Oct. 17, 1950 D. JOHNSTON 2,525,907

ROTARY HYDRAULIC PUMP

Filed Sept. 16, 1943 2 Sheets-Sheet 1

Fig. 1.

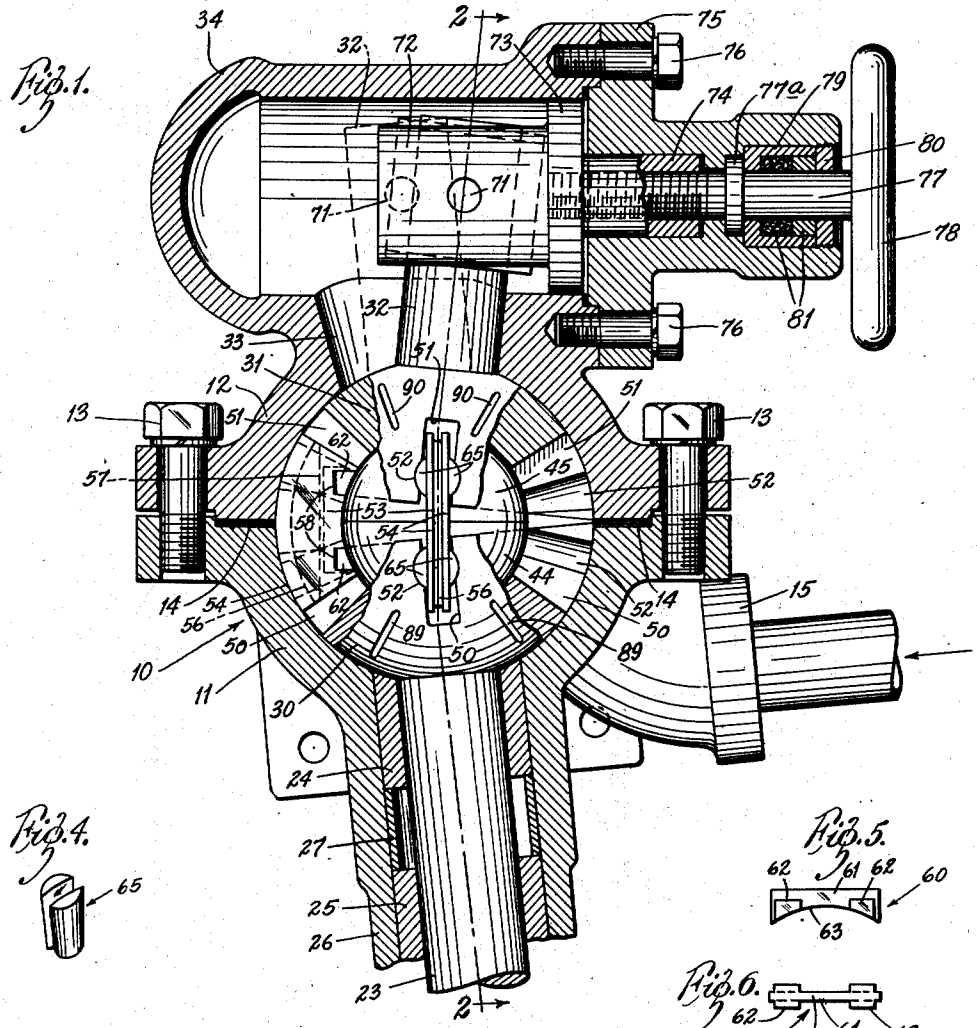



Fig. 4.




Fig. 5.




Fig. 6.




Fig. 7.

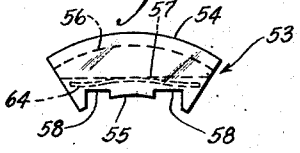



Fig. 8.

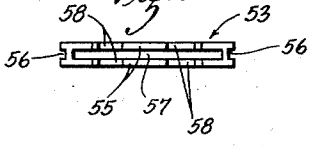
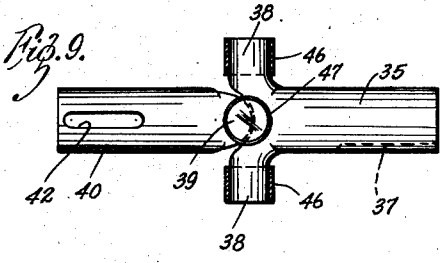



Fig. 9.




INVENTOR:
DOUGLAS JOHNSTON,

BY Kirkland Paquin & Eyre

ATTORNEYS.

Oct. 17, 1950 D. JOHNSTON 2,525,907

ROTARY HYDRAULIC PUMP

Filed Sept. 16, 1943 2 Sheets-Sheet 2

Fig. 2.

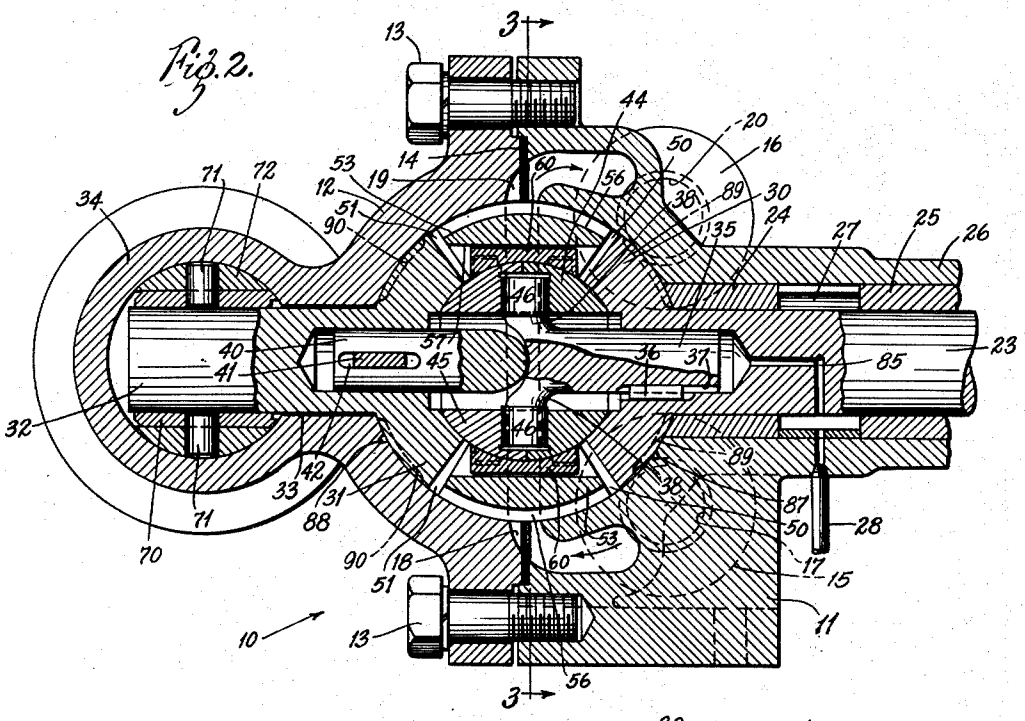
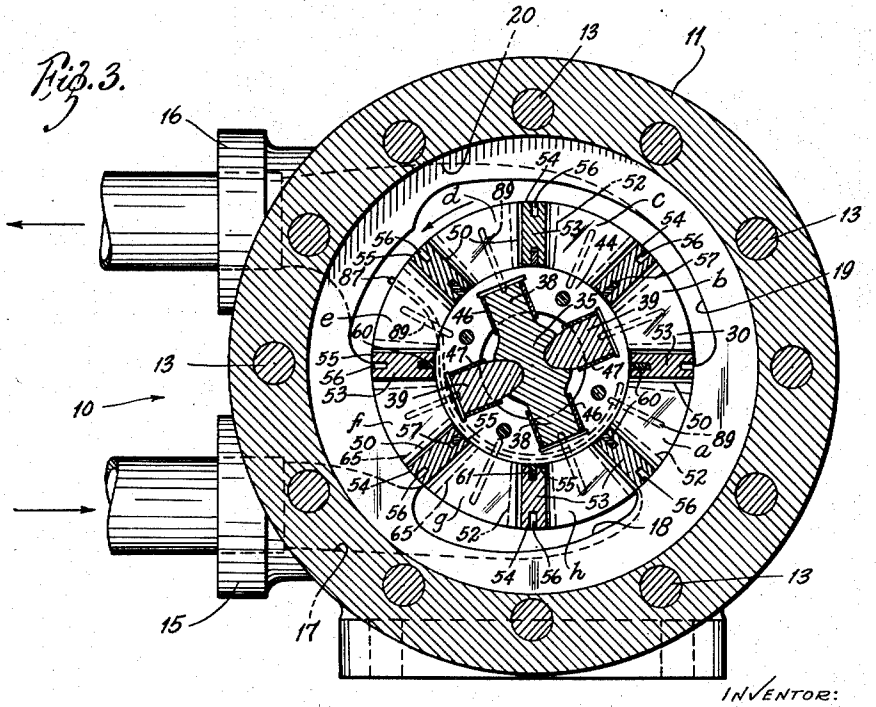



Fig. 3.




INVENTOR:
DOUGLAS JOHNSTON,

BY Kenyon & Kenyon Eyre

ATTORNEYS.

Patented Oct. 17, 1950 2,525,907

# UNITED STATES PATENT OFFICE

2,525,907

## ROTARY HYDRAULIC PUMP

Douglas Johnston, Shelbyville, Ill., assignor of one-half to Henry Packard White, Joppa, Md.

Application September 16, 1943, Serial No. 502,567

16 Claims. (Cl. 103—120)

1

This invention relates to hydraulic pumps and particularly to such pumps as are adapted to be used on portable or semi-portable machinery under severe conditions of use in such fields as agricultural, road building, oil well drilling, and the like in which hydraulic transmissions are used as means of transmitting the principal source of power.

The general object of this invention is to provide a high pressure, high capacity hydraulic pump.

More particularly, it is the object of this invention to provide such a pump with a simple variable volume control.

A further object is to provide such a pump at a cost comparable to the cost of ordinary rotary pumps.

A further object is to provide such a pump that will have wear compensating features for its moving parts.

A further object is to provide a rotary type pump having wearing qualities and pressures beyond those heretofore obtained, coupled with lightness providing portability.

A further object is to provide such a pump as can stand up under the abuse common to machinery in the fields.

In the drawings:

Fig. 1 is a sectional elevation of the invention;

Fig. 2 is a vertical section on the line 2—2 of Fig. 1;

Fig. 3 is a section on the line 3—3 of Fig. 2;

Fig. 4 is a detail of the split tapered bearing that supports the vanes;

Fig. 5 is an elevation of the mating member;

Fig. 6 is a bottom view of the same;

Fig. 7 is an elevation of the vane;

Fig. 8 is a bottom view of the vane as appears in Fig. 7; and

Fig. 9 is a side view of the universal joint.

The pump comprises a housing generally indicated at 10, providing a spherical pump chamber, and formed of a lower section 11 and an upper section 12. The two are joined together with screws 13, there being shims 14 between the sections for purposes of adjustment to be described.

Lower section 11 has an inlet 15 and an outlet 16. The inlet 15 extends by a passage 17 to an inlet port 18, opening into the inner wall of the housing 10 and being partly in the member 11 and partly in the member 12. A somewhat similar outlet port 19 extends from the inner surface of the housing, partly in the member 11 and partly in the member 12, and is connected by a passage 20 to the outlet 16.

2

The pump is driven by a drive shaft 23 which is supported by spaced bearings 24 and 25, disposed in an extension 26 on the housing member 11. The space between the bearings 24 and 25 provides an oil sump 27 for maintaining proper lubrication of the bearings. The oil sump 27 has an overflow drain 28 connected back into the inlet side of the pump, the entire connection not being shown.

Formed on the end of the shaft 23 is a spherical portion 30 that fits within the spherical housing 10. The member 30 has an inner surface that is also in the main spherical.

The operation of the pump involves the use of certain chambers that increase in size on the inlet side of the pump and decrease in size on the outlet side thereof. These chambers are formed by a plurality of vanes that are rotated by the driving shaft 23, and which cooperate with a spherical portion 31 similar to the portion 30 but at an angle thereto so that at one end of a diameter the two spherical portions are close together and at the other end are far apart, the two space conditions representing the limits of size of the expanding chambers.

The aforementioned second spherical portion 31 is shown engaging the inner face of the upper housing member 12, and formed as an integral part of a shaft 32 that operates through a slot 33 between the main portion of the housing member 12 and an adjustment containing extension 34 thereof.

The two shafts 23 and 32 are connected by a universal joint. To this end the shaft 23 has a hollow portion, into which is fitted a stud shaft 35, keyed to the shaft 23 by a key 36 that operates in an elongated slot 37 in the shaft 35. This elongated slot 37 permits some longitudinal displacement of the stud shaft 35 relative to the driving shaft 23. The stud shaft 35 has at its inner end oppositely projecting arms 38, between which are disposed similar arms 39 on a stud shaft 40 that is similarly keyed at 41 to the adjusting shaft 32. The key 41 operates in a slot 42 in the shaft 40 that is longer than the key to permit some longitudinal displacement of the shaft 40 relative to the shaft 32.

The two pairs of arms 38 and 39 engage in complementary semi-cylindrical slots formed in the facing surfaces of two spherically shaped holding members 44 and 45, the former being in the lower part of the housing and the latter in the upper. The holding members are spherically shaped on their outer surfaces to form a seal with the corresponding inner surfaces of the mem-

bers 30 and 31. The holding members likewise are provided with inner passages to receive the shafts 35 and 40. Suitable bearings 46 are disposed around the arms 38 and similar bearings 47 are disposed around the arms 39.

From the foregoing it may be seen that rotation of the shaft 23 rotates the stud shaft 35 through the key 36, and rotation of the stud shaft 35 through the arms 38, holding members 44 and 45, and the arms 39, causes rotation of the other stud shaft 40, which, in turn, causes rotation of the adjusting shaft 32.

It will be seen further that the shaft 32 is disposed at an angle to the shaft 23 so that the space between the facing edges of the members 30 and 31 is small at one end of a diameter, appearing in the right of Fig. 1, and is large in the opposite end of that diameter, appearing at the left of Fig. 1. The relationship of the figures is such that the small opening is at the left of Fig. 3 and the large opening at the right thereof. By further reference to Fig. 3 it may be understood that the space is increasing as the rotor portions approach and cross the inlet port 18 and is contracting as they cross the outlet port 19.

The vane members before mentioned are disposed between the facing edges of the spherical portions 30 and 31. To this end the portions 30 and 31 have a plurality of slots 50 and 51, respectively, extending back from their facing edges. Inwardly along these slots are provided arcuate cut-outs 52 for a purpose to be described. As here shown, there are eight sets of slots 50 and 51 in each member 30 and 31, and they are disposed opposite each other in pairs.

In each pair of slots is disposed a vane 53. The vanes are shown in detail in Figs. 7 and 8. Each has an arcuate outer surface 54 and an arcuate inner surface 55. The surface 54 engages in sealing relationship with the inner surface of the spherical housing 10. The surface 55 similarly may seal against the outer surface of the universal joint housing formed by the connecting members 44 and 45, or may be slightly spaced therefrom, particularly if wear occurs.

Each vane has a slot 56 extending down from the edge 54 and a slot 57 extending from the edge 55. The edge 55 also has notches 58 therein.

Each vane likewise receives a mating member 60, shown in detail in Figs. 5 and 6, which mating member has a center portion 61 that fits into the slot 57 and projections 62 that fit within the notches 58. Each mating member likewise has an inner arcuate edge 63 adapted to seat on the surface of the universal joint, in sealing relation. Light springs 64 may be disposed within the slots 57 to urge the members 53 and 60 apart so that their respective bearing surfaces may seal.

The vanes, with their mating members installed therein, are inserted into the facing slots 50 and 51 and bearings 65 of the split type, as appears in Fig. 4, are disposed on opposite sides of the vane in each slot, fitting into the arcuate notches 52 thereof. This type of bearing permits the vanes to slide longitudinally and to have oscillatory movement with respect to the spherical portions 30 and 31. The ends of the bearing elements are shaped to seal against the spherical surfaces of the housing and the universal joint. It will be seen that as any particular vane is moved from the left hand side of Fig. 1 to the right hand side hereof, by rotation of the shaft 23, the bottoms of the slots 50 and 51 will approach the ends of the vane, and the vane will oscillate from a position in line with the slots to a position of maximum disalignment, and back to a position of alignment. Likewise, during this operation, the chambers between adjacent vanes become increasingly smaller. During the subsequent 180° of rotation, these chambers will become larger. The vanes fit closely in the bearings, but some clearance is provided. This clearance, as will appear, provides communication from the side of the vane at higher pressure to the space at the ends of the notches. As will appear, the vanes seal against the bearing portion on the lower pressure side to prevent similar communication from that side.

The amount of change in size of the several chambers, between their minimum and maximum positions, is determined by the angularity of the shaft 32 relative to the driving shaft 23. In Fig. 1 this change is shown at its maximum adjustment. However, it may be moved and indeed shifted over center so as to reverse the flow of the pump.

The adjustment mechanism is contained within the extension 34 of the upper housing section 12. The upper part of the shaft 32 extends through a bearing 70 that is supported by trunnions 71, which trunnions are in turn supported by two arms 72, projecting outwardly from a plate 73 which is circular and which slides within the cylindrical interior of the extension 34.

The plate 73 has an extension 74 that bears rotatably in a cover 75, bolted at 76 to the extension 34. The projection 74 is internally threaded to receive the threaded end of a shaft 77, projecting through the cover 75, and provided with a handle 78. The shaft 77 has a collar 77a formed thereon and is held against a shoulder on the cover 75 by a cup-shaped element 79, which, in turn, is secured by a threaded collar 80. The cup-shaped member and collar 80 likewise enclose packing elements 81 to prevent leakage.

It will be seen that rotation of the handle 78 displaces the plate 73 inwardly or outwardly as the case may be, and this through the trunnions 71 displaces the shaft 32 within the slot 33 to adjust the angularity of the member 31, relative to the member 30.

The elements of the universal joint are fitted tightly together to avoid leakage of oil between them. However, if oil should penetrate to the interior of the joint it would escape through a passageway 85 that leads to the oil sump 27 between the bearings 24 and 25.

As will be explained in greater detail later, there is high pressure oil on one side of the rotating parts and low pressure on the other. This tends to cause unequal bearing loads and, to effect compensation for this, high pressure oil is introduced into certain limited areas of the bearing surfaces on the low pressure side. In Fig. 3 a port 87 is a shown as leading through the housing member 11 from the high pressure outlet 16 around to the low pressure side of the rotating parts. Again referring to Fig. 3, it will be understood that the lower part of this view is the low pressure side. The same relationship exists in Fig. 2. Fig. 1 shows only the high pressure side. A similar port 88 is disposed in the member 12 and is connected into the high pressure side 16.

The port 87 changes to a channel in the inner surface of the member 11, which is disposed to open against the bearing surface of the spherical portion 30 on the shaft 23 to cause high pressure oil to act against such surface on the low pressure side. Similarly, the port 88 changes into a channel on the low pressure side of the member

12 to act against the bearing surface of the member 31.

The member 30 is provided with a series of grooves 89 on its surface adjacent the housing member 11, which grooves communicate with the channel 87 as do all of the grooves 89 that are on the low pressure side at any particular time. In like manner, grooves 90 in the outer surface of the other spherical portion 31 register with the channel 88.

It will be seen that the registry of the grooves 89 and 90, with their respective channels, cannot occur as to any grooves on the high pressure side, because the channels 87 and 88 do not open into the surfaces of the members 11 and 12 except on the low pressure side.

*Operation*

By referring to Fig. 1, it may be seen that the oil is drawn in through the inlet 15. The vanes that provide the suction are those on the back side of Fig. 1 and on the lower part of Fig. 3. Both of these figures will show that as the vanes cross the inlet port 18, the chambers between successive vanes are constantly increasing in size, owing to the separation of the facing edges of the spherical portions 30 and 31, with the result that suction greater than that provide by ordinary vanes can be obtained. It will also be seen that oil will be entrained within the grooves 56 on the outer edges of the vanes 53 and will pass into the notches 50 and 51. Oil, likewise, will pass around into the inner notches 57 of the vanes 53. Since the notches 50 and 51 separate on the suction side, they will also tend to draw this oil within them.

Referring to Fig. 3, the chambers occupying the positions *g* and *h* will be filling themselves with oil because they are passing the inlet port 18. The chamber *a* will have left the inlet port but will not have reached the outlet port. It will be filled with oil which is subjected to a small amount of suction by the fact that this chamber *a* continues to increase in size until it reaches the three o'clock position of Fig. 3. The chambers *b*, *c*, *d*, and *e* will be discharging into the outlet port 19, the forces of this discharge including the extruding action of the decreasing chamber. The chamber *f* will have a minimum quantity of oil in it, the amount being that not actually forced out into the discharge port.

The oil in the chambers *a* and *f* acts as a seal between the inlet and outlet ports. This is designed to prevent slip of the pump.

It will be understood further that any oil within the notches 50 and 51, will, in the main, be ejected into the exhaust port.

The volumetric capacity of the pump is determined by the adjustment of the shaft 32, since the total capacity is the difference between the maximum size of each chamber and the minimum size of each chamber multiplied by the number of chambers. This difference between maximum and minimum sizes is the factor adjusted by rotating the wheel 78 which adjusts the aforesaid angularity of the shaft 32 relative to the shaft 23. If the shaft 32 is moved to the left as far as the dotted line positions in Fig. 1, the difference will be reduced to zero and the pumping action will be zero. If the shaft 32 is moved beyond the dotted line position, then it may be operated in the reverse direction of rotation.

The oil pressures produce bearing loads that result in loads on the high pressure side that are greater than the loads on the low pressure side.



Referring particularly to Fig. 2, the pressure on the upper vanes and walls forming the chambers is greater than that on the lower. These forces produce components along the axes of the shafts 23 and 32 and components acting downwardly in Figs. 2 and 3 transversely of the shafts. There are no corresponding forces on the low pressure side, or, in any case, the pressures on the low pressure side are less than those on the high pressure side. The large area of bearing provided by the spherical portions 30 and 31 reduces the total axial force tending to spread these elements to an overall unit pressure of less than the unit pressure of the oil on the high pressure side.

The resultant of the two force components is a force acting at an angle to the axes of the shafts. The value and direction of this resultant may be easily determined. It is at least to a great extent compensated for by the introduction of high pressure oil through the passages 87 and 88, and the grooves 89 and 90 to the low pressure bearing surfaces between the members 30 and 31 and the housing. Thus, the area and disposition of the said ports and grooves is determined to apply a component of force that provides counteracting transverse and axial forces on the shafts 23 and 32, that reduce the bearing loads well within safe limits.

The vanes form sealing members between the inlet opening 18 and the outlet opening 19. In the design illustrated, the separating walls between the inlet and the outlet are on the rotor side wherein the oil chambers are enlarging. This has advantages, but is not essential.

A vane in the space between outlet and inlet, Fig. 3, has high pressure on its back side, and low pressure on its front side. This is especially clear if the rotor be considered as a few degrees in advance of the position shown in Fig. 3. In such case the high pressure forces the vane 53 forward against the forward bearing element 65, sealing tightly thereagainst, leaving a space between it and the back bearing element through which fluid may enter into the spaces at the ends of the notches 50 and 51, this fluid being at high pressure. This fluid will enter the slots 56 and 57, in the latter acting to separate the vane and mating members to insure tight sealing of both.

If the vanes and mating members are quite new, they may fit closely enough to effect sealing without the foregoing action. The action, however, acts to secure proper seals even after wear. Such wear also will permit oil to enter between the inner edges 55 of the vanes and the universal housing. A brief consideration of this situation will show that this will admit high pressure oil on the high pressure side to such spaces, which acts to force the vane outward. The width of the slots 56 determines the amount of outward pressure exerted upon the vanes, and controls their bearing loads.

It will be seen further that a similar action occurs upon vanes at the space *a*, in which the approach side is exposed to high pressure and the back side to low.

If desired, the leaf springs 64 may be used to urge the members 53 and 60 apart. They will do so even in an interval before a pressure differential on opposite sides of a particular vane exists, to insure sealing.

Since the vane elements are self-adjusting to wear, and it will be noted that they will always contact the spherical surface of the housing, whatever their angles relative to the axes of the shafts, the only elements subjected to wear that

would provide leakage are the members 30 and 31, which might wear either at the surfaces of the universal joint or those of the housing, to permit leakage between either of these two surfaces. To compensate for this, the shims 14 are provided. By peeling off elements of the shims, the two housing elements 11 and 12 may be brought closer together to take up such wear.

In assembly or dismantling of the pump, the screws 13 may be removed and the entire upper part of the structure withdrawn, taking with it the bearing 70 of the adjustment, but leaving the shaft 32 and associated structure. The shaft 32 may be removed, as it slips off of the stud shaft to which it is keyed, which stud shaft is secured by the universal joint. The latter may easily be withdrawn after removal of the vanes. It will be seen that the dismantling takes place from the top down, and that the base elements may be permanently fixed without hindering complete repair.

It will be seen that the upper construction in the shape of a portion of a sphere accommodates rotation of the member 31 at any angle of adjustment of the shaft 32. The construction of the housing in spherical shape where the vanes wipe it permits the vanes to seal even when disposed at an angle to the axes of the shafts. The formation of portions of spheres for the bearing surfaces of both members 30 and 31 provides for taking up wear by removal of shims 14. These shapes may be modified individually at the cost of one or more of the foregoing advantages, but only the sum of all of them produces the complete result. The similar contribution of the spherical shape of the universal joint housing will be apparent.

The use of two sets of bearings 65 for the vanes is not absolutely necessary, as the vanes could be fixed to one of the facing members 31 or 32, but has the advantage of distributing the load and the amount of oscillation.

What is claimed is:

1. In a pump, a housing providing a pump chamber, a pair of opposed facing elements in said chamber, each element including a facing surface, means to simultaneously rotate each element in the chamber about an axis including a universal joint interconnecting the elements, the said axes being at an angle to each other whereby said elements are relatively close at one opposed pair of edge points of the facing surfaces and relatively spaced at the opposite opposed pair of edge points thereof, an inlet connected into the chamber at a point wherein the elements are separating, an outlet leading from the chamber at a point wherein the elements are approaching, means separating the inlet and outlet sides of the elements at the center thereof including a member rotatable with the universal joint, and vane means separating the inlet and outlet from said center separating means outwardly toward the walls of the pump chamber, said vane means comprising vane elements extending between the two facing elements, and means providing oscillatory movement relative to said facing elements and bodily longitudinal movement of each vane element on at least one of said facing elements.

2. In a pump, a housing providing a pump chamber, a pair of opposed facing elements in said chamber, each element including a facing surface, means to rotate each element in the chamber about an axis, the said axes being at an angle to each other whereby said elements are relatively close at one opposed pair of edge points of the facing surfaces and relatively spaced at the opposite opposed pair of edge points thereof, an inlet connected into the chamber at a point wherein the elements are separating, an outlet leading from the chamber at a point wherein the elements are approaching, means separating the inlet and outlet sides of the elements at the center thereof, and vane means separating the inlet and outlet from said center separating means outwardly toward the walls of the pump chamber, said vane means comprising vane elements extending between the two facing elements, means providing oscillatory movement relative to said facing elements and bodily longitudinal movement of each vane element on at least one of said facing elements, said vane means comprising opposed facing notches extending back from the edges of the facing elements, a vane in each pair of notches, and bearings in each notch to support the vane for oscillatory and longitudinal movement in the notches, and means permitting free communication between the notches and the inlet and the outlet when a vane is passing said inlet and outlet.

3. In a pump, a housing providing a pump chamber, a pair of opposed facing elements in said chamber, each element including a facing surface, means to simultaneously rotate each element in the chamber about an axis including a connection between the elements, the said axes being at an angle to each other whereby said elements are relatively close at one opposed pair of edge points of the facing surfaces and relatively spaced at the opposite opposed pair of edge points thereof, an inlet connected into the chamber at a point wherein the elements are separating, an outlet leading from the chamber at a point wherein the elements are approaching, means connected for rotation with the elements for separating the inlet and outlet sides of the elements at the center thereof, and vane means separating the inlet and outlet from said center separating means outwardly toward the walls of the pump chamber, said vane means comprising vane elements extending between the two facing elements, and means providing oscillatory movement relative to said facing elements and bodily longitudinal movement of each vane element on at least one of said facing elements, said vane means extending inwardly to bear upon the center separating means, and extending outwardly to bear upon the inner walls of the pump chamber.

4. In a pump, a housing providing a pump chamber, a pair of opposed facing elements in said chamber, each element including a facing surface, means to rotate each element in the chamber about an axis, the said axes being at an angle to each other whereby said elements are relatively close at one opposed pair of edge points of the facing surfaces and relatively spaced at the opposite opposed pair of edge points thereof, an inlet connected into the chamber at a point wherein the elements are separating, an outlet leading from the chamber at a point wherein the elements are approaching, means separating the inlet and outlet sides of the elements at the center thereof, and vane means separating the inlet and outlet from said center separating means outwardly toward the walls of the pump chamber, said vane means comprising vane elements extending between the two facing elements, and means providing oscillatory movement relative to said facing elements and bodily longitudinal

movement of each vane element on at least one of said facing elements, said vane means extending inwardly to bear upon the center separating means, and extending outwardly to bear upon the inner walls of the pump chamber, each of said vane elements having a slot on its outer edge, and a slot on the inner edge, a mating member located in said inner slot and having a surface complementary to the surface of the center separating member, the adjacent edge of the mating member and bottom of the inner slot on the vane being separable to admit fluid under pressure that may act to separate the vane and the mating member.

5. In a pump, a pump housing having opposed chamber sections at least one of which is shaped as a portion of a sphere, a pair of facing elements in said housing having bearing surfaces complementary to said chamber sections, a shaft for supporting each facing element, an inlet and an outlet for respectively admitting and discharging a fluid, entraining means comprising vanes extending between the facing elements to cause the facing elements to draw fluid in the inlet for ejection into the outlet, means to adjust the angle of the shaft having its facing element in the spherical portion, relative to the other, means to simultaneously drive the facing elements from the other shaft comprising a universal joint connection between the two shafts and disposed at the center of the pump housing, and a housing about the joint, said last named housing having an outer surface formed as a portion of a sphere, said spherical portion of the housing extending into complementary inner surfaces of the facing elements.

6. In a pump, a pump housing having opposed chamber sections, a pair of facing elements in said housing having bearing surfaces complementary to said chamber sections, a shaft for supporting each facing element, said shafts having their axes angularly related, an inlet and an outlet, entraining means to cause the facing elements to draw fluid in the inlet for ejection into the outlet, means for simultaneously driving the facing elements from one shaft comprising a universal joint connection disposed at the center of the pump housing, and a housing about the joint, said last named housing having an outer surface formed as a portion of a sphere, said spherical portion of the housing extending into complementary inner surfaces of the facing elements.

7. In a pump, a main housing comprising separable sections each having an inner surface including a portion of a sphere, a drive shaft extending into said housing and having a flared element on the inner end thereof that has a spherical outer face complementary to the inner surface of one of the housing sections, a second shaft adapted to be disposed at an angle to the drive shaft, a flared element on the second shaft shaped similarly to the first flared element and facing the same, each flared element including a facing surface, said flared elements being adapted to be relatively close at one opposed pair of edge points of the facing surfaces and relatively spaced at the opposite opposed pair of edge points thereof, means supported on the other housing section to support the second shaft, a universal joint between the two shafts at the center between the two flared elements, said joint including a universal housing split similarly to the division in the main housing, the outer surface of the universal housing having surfaces shaped to engage in the inner spherical surfaces of the flared elements, an inlet into the main housing, an outlet therefrom and spaced from the inlet, and vane means extending between the facing flared elements and engaging the inner surface of the main housing and the outer surface of the universal housing.

8. In a pump, a main housing comprising separable sections each having an inner surface including a portion of a sphere, a drive shaft extending into said housing and having a flared element on the inner end thereof that has a spherical outer face complementary to the inner surface of one of the housing sections, a second shaft adapted to be disposed at an angle to the drive shaft, a flared element on the second shaft shaped similarly to the first flared element and facing the same, said flared elements being adapted to be relatively close at one end of an opposed transverse diameter of each element and relatively separated at the opposite end thereof, means supported on the other housing section to support the second shaft, a universal joint between the two shafts at the center between the two flared elements, said joint including a universal housing split similarly to the division in the main housing, the outer surface of the universal housing having surfaces shaped to contact the inner spherical surfaces of the flared elements, an inlet into the main housing, an outlet therefrom and spaced from the inlet, vane means extending between the facing flared elements and contacting the inner surface of the main housing and the outer surface of the universal housing, said universal joint including a stud shaft with arms at one end, disposed slidably but not rotatably in each of the shafts, and the universal housing elements having means oscillatably to support and to connect both sets of arms on the stud shafts.

9. In a pump, a main housing comprising separable sections each having an inner surface including a portion of a sphere, a drive shaft extending into said housing and having a flared element on the inner end thereof that has a spherical outer face complementary to the inner surface of one of the housing sections, a second shaft adapted to be disposed at an angle to the drive shaft, a flared element on the second shaft shaped similarly to the first flared element and facing the same, said flared elements being adapted to be relatively close at one side of their axes and relatively separated at the opposite side thereof, means supported on the other housing section to support the adjusting shaft, a universal joint between the two shafts at the center between the two flared elements, said joint including a universal housing split similarly to the division in the main housing, the outer surface of the universal housing having surfaces shaped to contact the inner spherical surfaces of the flared elements, an inlet into the housing, an outlet therefrom and spaced from the inlet, vane means extending between the facing flared elements and contacting the inner surface of the main housing and the outer surface of the universal housing, and shims between the main housing sections to permit adjustment for wear in the elements along the directions of the shafts.

10. In a pump, a housing having an inlet and an outlet, said housing having a bearing surface therein having a center and a component extending laterally and axially of said center, a rotating element in said housing rotatable about said center and having a surface rotatable on said bearing surface, entraining means causing

said rotating element to draw fluids from the inlet and to discharge the same under pressure from the outlet, said pressure causing a bearing load having a component transversely of the axis of rotation of the element toward the inlet side thereof, and means introducing fluid under pressure from the outlet side of the pump to said lateral and axial part of the bearing surface to provide a force component opposing the aforesaid transverse bearing load component.

11. In a pump, a housing having an inlet and an outlet, said housing having a bearing surface that is a portion of a sphere, a rotor in said housing having a surface fitting on the bearing surface, and an axis extending through said surface, entraining means causing the rotor to draw fluid from the inlet and discharge the same under pressure into the outlet, said pressure causing bearing load forces to act to urge the rotor axially against the bearing surface and forces acting transversely against the rotor from the outlet side to the inlet side, and means introducing fluid from the high pressure side into the bearing surface on the low pressure side to act against the surface of the rotor in opposition to said forces.

12. In a pump, a housing having an inlet and an outlet, said housing having a bearing surface that is a portion of a sphere, a rotor in said housing having a surface fitting on the bearing surface, an axis extending through said surface, entraining means causing the rotor to draw fluid from the inlet and discharge the same under pressure into the outlet, said pressure causing bearing load forces to act to urge the rotor axially against the bearing surface and forces acting transversely against the rotor from the outlet side to the inlet side, means introducing fluid from the high pressure side into the bearing surface on the low pressure side to act against the surface of the rotor in opposition to said forces, said introducing means comprising a channel extending around the inlet side of said bearing surface and connected to the outlet side, and a plurality of fluid receiving cut-out means on the surface of the rotor adapted to register with the channel and receive fluid under pressure therefrom to act against said bearing load forces.

13. In a pump, a housing having an inlet port and an outlet port opening therein, a rotor mechanism comprising a pair of opposed facing elements having axes of rotation disposed at an angle to each other, means joining the facing elements to provide a driving connection therebetween and to establish a channel shaped fluid receiving space relatively narrow at one end of a diameter across the facing elements and relatively wide at the other end of said diameter, a plurality of vanes dividing said fluid receiving space into chambers, said vanes extending from facing element to facing element and from the joining means to the inner wall of the housing, said inlet port and said outlet port each having a portion extending over a considerable arc of the rotor mechanism opposite the channel shaped space and being separated at both ends by a space substantially equal to the peripheral length of one chamber.

14. In a rotary hydraulic pump, a fluid chamber therein having inner and outer walls, a wear adjusting vane comprising a main member and a mating member movable relative to said main member, said main member having a fluid receiving lengthwise slot in the upper edge of the periphery thereof, a lengthwise slot in the lower edge of the periphery thereof, and two cross-wise slots in the lower edge of the periphery thereof, said mating member having an upper portion adapted to fit slidably in the lower lengthwise slot of said main member, two thicker portions adapted to fit slidably in the cross slots of said main member, and an inner surface machined to fit the inner wall of the fluid chamber of said pump.

15. In a pump having a housing with inlet and outlet openings, a rotor rotatable in the housing, vanes on the rotor, said vanes comprising complementary elements adapted for relative movement in a radial direction, one element being adapted to seal inwardly against the rotor and the other element outwardly against the housing, means to support the vanes on the rotor, and means to admit fluid from the high pressure side of the vanes only to the space between the complementary elements to urge both elements into sealing relationship with the rotor and housing including a groove in one of the elements into which the other element fits, said groove being in communication with fluid on the high pressure side of the vanes.

16. In a rotary hydraulic pump, a fluid chamber therein including inner and outer walls, wear adjusting vanes dividing the chamber into a plurality of compartments, each vane having a high pressure side and a low pressure side when the pump is in operation, each vane comprising a main member and a mating member, said main member having a lengthwise slot in the upper edge of the periphery thereof, a lengthwise slot in the lower edge of the periphery of the main member, said mating member having an upper portion adapted to fit slidably in the lower lengthwise slot of said main member and means for introducing fluid from the high pressure side of the vane into both of said slots.

DOUGLAS JOHNSTON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 15,173 | Carpenter | June 24, 1856 |
| 295,380 | Froude | Mar. 18, 1884 |
| 764,465 | Hendricks | July 5, 1904 |
| 1,678,050 | Kearney | July 24, 1928 |
| 1,777,923 | Johansson | Oct. 7, 1930 |
| 1,961,592 | Muller | June 5, 1934 |
| 2,049,775 | Holmes | Aug. 4, 1936 |
| 2,101,051 | Cuny | Dec. 7, 1937 |
| 2,101,428 | Cuny | Dec. 7, 1937 |
| 2,154,456 | Knapp | Apr. 18, 1939 |
| 2,211,417 | Granberg | Aug. 13, 1940 |

FOREIGN PATENTS

| Number | Country | Date |
|---|---|---|
| 462,054 | Great Britain | Mar. 1, 1937 |
| 522,845 | Germany | 1931 |
| 626,506 | Germany | Feb. 27, 1936 |