Feb. 6, 1945. H. L. CHISHOLM, JR 2,369,019

ROTARY HYDRAULIC PUMP OR MOTOR

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Fig. 5.

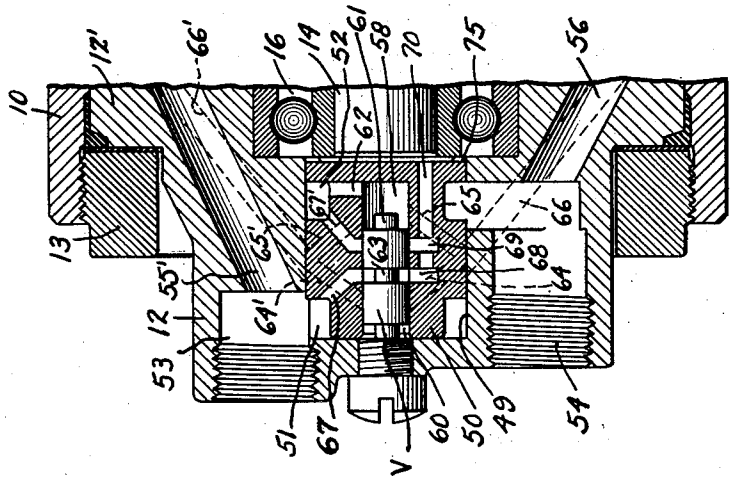
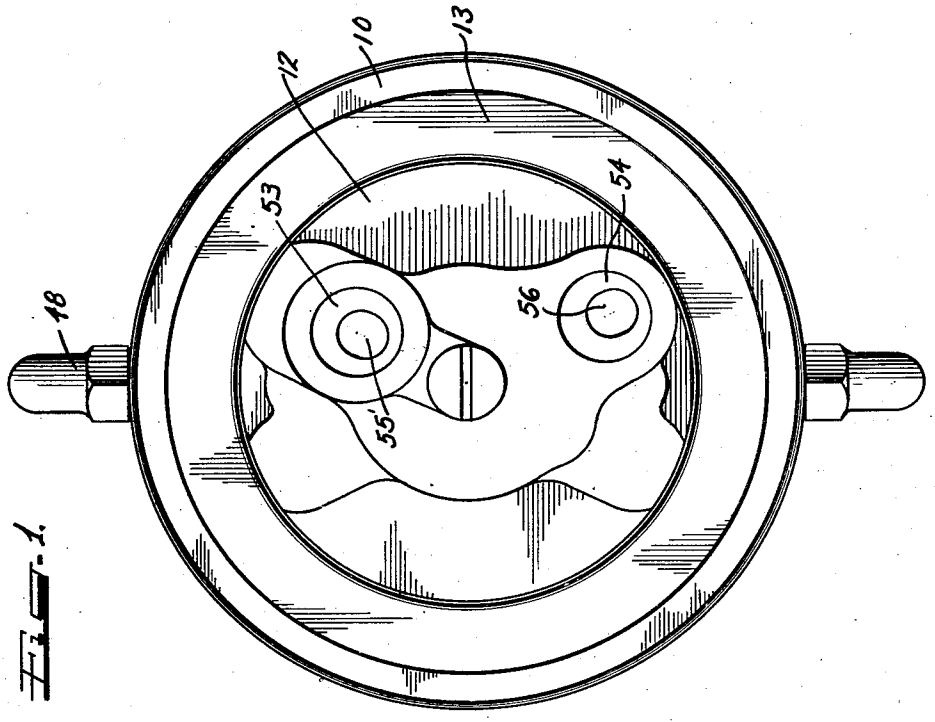


Fig. 1.



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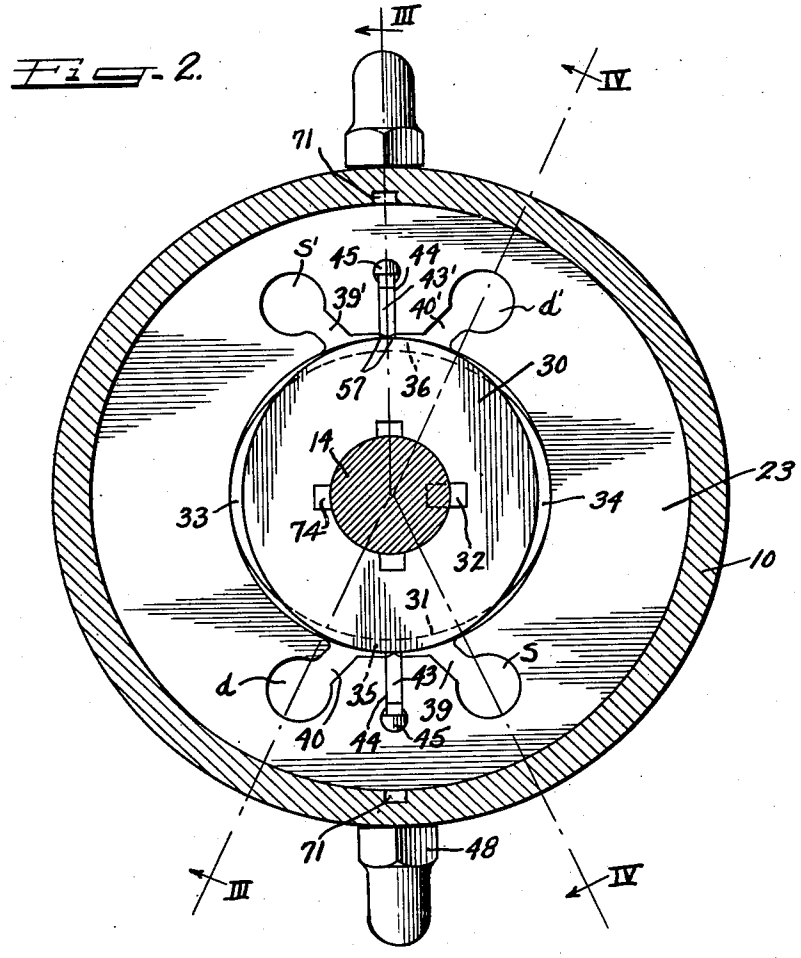
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ROTARY HYDRAULIC PUMP OR MOTOR

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Fig. 2.



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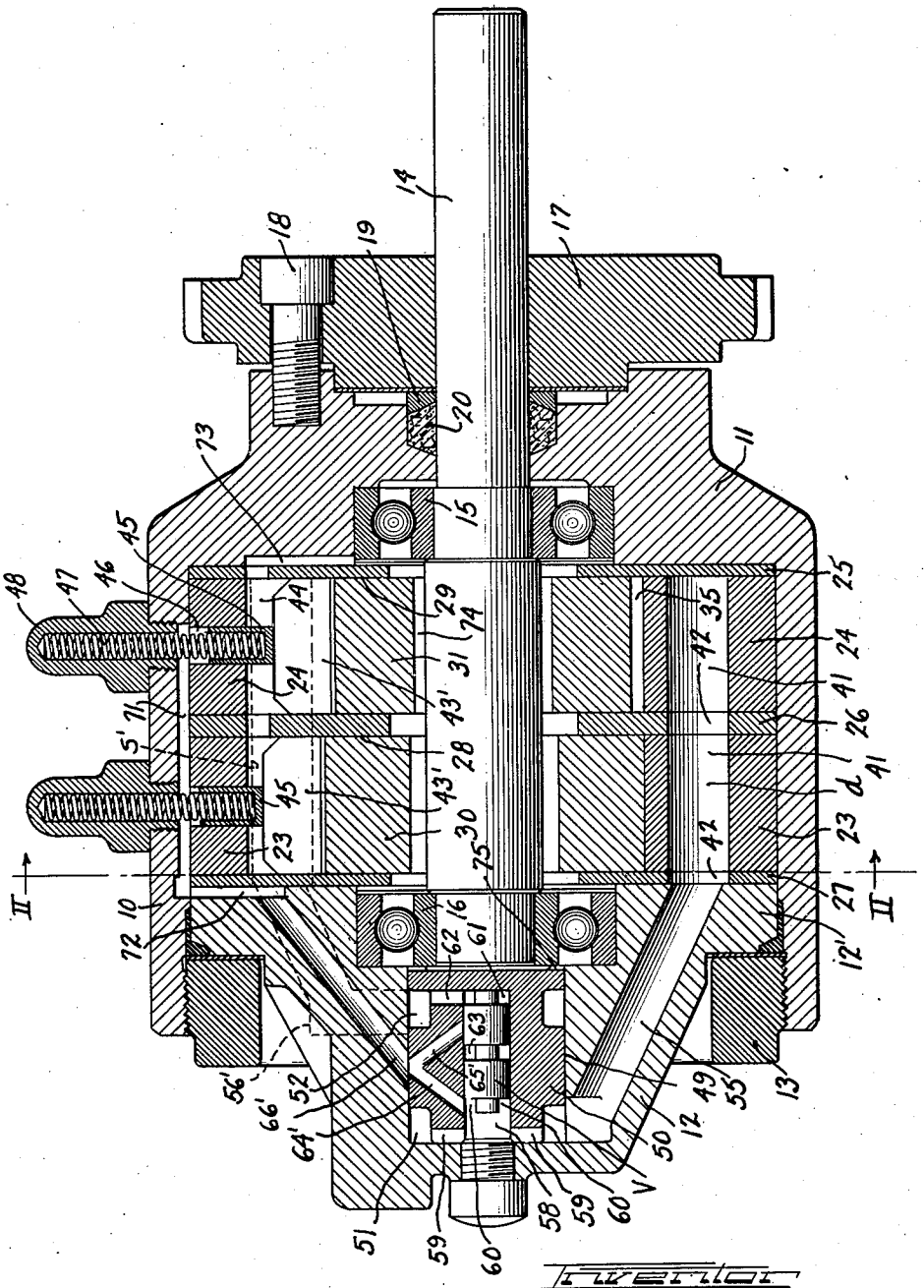
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ROTARY HYDRAULIC PUMP OR MOTOR

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Fig. 3.



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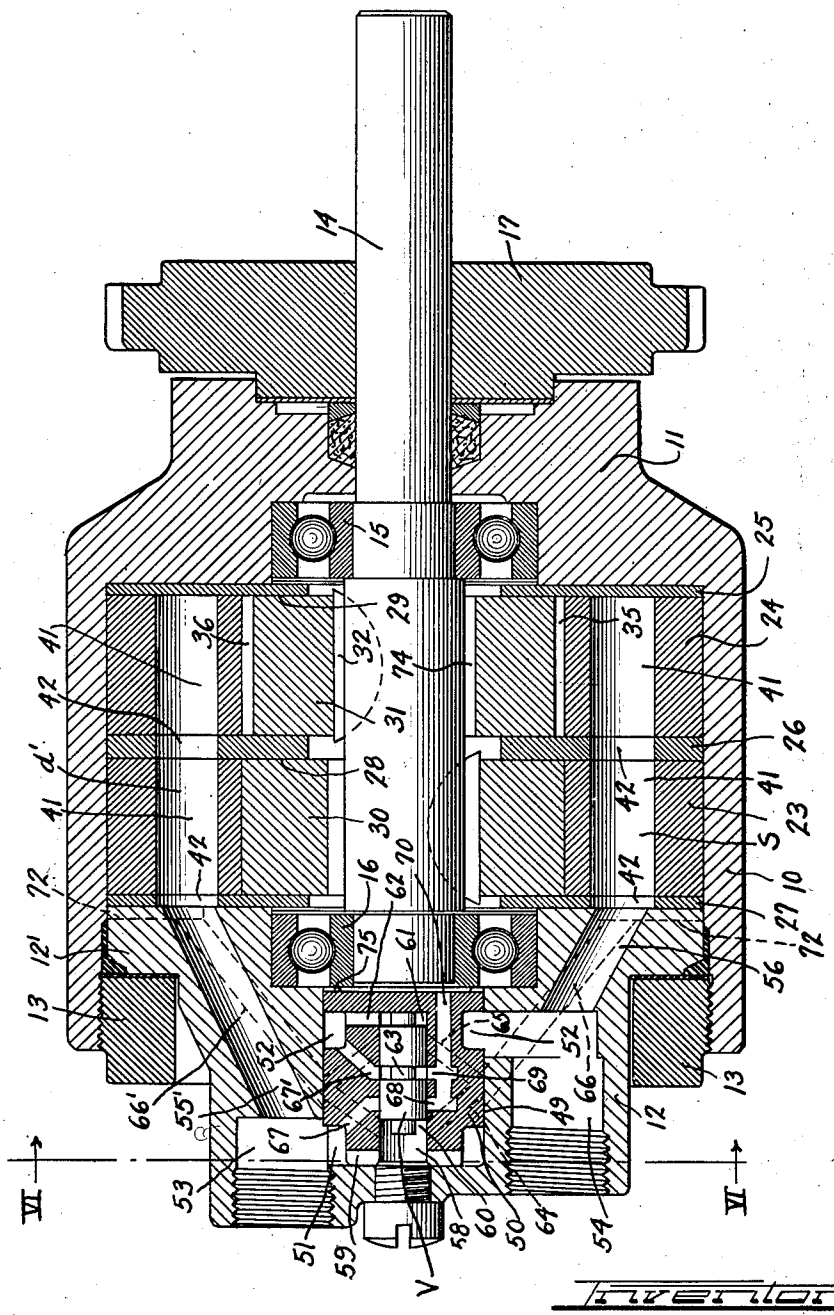
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FIG. 4



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Fig. 6.

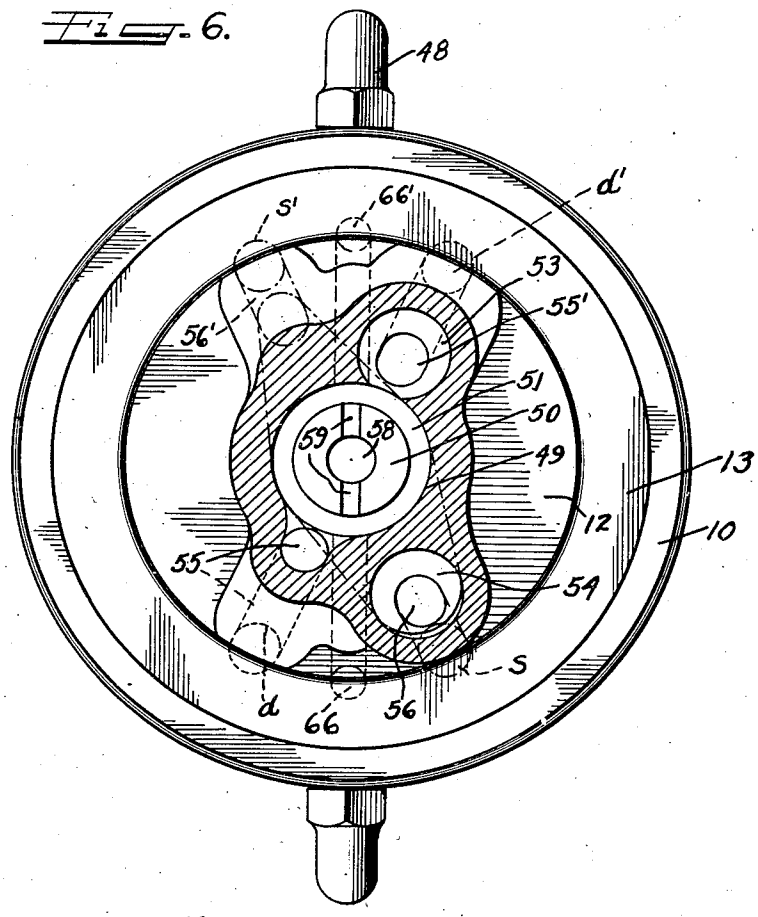


Fig. 7.

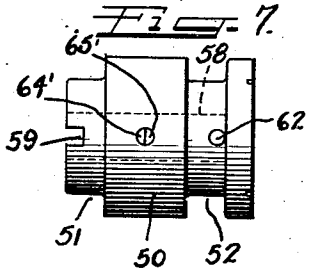


Fig. 8.

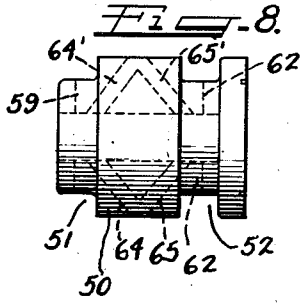
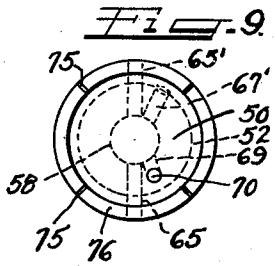


Fig. 9.



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Patented Feb. 6, 1945

2,369,019

UNITED STATES PATENT OFFICE

2,369,019

ROTARY HYDRAULIC PUMP OR MOTOR

Harry L. Chisholm, Jr., Buffalo, N. Y., assignor to Houdaille-Hershey Corporation, Detroit, Mich., a corporation of Michigan

Application May 8, 1942, Serial No. 442,147

2 Claims. (Cl. 103—123)

My invention relates to hydraulic devices, particularly of the rotary type, which can be operated with equal efficiency to function as a pump or a motor. My invention is particularly applicable to hydraulic structures such as disclosed in my copending application, Serial No. 437,334, filed April 2, 1942. The hydraulic structure in this pending application is operable either as a rotary pump or as a hydraulic motor, but with only one direction of rotation of the rotor element so that the structure is not reversible.

An important object of my present invention is to adapt structures of the type referred to for reversibility when operated either as a hydraulic pump or as a motor.

A further object is to provide improved construction and control of the rotor engaging blades for adaption of the structure for equally efficient forward or reverse operation.

Still another object is to provide for subjecting the rotor engaging blades to differential high pressures cooperable with spring means engaging the blades so that the pressure engagement of the blades with the rotor will be substantially constant under all pressures of the fluid flow through the structure and with minimum friction so as to avoid loss of energy and efficiency, particularly during starting of the structure as a pump or as a motor.

A further object is to provide valving means automatically set by the direction of fluid flow through the structure for connecting at all times the outer ends of the blade chambers for flow of fluid thereinto from the high pressure side of the structure, whether the structure is operated in either direction as a pump or as a motor.

The above enumerated and other features of my invention are embodied in the structure shown on the accompanying drawings, in which drawings

Figure 1 is an end view of the structure:

Figure 2 is a section on plane II—II of Figure 3;

Figure 3 is a section on plane III—III of Figure 2 showing the automatic valve in its inner position;

Figure 4 is a section on plane IV—IV of Figure 2 showing the automatic valve in its inner position.

Figure 5 is a section similar to Figure 4 of the end of the structure but showing the automatic valve in its outer position;

Figure 6 is a section on plane VI—VI of Figure 4;

Figure 7 is a side elevation of the plug or housing in which the automatic valve is movable;

Figure 8 is a side elevation of the valve housing displaced 90° from the position shown on Figure 7; and

Figure 9 is an inner end view of the valve housing.

The structure shown comprises a cylindrical housing wall 10 having the inner wall or head 11 integral therewith. On the other end of the housing a head 12 is provided whose flange 12' fits into the housing and between which and the head 11 are clamped the various elements which form the pump cylinder, the clamping being effected by a ring 13 threading into the end of the wall 10. A shaft 14 extends into the housing and is journaled in ball bearings 15 and 16 supported respectively by the head 11 and the head 12, the shaft extending outwardly from the head 11 for mounting or connection with a driving source, such as an electric motor, when the structure is used as a pump, or with devices to be driven when the structure is operated as a motor.

A fitting 17 receives the shaft and is secured as by bolts 18 to the head 11 and may serve as a bracket for supporting the hydraulic structure. The fitting 17 engages the washer 19 for compressing packing 20 around the shaft to prevent leakage.

The pump cylinder forming elements comprise two rings 23 and 24, an inner plate 25, an intermediate plate 26, and an outer plate 27, the outer diameters of the rings and plates being such that they will fit snugly in the cylindrical bore of the wall 10 to be clamped between the heads 11 and 12 by the clamping ring 13. The rings and plates define annular cylindrical spaces 28 and 29 into which the rotor elements 30 and 31 extend for rotation by the shaft 14 to which they are secured as by keys 32. The pump may have any number of rotors and rings, two sets being shown.

The rotor elements 30 and 31 are of generally elliptical or oval shape so as to define with the cylinder space walls crescent-shaped working chambers. The rotors are displaced 90° on the shaft 14 so that the opposite working chambers 33 and 34 between the rotor 30 and ring 23 will have their maximum volumetric displacement when the working chambers 35 and 36 between the rotor 31 and the ring 24 have their minimum volumetric displacement.

For the cylinder spaces 28 and 29, in which

the rotors operate, diametrically opposite fluid inlet passageways *s* and *s'* and diametrically opposite fluid discharge passageways *d* and *d'* are provided. To form these passageways, the rings 23 and 24 have transverse bores 41 which align with the bores 42 through the plates 26 and 27. The inlet passageways *s* and *s'* communicate with the cylinder spaces through ports 39 and 39' while the passageways *d* and *d'* communicate with the cylinder spaces through ports 40 and 40' (Figure 2). At their inner ends the inlet and outlet passageways are closed by the plate 25.

Rings 23 and 24 are each provided with diametrically opposite blades 43 and 43' for cooperating with the rotors surrounded by the blades, the blades operating in radially extending slots or chambers 44, the blades 43 being located between the inlet passageway *s* and the outlet passageway *d*; while the blades 43' are located between the inlet passageway *s'* and the outlet passageway *d'*. Engaging the outer end of each blade is a plunger or piston 45 slidable in a passageway 46 extending radially through the corresponding ring 23 or 24. The piston is cylindrical and bored to receive a spring 47 which extends outwardly into a plug 48 secured to the housing wall 10. The pressure of the springs 47 tends to keep the blades seated with their inner ends against the respective rotors.

The head 12 has the axial bore 49 extending from its inner end to within a short distance from its outer end, and in this bore is immovably seated the plug 50 which at its outer end has the circumferential channel 51 open to the outer end of the bore 49, and the inner circumferential channel 52 open to the inner end of the bore 49. The head 12 has the passageway 53 open to the exterior and communicating with the plug channel 51. Another passageway 54 in the head is open to the exterior and at its inner end communicates with the plug channel 52. A passageway 55 through the head 12 connects the plug outer channel 51 with the passageway *d* (Figure 3) while a passageway 55' (Figure 4) directly connects the passage 53 with the passageway *d'* within the structure body. The passageway 54 is connected directly through passageway 56 with the passageway *s* in the structure body while a passageway 56' (Figure 3) connects the plug inner channel 52 with the passageway *s'* in the structure body.

The passageways 53 and 54 have internal threading at their outer ends for receiving piping for conducting hydraulic fluid. With the arrangement thus far described, the structure may be operated in either direction as a pump or as a motor.

With the shaft 14 driven by a motor for counterclockwise rotation of the rotors (Figure 2) the passageway 54 will be the inlet for hydraulic fluid flow to the pump and the passageway 53 will be the discharge end of the pump. The drawn in fluid will flow through the passageways 56 and 56' into the pump chambers *s* and *s'* for discharge from the working chambers into the discharge passageways *d* and *d'* and then out through the passageways 55 and 55' and the discharge outlet 53. If the pump is to be driven in clockwise direction (Figure 2) then the passageway 53 will be the inlet and the passageway 54 the discharge outlet, the fluid flow being in reverse direction through the pump. If the structure is to be operated as a motor in clockwise direction (Figure 2) fluid under pressure will enter at the head passageway 53 for flow through passageways 55 and 55' into the passageways *d* and *d'*, the spent fluid flowing out through the passageways *s* and *s'* and the outlet 54. If the structure is to be operated as a motor in reverse or counter-clockwise direction, then the hydraulic fluid under pressure will enter the passageway 54 for flow into the passageways *s* and *s'*, the spent fluid flowing out through the passageways *d* and *d'* and the passageway 53.

In order to obtain efficiency, it is very important that the blades be held with their tips in perfect contact with the rotors so as to avoid leakage of fluid directly from the high pressure to the low pressure side, while at the same time the pressure holding the blades against the rotors is kept constant and with minimum friction between the blades and the rotors, whether the hydraulic structure is operated in either direction as a pump or as a motor. To adapt the blades for reverse operation of the hydraulic structure, the contact ends thereof are of V cross section for presenting a narrow contact line to the rotors and sloping symmetrical surfaces 57 on each side of the central or contact line, with the slope of the surfaces at the most efficient angle. As shown, the angle of slope is about 30.

During operation of the structure in either direction, either of the surfaces 57 will be subjected to the high pressure fluid while the other surface is subjected to low pressure. This high pressure against the blades will tend to shift them outwardly against the resistance of their springs 47, and this outward effort against the blades is always in direct proportion to the pressure of the fluid. I therefore provide means for subjecting the outer ends of the blades at all times to the same hydraulic pressure per square inch as that of the high pressure acting against either end surface of the blades. Such counteracting pressure against the blades is preferably controlled to be at all times slightly greater than the outward pressure against the blades so that this differential pressure will assist the springs 47 in holding the blades in proper contact with the rotors.

For controlling the counteracting pressure against the blades, a valve V is provided. This valve is cylindrical and is slidable in the axial bore or valve chamber 58 extending through the plug 50 from the outer end thereof to within a short distance of the inner end. At its outer end the valve chamber 58 is in communication with the outer plug channel 51 by way of cross passages 59 in the outer end of the plug 50. The valve has the outer port 60 communicating at all times with the outer end of the valve chamber 58, and an inner port 61 communicating at all times with the inner end of the valve chamber which is at all times in communication with the inner plug channel 52 through a passageway 62. The valve has also the intermediate annular port 63.

The valve plug 50 has a pair of outer and inner ports 64 and 65, these ports communicating with the valve chamber 58 and converging outwardly for connection with the passageway 66 through the head 12. Diametrically opposite the ports 64 and 65 the valve plug has similar ports 64' and 65' for connecting the valve chamber with the passage 66' in the head 12.

Referring to Figures 4, 5 and 9, the valve plug has the passages or ports 67 and 67' connecting the valve chamber 58 with the plug channels 51 and 52 respectively, and the passageway or ports 68 and 69 in the valve plug connect the valve

chamber with the passageway 70 terminating at the inner end of the valve plug.

The valve V automatically controls the flow of the high pressure fluid for counteracting the outward pressure of the fluid against the inner end of the blades. Referring to Figures 2 and 3, channels 71 are cut in the housing wall 10 in alignment with the passageways 46 in which the pistons 45 for the blades operate. These channels communicate with the channels 72 in the inner side of the head 12 which are in communication with the passageways 66 and 66' through the head 12. The valve V is automatically shifted by the high pressure flow so that the passageways 66 and 66' will always be open to the high pressure fluid flow whether the structure is operating in either direction as a pump or as a motor.

The surfaces 57 at the contact end of each blade are of the same area, and this area is so proportioned to the area of the respective plunger 45 subjected to the counteracting high pressure that the counteracting pressure is sufficiently greater than the outward pressure against the blade so that this pressure differential may assist the blade spring 47 in holding the blade in proper contact with the respective rotor. This pressure differential varies in value in direct proportion to the variation of the high pressure flow through the structure, thus automatically increasing the force of the blade contact as demanded by the operation of the structure. The differential pressure against the blade is made just sufficient so that this pressure together with the spring will hold the blade in leakage preventing contact with its rotor and with minimum friction under all conditions of fluid flow through the structure, whether the structure is operated as a pump or as a motor in either direction.

Describing now the operation, suppose that the structure is to be operated as a pump with the rotors turning in counterclockwise direction, the hydraulic fluid will be drawn into the passageway 54 and the passageways 56 and 56' and the pump passageways *s* and *s'* and the fluid under pressure will enter the pump passageways *d* and *d'* for discharge through the passageways 55 and 55' and the outlet passageway 53. The high pressure discharge fluid will enter the outer end of the valve chamber 58 through the plug end passageways 59, and this high pressure will shift the valve V to its inner position shown on Figures 3 and 4, the inner end of the valve chamber being under low pressure by virtue of its connection through passageways 56 and 56' with the pump inlet passageways *s* and *s'*. With the valve in its inner position, the plug ports 65 and 65' will be closed by the valve and the ports 64 and 64' will be open to the outer end of the valve chamber for high pressure flow through the passageways 66 and 66' to the channels 71 behind the pistons 45 which engage the blades, for counteraction of the outward high pressure against the blades.

If the direction of rotation is reversed, then the head passageway 53 will be connected to receive the fluid supply which will be drawn into the pump passageways *d* and *d'* and discharged from the passageways *s* and *s'* through the head passageway 54. The outer end of the valve chamber 58 will then be connected with the inlet or low pressure side of the pump while the inner end of the valve chamber will be in communication with the high pressure or discharge side of the pump, this high pressure flow entering the inner end of the valve chamber through the inner plug channel 52 and the passageway 62, and the valve will be shifted to its outer position shown on Figure 5. The outer plug ports 64 and 64' will now be closed and the inner ports 65 and 65' opened to the inner end of the valve chamber so that the high pressure fluid may flow through the passageways 66 and 66' into the channels 71 behind the blade engaging pistons 45 for the counteracting high pressure.

If the hydraulic structure is to be operated as a motor in clockwise direction, the fluid under pressure will be through the head passageway 53 and the passageways 55 and 55' into the passageways *d* and *d'*, the spent fluid entering the passageways *s* and *s'* for outflow through the head passageways 56 and 56' and the outlet 54. The outer end of the valve chamber will then be in connection with the high pressure flow and the valve will be shifted inwardly for flow of counteracting high pressure into the channels 71 behind the blade engaging pistons. For reverse operation of the structure as a motor, the high pressure fluid will enter the head passageway 54 for delivery to the passageways *s* and *s'* for counterclockwise rotation of the motors, the spent fluid entering the passageways *d* and *d'* for discharge through the passageways 55 and 55' and the outlet 53. The outer end of the valve chamber will now be at low pressure and the inner end at high pressure so that the valve V is shifted to its outer position shown on Figure 5, and again the channels 71 behind the blade engaging pistons receives fluid under pressure for counteraction of the outward high pressure against the blades. Thus, whether the structure is operated in either direction as a pump or as a motor, the valve V will automatically be set by the fluid flow for supply of counteracting high pressure against the valve engaging pistons.

As shown on Figure 2, each rotor has four keyways 74 for keys 32 which are preferably Woodruff keys, as shown in Figure 4. However, only one key is used to secure a rotor to the shaft, leaving the other keyways open to form flow passageways between the shaft and rotors. The outer ends of the blade chambers 44 communicate through passages 73 in the head 11 with these flow passageways which are also in communication with the passageway 70 in the valve plug 50 through the ball bearing 16 and passages 75 in the annular seat 76 on the inner end of the valve plug which engages the inner ring of the ball bearing. The passageway 70 is at all times connected with the low pressure side of the structure under control of the valve V. When the valve is in its inner position, the port 69 leading from the passageway 70 is connected through the valve intermediate port 63 and the plug port 67' with the low pressure channel 52, and when the valve is in its outer position (Figure 5) the port 68 extending from the passageway 70 is in register with the intermediate port 63 of the valve for connection with the low pressure outlet of the valve which registers with the passageway 67 in the valve plug leading to the low pressure outlet 53. Thus any leakage fluid is at all times drawn into the low pressure side of the structure.

I have thus produced a practical and highly efficient hydraulic structure which may be operated with equal efficiency in either direction as a pump or as a motor. The valve mechanism automatically controlled by the fluid flow establishes connection at all times for flow of fluid from the high pressure side of the structure for subjection to the blades to counteract the out-

ward high pressure against the blades and to assist the blade springs in holding the blades in accurate contact at all times with the rotor and with minimum friction.

I do not, however, desire to be limited to the exact construction, arrangement and operation shown and described as changes and modifications may be made without departing from the scope of the invention.

I claim as my invention:

1. A hydraulic rotary structure of the type described comprising a housing defining a cylinder space, a rotor within said space shaped to cooperate with the cylinder space wall to define a working chamber, ports for said working chamber connected with the exterior of said housing for fluid flow through said working chamber in forward or reverse direction, a blade between said ports, a passageway behind said blade for receiving fluid for acting against said blade to hold it seated against said rotor, an extension on said housing having a bore, a seat plug in said bore providing a cylindrical valve chamber, a cylindrical valve shiftable axially in said valve chamber, said seat plug and said valve having cooperating ports for controlling the flow of high pressure fluid to said passageway behind said blade, each end of said valve chamber being connected with one of said working chamber ports so that the outer end of said valve chamber is subjected to the high pressure flow when said rotor is operated in one direction and the inner end of said valve chamber is subjected to the high pressure flow when the rotor is operating in the opposite direction, said valve responding to said high pressure flow to be shifted for setting of its ports relative to the seat plug ports for high pressure flow into said passageway during either direction of operation of said rotor.

2. A hydraulic rotary structure of the type described comprising a housing defining a cylinder space, a rotor within said space shaped to cooperate with the cylinder space wall to define a working chamber, ports for said working chamber connected with the exterior of said housing for fluid flow through said working chamber in forward or reverse direction, a blade between said ports, a passageway behind said blade for receiving fluid for acting against said blade to hold it seated against said rotor, an extension on said housing having a bore, a seat plug in said bore providing a cylindrical valve chamber, a cylindrical valve shiftable axially in said valve chamber, said seat plug and said valve having cooperating ports for controlling the flow of high pressure fluid to said passageway behind said blade, each end of said valve chamber being connected with one of said working chamber ports so that the outer end of said valve chamber is subjected to the high pressure flow when said rotor is operated in one direction and the inner end of said valve chamber is subjected to the high pressure flow when the rotor is operating in the opposite direction, said valve responding to said high pressure flow to be shifted for setting of its ports relative to the seat plug ports for high pressure flow into said passageway during either direction of operation of said rotor, said seat plug having a passageway communicating with leakage spaces in the interior of said structure and with certain of said valve seat ports for conducting leakage fluid from said structure into the low pressure end of said valve chamber.

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