amount of wear on the cam contacting surface will result.

It has also been found desirable to eliminate as much as possible any side thrust on the rotor which might cause the parts to wear or oppose the rotation of the rotor and thus decrease the efficiency of the device. Side thrusts may be caused by leakage of fluid under high pressure between either side of the rotor and the side wall of the adjacent end member. To counteract this tendency the end members are provided with concentric grooves **54** and **55** the first groove being the outer one which is relatively narrow and has a small area, the second being the inner groove which is wider and has a greater area. These grooves are located between the inner ends of the vane slots and the axis of rotation of the shaft so that the grooves will not directly communicate with such slots. When fluid under pressure is introduced into the inlet ports and the pockets between the vanes to effect the operation of the motor some of this fluid may tend to seep toward the axis of rotation between the side walls of the rotor and the end sections **22** and **23** at one side or the other of the rotor; this fluid will be collected by the groove **54** on that particular side before it can exert any great force to move the rotor toward the opposite side wall. Grooves **54** are connected by angularly extending passages **56** with the inner grooves **55** at the opposite sides of the rotor. Since the grooves **55** are of greater area than the grooves **54** the fluid under pressure flowing thereto will exert a greater force tending to move the rotor in the opposite direction which force will counteract the tendency of the fluid at the opposite side to move the rotor. Since the total widths of the groves at both sides are equal the rotor will be centered in the rotor chamber and the least amount of leakage between the rotor and the chamber walls will be encountered.

From Figs. 1 and 6 it will be noted that slots **56A** of reduced width extend from the inner grooves **55**, or the adjacent ends of the angular passages **56**, to the space surrounding the shaft **35** which is connected, as will hereinafter be set forth, with exhaust. The slots **56A** provide for the drainage of fluid that leaks past the rotor and is collected by the grooves **54** and **55**. These slots are relatively narrow so that they will not interfere with the primary purpose of the grooves **54** and **55**, i. e., of centering, by the force of fluid pressure leakage, the rotor in its chamber.

It has been found that pulsation of discharge, shock of operation and consequent wear may be reduced by equalizing the pressure in the pockets between the vanes as these pockets move from one port to another. This operation is performed by connecting all of the pockets located midway between adjacent inlet and outlet ports. From Fig. 2 it will be observed that when the pockets are located at these points the vanes at either side of the pockets completely seal the pockets from the inlet and outlet ports. It will also be noted that since there are four ports, four pockets will be sealed from such ports at the same time. One end member is provided with angularly directed passages **57** as disclosed in Figs. 4 and 5 which connect chamber **26** with a groove **58**, this groove being formed in the member **22** around the opening for the inner bearing **34**. This bearing serves to complete the groove into an annular passage. With this construction the annular passage **58** is connected with the chamber as shown in Fig. 4, at four points spaced 90° apart, which points are disposed midway

between outlet ports 32 and recesses 31A which are connected with the inlet ports 31. As shown in Figs. 5 and 6 the rotor has inwardly extending radial slots 60 at the inner edges of the relieved portions 53. It will be obvious that when the rotor is disposed as in Fig. 2 the pockets in the transfer sections will be connected with the pockets in the sealing sections, through the slots 60 and passages 57 and 58. As the pockets move from the inlet port to the position shown in Fig. 2 in the transfer section they will carry fluid at the inlet port pressure, this pressure will be dissipated through passages 57 to the annular passage 58 and from this passage through other passages 57 to the pockets in the sealing section which have immediately before been in communication with the exhaust ports. The fluid pressure in the four pockets thus connected will be equalized when such pockets communicate with the next port, either an inlet or outlet port, the pressure differential between the fluid in the port and that in the pocket will be just half of the pressure differential between the inlet and outlet ports. The shock of connecting regions containing fluid under different pressures will thus be reduced. By the reduction in shock consequent wear and noise will also be reduced and the life of the device will be prolonged. The pulsation of fluid discharged will also be materially lessened.

Fluid leaking into the space around the shaft 35 is conducted to the reservoir or tank of the hydraulic system through a drain connection 61, this connection communicating through an angular passage 62 with a central opening 63 formed in end section 23, this central opening communicating with the chamber 26 through a central passage 64 and lateral passage 65 in the shaft 35, with the opening provided in section 22 for the bearings 34. The open outer end of this bearing-receiving opening is sealed by a shaft seal 66 which is held in place by a cap 67, this cap being secured to the section 22 by screws 68. A spacing and sealing sleeve 70 is disposed between the bearing members 34 to separate the outlet port 28 from the portion of the opening for the bearings 34 containing fluid at tank pressure. Suitable seals 71 are provided around the member 70 and cap 67 to prevent leakage. Other seals 72 are disposed between the sections 22, 23 and 24 for a similar purpose. In the form of the invention shown, the end walls of the rotor chamber are lined with bronze or other bearing mtaerial to provide a better bearing surface.

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 adopted, all coming within the scope of the claims which follow:

We claim:

1. A fluid pressure energy translating device comprising a casing defining a rotor chamber having a plurality of alternately arranged fluid transfer and sealing sections with peripheral wall surfaces spaced different distances from the axis of said chamber, said casing having inlet and exhaust ports communicating with said chamber at opposite ends of said transfer sections; a rotor disposed for rotation in said chamber; vane elements spaced circumferentially around said rotor and movable radially therein to continuously engage said peripheral wall surfaces, adjacent vane elements cooperating with wall surfaces of said chamber to provide a plurality of pockets operative upon rotation of said rotor to transfer fluid from said inlet to said exhaust ports; and passage means in said casing establishing communication between all of said pockets disposed at points midway between the ends of each of said transfer and sealing sections as the rotor revolves, said rotor interrupting such communication immediately following the movement of said pockets beyond said midpoints.

2. A fluid pressure energy translating device comprising a casing defining a rotor chamber having a plurality of alternately arranged fluid transfer and sealing sections

with vane engaging peripheral wall surfaces spaced at different distances from the axis of said chamber, said casing having inlet ports communicating with said chamber at corresponding ends of said transfer sections and exhaust ports communicating with said chamber at the opposite ends of said transfer sections; intercommunicating passages formed in said casing, said passages terminating in pressure equalizing ports disposed in communication with said chamber at the points disposed midway of the length of each of said transfer and sealing sections; a rotor disposed for rotation in said chamber; and vane elements spaced circumferentially around said rotor and movable radially therein to continuously engage said peripheral wall surfaces, adjacent vane elements cooperating with the vane engaging wall surfaces of said chamber to form fluid receiving pockets operative to transfer fluid from said inlet to said exhaust ports, each of said pockets communicating with a pressure equalizing port as it moves across the fluid transfer and sealing sections, said equalizing ports being disposed to communicate with each of said pockets as the latter rotate past them and to be closed by said rotor as the pockets move beyond the midpoints of said transfer and sealing sections.

3. A fluid pressure energy translating device comprising a casing provided with a rotor chamber having spaced side walls and a vane-engaging peripheral wall with fluid transfer and sealing sections alternately arranged and spaced different distances from the axis of said chamber, said casing having inlet ports communicating with the chamber at corresponding ends of said transfer sections and exhaust ports communicating with said chamber at the other ends of said transfer sections; a rotor disposed for rotation in said chamber, the sides of said rotor having a bearing engagement with the adjacent walls of said rotor chamber, said adjacent chamber walls each being provided with leakage-collecting grooves entirely covered by said rotor and being of different areas; passages extending transversely of said rotor to establish communication between grooves of different areas on opposite sides of said chamber, and vane elements spaced circumferentially around said rotor and movable radially therein to continuously engage the peripheral wall of said chamber, adjacent vanes cooperating with said rotor and casing to form pockets operative to transfer fluid from said inlet to said exhaust ports during rotation of said rotor.

4. A fluid pressure energy translating device comprising a casing provided with a rotor chamber having spaced side walls and a vane-engaging peripheral wall with fluid transfer and sealing sections alternately arranged and spaced different distances from the axis of said chamber, said casing having inlet ports communicating with the chamber at corresponding ends of said transfer sections and exhaust ports communicating with said chamber at the other ends of said transfer sections; a rotor disposed for rotation in said chamber, the sides of said rotor having a bearing engagement with the adjacent walls of said rotor chamber, said adjacent chamber walls each being provided with an outer circular leakage-collecting groove and an inner circular leakage-collecting groove having a greater area than the first-mentioned groove, both of said grooves being entirely covered by said rotor; passages extending transversely of said rotor to establish communication between the inner and outer grooves at opposite sides of said chamber, and vane elements spaced circumferentially around said rotor and movable radially therein to continuously engage the peripheral wall of said chamber, adjacent vanes cooperating with said rotor and casing to form pockets operative to transfer fluid from said inlet to said exhaust ports during rotation of said rotor.

5. A fluid pressure energy translating device comprising a casing provided with a rotor chamber having spaced side walls and a vane-engaging peripheral wall with fluid

transfer and sealing sections alternately arranged and spaced different distances from the axis of said chamber, said casing having inlet ports communicating with the chamber at corresponding ends of said transfer sections and exhaust ports communicating with the chamber at the other ends of said transfer sections; a rotor disposed for rotation in said chamber, said rotor being provided with radially extending transverse vane-receiving slots, the sides of said rotor having a bearing engagement with the adjacent side walls of said rotor chamber, said side walls being provided with concentric circular leakage-collecting grooves of different areas, the radius of the largest diameter groove being less than the distance from the axis of said rotor to the inner ends of the vane slots therein; passages in said rotor to establish communication between grooves of different areas on opposite sides of said rotor chamber, and vane elements disposed for radial movement in the slots in said rotor to continuously engage the peripheral wall of said rotor chamber, adjacent vanes cooperating with said rotor and casing to form pockets operative to transfer fluid from said inlet to said exhaust ports during rotation of said rotor.

6. In a fluid pressure energy translating device, a casing having a rotor chamber and inlet and outlet ports; a rotor disposed for rotation in said chamber, portions of the periphery of said rotor being spaced from the adjacent casing wall to provide fluid pressure receiving sections, the side walls of said rotor being in sliding engagement with the side walls of said chamber; vane elements disposed in said rotor for radial movement to continuously engage the walls of said rotor chamber, adjacent vane elements cooperating with said rotor and casing to provide pockets operative to transfer fluid between said inlet and outlet ports during rotation of said rotor; centering means for said rotor having a circular leakage-collecting groove at each side of said rotor between the periphery of said rotor and the axis thereof; a second circular leakage-collecting groove of greater area than the first-mentioned groove and between the same and the axis of said rotor, said grooves being entirely covered by said rotor; and passage means establishing communication between the outer groove on either side and the inner groove on the opposite side.

7. In a fluid pressure energy translating device, a casing having a rotor chamber with inlet and outlet ports and a drain passage leading therefrom; a rotor disposed for rotation in said chamber, portions of the periphery of said rotor being spaced from the adjacent casing wall to provide fluid pressure receiving sections in communication with said inlet and outlet ports, the side walls of said rotor being in sliding engagement with the side walls of said chamber; vane elements disposed for radial movement in said rotor to continuously engage the peripheral wall of said rotor chamber and form pockets to transfer fluid from said inlet to said outlet ports during rotary movement of said rotor; fluid pressure centering means

for said rotor having concentric leakage-collecting grooves at each side of said rotor between the periphery and the axis of rotation thereof entirely covered by said rotor, the inner-most groove having a greater area than the outer groove, passage means establishing communication between the outer groove on either side and the inner groove on the opposite side of said rotor; and additional passage means establishing limited communication between the inner-most groove and the drain passage leading from the rotor chamber.

8. A fluid pressure energy translating device comprising a casing defining a rotor chamber having a plurality of alternately arranged fluid transfer and sealing sections with wall surfaces spaced different distances from the axis of said chamber, said casing having inlet and exhaust ports communicating with said chamber at opposite ends of said transfer sections; a rotor disposed for rotation in said chamber; vane elements spaced circumferentially around said rotor and movable radially therein, adjacent vane elements cooperating with wall surfaces of said chamber to provide pockets operative to transfer fluid from said inlet to said exhaust ports during rotary movement of said rotor; port means in a side wall of said casing at points disposed midway of the length of each of said transfer and sealing sections and communicating with each of said pockets as the latter rotate past said port means; passage means establishing communication between all of said port means, said communicating port means serving to equalize the pressures in all of the pockets disposed midway of the length of the transfer and sealing sections as the rotor revolves, the said equalizing ports being disposed to be closed by the rotor before the pockets communicate with the inlet and exhaust ports.

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