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ROTARY PISTON ACTION PUMPS

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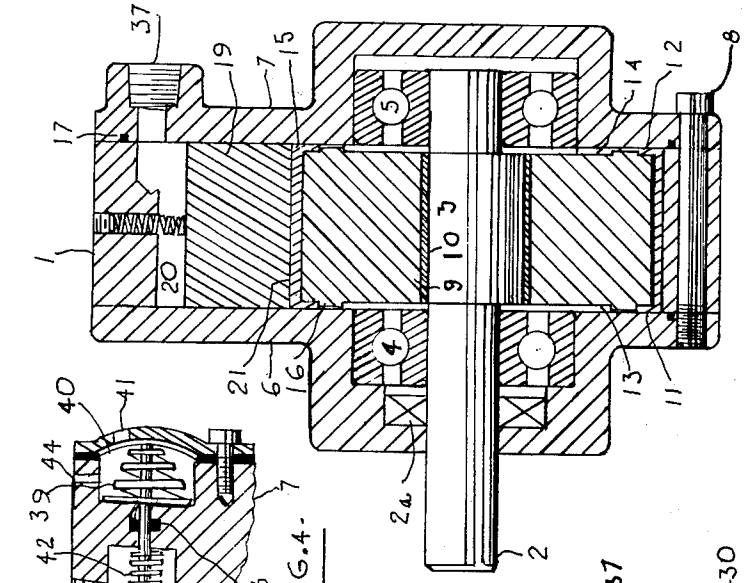


FIG. 2.

FIG. 4.

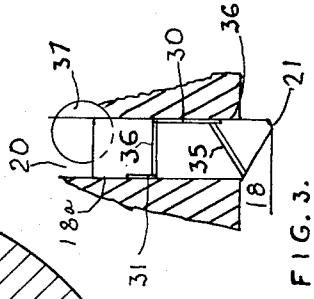


FIG. 3.

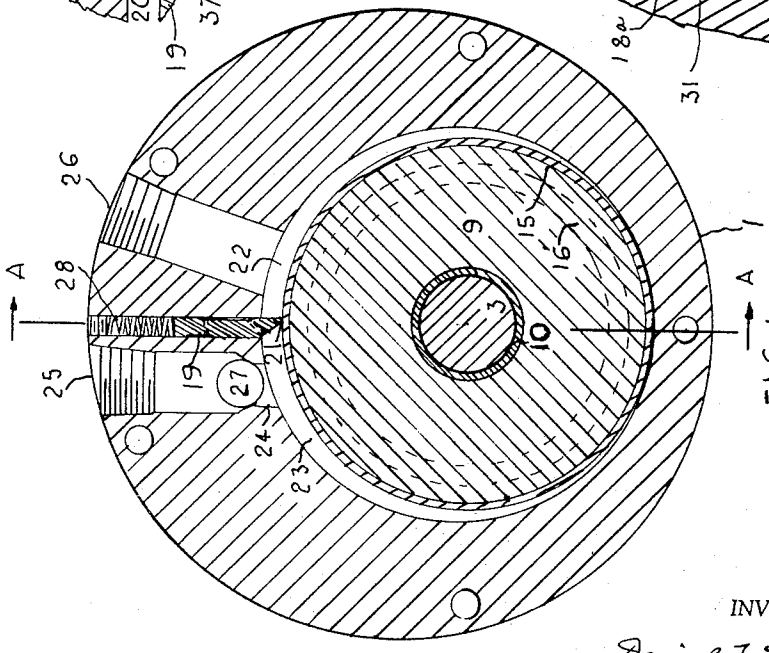


FIG. 1.

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ROTARY PISTON ACTION PUMPS

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This invention relates to rotary piston action pumps, motors, vacuum units and air compressors that will operate with various types of liquids and gases at very high efficiency.

A feature of this invention is that there are only four moving parts including the discharge check valve.

Another feature of this invention is that the velocity of the parts of the pump are reduced to such slow movement relative to that of the operating shaft that the friction and wear is practically nil.

Another feature of this invention is that a rotor is mounted to rotate eccentrically within a circular housing. A second rotor is floatingly mounted to rotate on the eccentric rotor, forming a sealing and rolling contact on the inner wall of the pump housing. When the pump shaft is rotated the second rotor rolls around on the inner wall of the housing, rotating in the opposite direction to that of the pump shaft. The relative speed of rotation between the second rotor and that of the pump shaft depends upon the length of the vane stroke and the diameter of the second rotor relative to the diameter of the pump housing.

Another feature of this invention is that the reciprocating vane is mounted in the housing bearing on the second rotor forming intake and discharge chambers with the second rotor sliding over the end of the vane, per revolution of the pump shaft, only equaling the difference in the circumference of the inner wall of the housing and that of the second rotor.

Another feature of this invention is that the pressure transverse loading on the vane is hydraulically balanced out preventing a sliding friction loading against the normal fulcrum point on the low pressure side of the vane slot wall and between the lever arm on the high pressure side of the outer end of the vane and the vane slot wall, preventing a rocking action of the vane from wearing the vane slot wall at these points.

Another feature of this invention is that by floatingly mounting the second rotor on a bearing between face plates preventing transfer of axial thrust from the pump shaft to the second rotor, thereby, making it impossible to hydraulically unbalance the rotor axially.

Another feature of this invention is that the sealing pressure of the vane on the rotor is controlled by the difference in areas exposed to fluid pressure on the outer and inner end of the vane and more particularly by counter-balancing the pressure transverse loading of the vane on the vane slot fulcrum point, permitting the vane to move up and down with little or no friction.

Another feature of this invention is that with the second rotor rolling on the pump housing wall the pressure transverse loading on the rotor is carried by the pump housing wall, thereby, increasing the life of the shaft bearings.

Another feature of this invention is that the problem of cold starts is eliminated by the lack of friction caused by high velocities and unbalanced parts, when using an all metal rotor that rotates with the shaft.

Another feature of this invention is that the cold start problem is eliminated by the lack of friction caused by close fits due to increased oil viscosity, by the flexibility of the rubber mounting on the second rotor.

Another feature of this invention is that by the very slow rotation of the second rotor and the short distance the rotor slides over the end of the vane the friction will be practically nil, permitting the pump to run indefinitely without servicing.

Another feature of this invention is that by using flexible material on the circumference of the second rotor, such as rubber or synthetic rubber, as the rotor rolls on the inner wall of the pump housing, small grit in the fluid will imbed into the flexible material as the rotor rolls over it without damage to either the rotor or the pump housing wall and release itself to be carried out with the pump discharge by the next revolution of the operating shaft.

Another feature is that a second rotor and end plate between the rotors may be mounted in tandem with the valve, vane and ports at 180 degrees from the first rotor, vane, valve and ports to produce a constant fluid flow.

Another feature of this invention is that a flexible material, such as rubber or synthetic rubber, bonded and vulcanized on the rotor preventing the rubber from rolling and creeping and forms a perfect seal between the rotor, pump housing, end plates and vane permitting the bearings to be grease packed.

Another feature of this invention because of its simplicity the manufacturing cost will be much less than that of other pumps.

Further objects and features of my invention will be more clearly understood by reference to the following detail description of the accompanying drawings, in which:

FIGURE 1 is a cross section taken through the center of the pump.

FIGURE 2 is a longitudinal section taken on line A—A in FIG. 1.

FIGURE 3 is an enlarged vane showing means of counter-balancing the pressure transverse loading.

FIGURE 4 is a cross sectional view of a portion of end plate 7 showing means of automatically cutting out the pump at a prescribed pressure.

In FIGURES 1 and 2 in the drawings numeral **1** represents the pump housing with **2** the shaft and **3** the eccentric rotor formed as part of shaft **2**. A suitable seal **2***a* is provided for shaft **2**. End plates **6** and **7** are bolted to housing **1** by bolts **8** with suitable seals at **17** provided. A second rotor **9** is floatingly mounted on bearing **10** on eccentric rotor **3** between end plates **6** and **7** permitting axial movement of shaft **2** and eccentric rotor **3** without effecting the axial movement of rotor **9**.

A flexible material **15**, such as rubber or synthetic rubber, is bonded and vulcanized on the circumference of rotor **9** and overlapping on the ends of the rotor at **11** and **12** forming a wiping up and down sealing surface between rotor **9** and end plates **6** and **7**, for only the length of the vane stroke. The wiping action will be like a squeegee not permitting the grit to pass between the rubber and the end plates as the fluid pressure will hold the rubber tight against the end plates and also prevent leaks into bearings **4**, **5** and **10**.

Bearings **4**, **5** and **10** may be grease packed, which also will form a lubricant for the inner edges of the rubber, at contacts **11** and **12**, as the rotor moves up and down forming the pulsating pumping action. Seal **2***a* around shaft **2** will prevent the grease from leaking out, or dirt from entering to the bearings.

Rotor **9** with rubber vulcanized on its circumference should be from .010 to .020 oversize so that rotor **9** will roll on the inner wall of pump housing **1** and comprress the rubber from .005 to .010 forming a perfect seal and cause rotor **9** to roll in the opposite direction of rotation to that of shaft **2** and eccentric rotor **3**. 50 to 60 hardness of the rubber should be satisfactory but experience will tell for different operating conditions.

The relative speed of rotation of rotor **9** to that of shaft **2** and eccentric rotor **3** is determined by the difference in diameters of rotor **9** and the inner wall of housing **1**.

Any grit in the fluid being pumped that does not flush out with the fluid will not scratch the pump housing as it will compress into rubber **15** without damage to the rotor

or housing and be picked up by the next shaft revolution to discharge it out through port **25**. Under some working conditions it may be advisable to make ball check valve **27** of rubber so that a perfect seal will always be made.

Vane **19** is mounted in vane slot **20** and bears on rotor **9** at contact **21** forming intake chamber **22** and discharge chamber **23**. Intake port **26** leads to intake chamber **22** and discharges through port **24**, which leads from pressure chamber **23** when ball check valve **27** is forced open, to discharge port **25**. Vane **19** is held to bear against rotor **9** by light spring **28**, so that the vane will be held against rotor **9** on contact **21** when the pump is started, or when pumping with no discharge pressure.

Working fluid pressure is applied to the top of vane **19** in vane slot **20** through port **37** to aid spring **28** and hydraulically operate the vane at high speeds of the pump shaft.

In pumps where it is possible to filter out the grit rotor **9** may be made of all metal by mounting bearing **10** with additional running clearance permitting the transverse pressure loading on the rotor to hold rotor **9** against the inner wall of housing **1** causing it to roll on the inner wall of the housing in the opposite direction of rotation relative to that of operating shaft **2**, relieving the transverse loading on the rotor from bearings **4** and **5**, thereby, permitting the pump to run much longer without servicing.

The fact that rotor **9** rotates very slowly and that the only sliding action of the rotor over the vane is equal to the difference of the circumference of the inner wall of the pump housing to that of the rotor for each shaft revolution, as the rotor passes from one side of the pump to the other with the vane fully extended, the heat and wear generated will be practically nil.

There will never be any trouble of cold starts even with rubber **15** fitting flush against end plates **6** and **7** because of the lack of velocity and the flexibility of the rubber flanges **16** on rotor **9** provide enough clearance to prevent a metal to metal contact but close enough to support rubber **15** at contacts **11** and **12**.

In FIG. 3 an enlarged vane is shown pointing to the means of hydraulically balancing out the pressure transverse loading on vane **19**. Transverse pressure loading is against exposed area **18** crowding vane **19** against fulcrum point **36** on the low pressure side of the vane slot wall **20** and reacting on lever arm **18***a* at the outer end of the vane on the high pressure side of vane slot **20** wall. This tends to cause a rocking action of the vane wearing the vane slot wall at fulcrum point **36** and at the lever arm contact **18***a* on the opposite side of the vane slot wall. Just a few thousandth of an inch recess formed across the vane at **30** on the low pressure side of the vane and at **31** on the high pressure side of the vane to apply the working pressure is sufficient. Ports **35** leading from pressure chamber **23** to recess **30** and port **36** from recess **30** to recess **31**. These ports may be drilled, or grooved across both edges of the vane as shown thereby, supplying lubrication to the edges of the vane.

The top of vane **19** is subject to working pressure in vane slot **20** tending to hold the vane against rotor **9** with area **18** in pressure chamber **23** tending to lift the vane off its seat at contact **21**. The difference in area forces on the opposite ends of the vane controls the holding sealing force of vane **19** on rotor **9**.

With the sum of areas **18** and **31** being equal to area **30** it will completely balance out the transverse loading permitting the vane to float in vane slot **20** with little or no wear on the vane slot walls. For some low pressure installations recess **31** could be omitted and recess **30** will hold the vane against the high pressure side of the vane slot wall with but little wear. The fluid pressure in the top of vane slot **20** should not enter recess **30** or **31**, or there would be a loss in efficiency at the low pressure stage in chamber **23**.

In FIG. 4 means are shown to cut out the pump above a prescribed pressure, which may be an advantage for some installations. End plate **7** is provided with valve **38** to close port **37***a* to vane slot **20**. While the pump is operating valve **38** is held open by spring **39** in diaphragm **40** with the working pressure connected to the top of vane slot **20** through port **37**. When pressure is allowed to enter port **41** to diaphragm **40** it compresses spring **39** closing valve **38** cutting off the fluid pressure from port **37**. Valve **38** is floatingly mounted on rod **38***a*. Should valve **38** be closed when vane **19** is extended rotor **9** will force vane **19** back into vane slot **20** by compressing spring **42** and when the fluid in vane slot **20** has been discharged valve **38** will be closed by spring **42**. As spring **28** tends to force vane **19** to follow the rotor a vacuum will be formed in vane slot **20** preventing it from following the rotor, thereby, permitting the pump to run completely unloaded. As fluid pressure is released from diaphragm **40** valve **38** will be opened by spring **39** placing the pump back in operation. A suitable seal **43** will prevent fluid from passing in either direction. Vent **44** leads from diaphragm **40** to permit operation of the diaphragm.

Having described the disclosed invention as being the preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

I claim:

1. In a machine comprising a housing, end plates, inlet and outlet ports, a check valve in one of said ports, a rotor mounted for rotation in said housing having a sealing contact between said end plates and a line sealing contact on the peripheral wall of said housing as said rotor rotates, a vane mounted to reciprocate from an open end of a vane slot in said housing having a sealing contact with said end plates and said rotor, means reciprocating said vane from said open end of said vane slot through a clearance between said housing and said rotor holding its inner end in said sealing contact with said rotor as it rotates forming on opposite sides of said vane low inlet and high pressure fluid chambers, a relief on said vane starting from said sealing contact with said rotor to the full length of said vane stroke on said high pressure side exposing said relief area to said high fluid pressure providing a uniform transverse high pressure throughout its inward and outward movement, a recess on said vane near its outer end at the closed end of said vane slot on said high pressure side, a recess on said vane on said low pressure side of said vane beginning at near the fulcrum point at said open end of said vane slot wall opposite said transverse high pressure loading side when said vane is fully extended to the length of said vane stroke, ports from said high pressure side of said vane leading to said recesses, recess area on said vane on said low pressure side of said vane equaling the area of said recess on said vane on said high pressure side and said vane plus said relief area on said vane exposed to said high fluid pressure hydraulically floating said vane in said vane slot by balancing out said transverse loading during its inward and outward movement as said rotor rotates.

2. In a machine comprising a housing, inlet and outlet ports, a check valve in one of said ports, an eccentric first rotor mounted on a shaft, a second rotor mounted to rotate on a bearing on said eccentric first rotor and bearing to roll on the inner wall of said housing as it follows said eccentric first rotor turning in the opposite direction and at a reduced speed of rotation relative to that of said eccentric first rotor, a vane mounted to reciprocate from an open end vane slot in said housing having a sealing contact with said end plates and with its inner end extending from said vane slot through a clearance between said housing and said second rotor making a sealing contact with said second rotor forming low and high pressure fluid chambers on opposite sides of said

vane, means holding said vane in sealing contact with said second rotor during the full length of its stroke as said eccentric first rotor rotates, a relief on said high pressure side of said vane equaling the full length of said vane stroke providing a uniform force of transverse high pressure loading tending to cock said vane by urging it against the fulcrum point on said low pressure side at said open end of said vane slot wall for the full length of said vane stroke, a recess on said vane near its outer end on said high pressure side at the closed end of said vane slot, a recess on said vane on said low pressure side beginning near said fulcrum point on said vane slot wall when said vane is fully extended for its longest said stroke, high pressure ports leading to said recesses, area of said recess on said vane on said low pressure side of said vane equaling the area of said recess on said vane on said high pressure side of said vane plus said relief area on said vane exposed to said transverse high pressure loading hydraulically floating said vane in said vane slot by balancing out said transverse high pressure loading during its inward and outward movement as said rotor rotates preventing cocking and wear on said vane slot wall.

3. In a fluid machine comprising a housing, end plates, inlet and outlet ports, a check valve in one of said ports, an eccentric rotor mounted to rotate on a shaft in said housing forming a sealing contact with the peripheral wall of said housing as it rotates, said rotor having a flexible material bonded to a portion of its ends forming a sealing contact between said end plates while wiping away grit and preventing a metal to metal contact between said housing and said rotor as it forms the pumping action for said machine, a vane mounted to reciprocate in a vane slot in said housing with its inner end extending from an opening in said vane slot through a clearance between said housing and said rotor making a sealing contact with said rotor forming low intake and high pressure discharge chambers on opposite sides of said vane, means holding said vane in sealing contact with said rotor for the full length of its stroke as said rotor rotates, a relief on the portion of said inner end of said vane extending from said open end of said vane slot on said high pressure side equaling the greatest length of said vane stroke with said high pressure providing uniform transverse high pressure loading throughout its inward and outward movement tending to cock said vane by urging it against the fulcrum point at said open end of said vane slot wall on said low pressure side, a recess on said vane on said high pressure side of said vane near its outer end at the closed end of said vane slot, a recess on said vane on said low pressure side of said vane extending from near said fulcrum point on said vane slot wall forming an area equaling said relief transverse high pressure loading area and said recess area on said vane on said high pressure side of said vane, ports from said high pressure side leading to said recesses forming means hydraulically floating said vane in said vane slot by balancing out said transverse high pressure loading preventing cocking and the wear on said vane slot wall as it follows said rotor, the depth of said relief forming an area over the end of said vane exposing it to high fluid pressure tending to lift it off said sealing contact on said rotor, a port from said high fluid pressure chamber leading to said closed end of said vane slot exposing a larger area on the outer end of said vane over-balancing said tendency to lift said vane off said sealing rotor contact controlling the fluid force holding said vane on said sealing rotor contact.

4. In a fluid machine comprising a housing, inlet and outlet ports, a rotor mounted on a shaft to rotate in said housing forming sealing contact with the inner wall of said housing, a check valve in one of said ports, a vane with its inner end mounted to extend from an opening in said vane slot through a clearance making a sealing contact with said rotor forming low intake and high pressure fluid chambers on opposite sides of said vane forming means of transferring fluid, a first spring in the closed end of said vane slot bearing on said vane holding it in said sealing contact with said rotor, a high pressure port leading to the closed end of said vane slot assisting said first spring, a valve mounted on a shaft between said high pressure port and said closed end of said vane slot, said valve held open by a second spring mounted in a diaphragm, a port leading from said high pressure port to said diaphragm over-balancing said second spring above a predetermined fluid pressure closing said valve, said valve mounted to move freely on said shaft provided with a third spring holding it closed at said above predetermined fluid pressure on said diaphragm, said vane when forced into said vane slot from said clearance by said rotor increasing said fluid pressure in said vane slot over-balancing said third spring at a predetermined fluid pressure above said first predetermined fluid pressure on said diaphragm permitting said valve to open only while discharging the fluid from said closed end of said vane slot, said vane prevented from following said rotor after discharging said fluid by vacuum formed in said vane slot over-balancing said first spring permitting said rotor to freely rotate unloaded while said valve is held closed.

5. In a pump comprising a housing member and a rotor member having a portion of said members separated by a clearance, inlet and outlet ports, end plates, said rotor mounted on a shaft on bearings in said housing member, a vane slot in one of said members with one end opening into said clearance, said vane mounted to reciprocate from said open end vane slot into said clearance, means reciprocating said vane from said open end of said vane slot holding it in sealing contact with its opposite member forming low and high pressure fluid chambers on opposite sides of said vane, a high pressure port leading to the closed end of said vane slot, said high fluid pressure on said vane forming a transverse high pressure loading force tending to cock said vane by urging it against the fulcrum point on said low pressure side at said open end of said vane slot wall, a relief on said sealing contact end of said vane on said high pressure side equaling the length of its vane stroke providing a uniform force of said transverse high pressure loading for the entire length of said vane stroke, a recess on said vane near its end at the closed end of said vane slot on said high pressure side, a recess on said vane on said low pressure side of said vane near said fulcrum point at said open end of said vane slot wall when said vane is fully extended into the deepest portion of said clearance,said recess area on said vane on said low pressure side equaling said relief area on said vane plus said recess area on said vane on said high pressure side, high pressure ports leading to said vane recesses providing means hydraulically balancing said vane preventing cocking thereby floating said vane in said vane slot as it reciprocates while circulating fluid under high pressure.

6. In combination with claim 5: said relief depth on said vane forming an area over said sealing contact end of said vane on said high pressure side of said sealing contact with said pressure fluid force tending to urge said vane off said sealing contact, said high pressure port leading to the enclosed end of said vane slot exposing a greater area over the end of said vane over-balancing the opposing pressure fluid force controlling said fluid force holding said vane on said sealing contact.

7. In combination with claim 5: a valve mounted on a shaft between said high pressure port and said closed end of said vane slot, said valve held open by a first spring mounted in a diaphragm, a port leading from said high pressure port to said diaphragm over-balancing said first spring above a predetermined fluid pressure closing said valve, said valve mounted to move freely on said shaft provided with a second spring holding it closed at said above predetermined fluid pressure on said diaphragm,

said vane when forced into said vane slot from said clearance by its opposing member increasing said fluid pressure in said vane slot over-balancing said second spring at a predetermined fluid pressure in said vane slot above said first predetermined fluid pressure on said diaphragm permitting said valve to open while discharging the fluid from said closed end of said vane slot, said vane prevented from following said opposing member by vacuum formed in said vane slot over-balancing said vane reciprocating means permitting said rotor to freely rotate unloaded while said valve is held closed.

8. In combination with claim 5: a check valve mounted in said port leading to said closed end of said vane slot, means holding said check valve open below a predetermined fluid pressure, means closing said check valve above said predetermined fluid pressure, said vane when forced into said vane slot from said clearance by said rotating rotor increasing said fluid pressure in said vane slot above said first predetermined fluid pressure closing said check valve permitting said check valve to open and remain open only while discharging the fluid from said closed end of said vane slot, said vane prevented from following said rotor after discharging said fluid from said closed end of said vane slot by vacuum formed in said vane slot over-balancing said means closing said check valve permitting said rotor to freely rotate unloaded only while said check valve is held closed preventing the circulation of said fluid.

9. In a pump comprising a housing member and a rotor member, inlet and outlet ports, said rotor mounted on a shaft for rotation in said housing member, a clearance between a portion of said members, a vane slot in one of said members opening into said clearance, a sealing contact between said rotor member and said housing member as said rotor rotates, a reciprocating vane mounted in one of said members in a vane slot with one end extending through said clearance making a sealing contact with its opposite member, said members forming low intake and high pressure discharge fluid chambers on opposite sides of said vane, a relief on said vane on said high pressure side of said vane extending from said sealing contact on said opposite member to the fullest depth of said clearance, said high fluid pressure force against the area of said relief on said vane forming a uniform transverse high pressure loading tending to cock said vane against the fulcrum point on said low pressure side of said vane slot wall at the opening into said clearance, a recess on said vane on said high pressure side of said vane near its end in the closed end of said vane slot, a recess on said vane on said low pressure side of said vane beginning near said fulcrum point forming an area equaling said recess area on said vane plus said relief area on said vane on said high pressure side, ports leading from said high pressure to said recesses forming means hydraulically floating said vane by balancing out said transverse pressure loading preventing said cocking tendency thereby permitting said vane to freely reciprocate in said vane slot with little or no wear.

10. A machine comprising a housing member, a rotor member, a portion of said members separated by a clearance, inlet and outlet ports, end plates, said rotor mounted on a shaft for rotation in said housing member, a vane mounted to reciprocate in a vane slot having an open end into said clearance in one of said members, means to reciprocate said vane from said vane slot holding it in sealing contact with said opposite member forming low and high pressure fluid chambers on opposite sides of said vane, a port leading to the closed end of said vane slot forming means of circulating fluid under pressure, a check valve mounted in said vane slot port, means holding said check valve open below a first predetermined fluid pressure, means closing said check valve at a second predetermined fluid pressure, said vane forced into said vane slot from said clearance as said rotor rotates increasing said fluid pressure in said vane slot above said second predetermined fluid pressure permitting said check valve to open and remain open only while discharging said fluid from said closed end of said vane slot, said vane prevented from following said rotor after discharging said fluid from said closed end of said vane slot by vacuum formed in said vane slot permitting said rotor to freely rotate unloaded while said check valve is held closed preventing the circulation of fluid, said check valve is reopened when said pressure is reduced to below said first predetermined fluid pressure permitting said vane to follow its opposite member putting said machine back in operation.

11. In a machine comprising a housing member, a rotor member mounted for rotation in said housing member, end plates, inlet and outlet ports, a clearance between a portion of said members, a vane slot in one of said members having an opening into said clearance, a reciprocating vane mounted in said vane slot extending through said clearance having a sealing contact with its opposite member forming with said members low intake and high pressure discharge fluid chambers on opposite sides of said vane, a port leading to the closed end of said vane slot, means of reciprocating said vane as said rotor rotates, a relief area on said sealing contact end on said high pressure side of said vane equaling the fullest length of its stroke through said clearance, said relief area when subjected to high fluid pressure forming a high pressure transverse loading on said vane tending to cock and rock said vane against the fulcrum point on said low pressure side at said open end of said vane slot wall and gouge said vane slot wall with its inner end on its high pressure side with each reciprocation of said vane doing more damage, a recess area on said vane near its outer end at said closed end of said vane slot on said high pressure side equaling said relief area, a recess area on said vane on said low pressure side of said vane starting near said fulcrum point and extending toward said closed end of said vane slot midway between said recess area and said relief area on said high pressure side forming an area equaling the sum of said recess area and said relief area, high pressure ports leading from said relief area to said recesses forming means hydraulically floating said vane in said vane slot preventing said cocking and rocking and gouging said vane slot wall while delivering fluid under high pressure.

12. In a machine comprising a housing member, a rotor member mounted for rotation in said housing member, inlet and outlet ports, end plates, a clearance between a portion of said members, a vane slot in one of said members having an opening into said clearance, a reciprocating vane mounted in said vane slot extending through said clearance having a sealing contact with its opposite member forming with said members low intake and high pressure discharge fluid chambers on opposite sides of said vane, a port leading to the closed end of said vane slot, means reciprocating said vane as said rotor rotates, an area on said sealing contact end when subjected to high fluid pressure forming a transverse pressure loading tending to cock and rock said vane against the fulcrum point of said low pressure side of said vane slot wall and gouge said vane slot wall on said high pressure side with its inner end, an area near its inner end on said high pressure side when subjected to high fluid pressure tending to balance said transverse loading pressure area holding said vane parallel against said low pressure wall of said vane slot, an area on said vane on said low pressure side equaling the sum of said transverse loading area and said area near its inner end when subjected to high fluid pressure tending to balance said high fluid pressure forces on said vane, high pressure ports connecting said areas forming means hydraulically floating said vane in said vane slot when subjected to various high fluid pressures while transferring fluid.

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