Sept. 13, 1949. H. A. W. PETERSEN 2,481,613

HYDRAULIC PUMP

Filed July 2, 1948 3 Sheets-Sheet 1

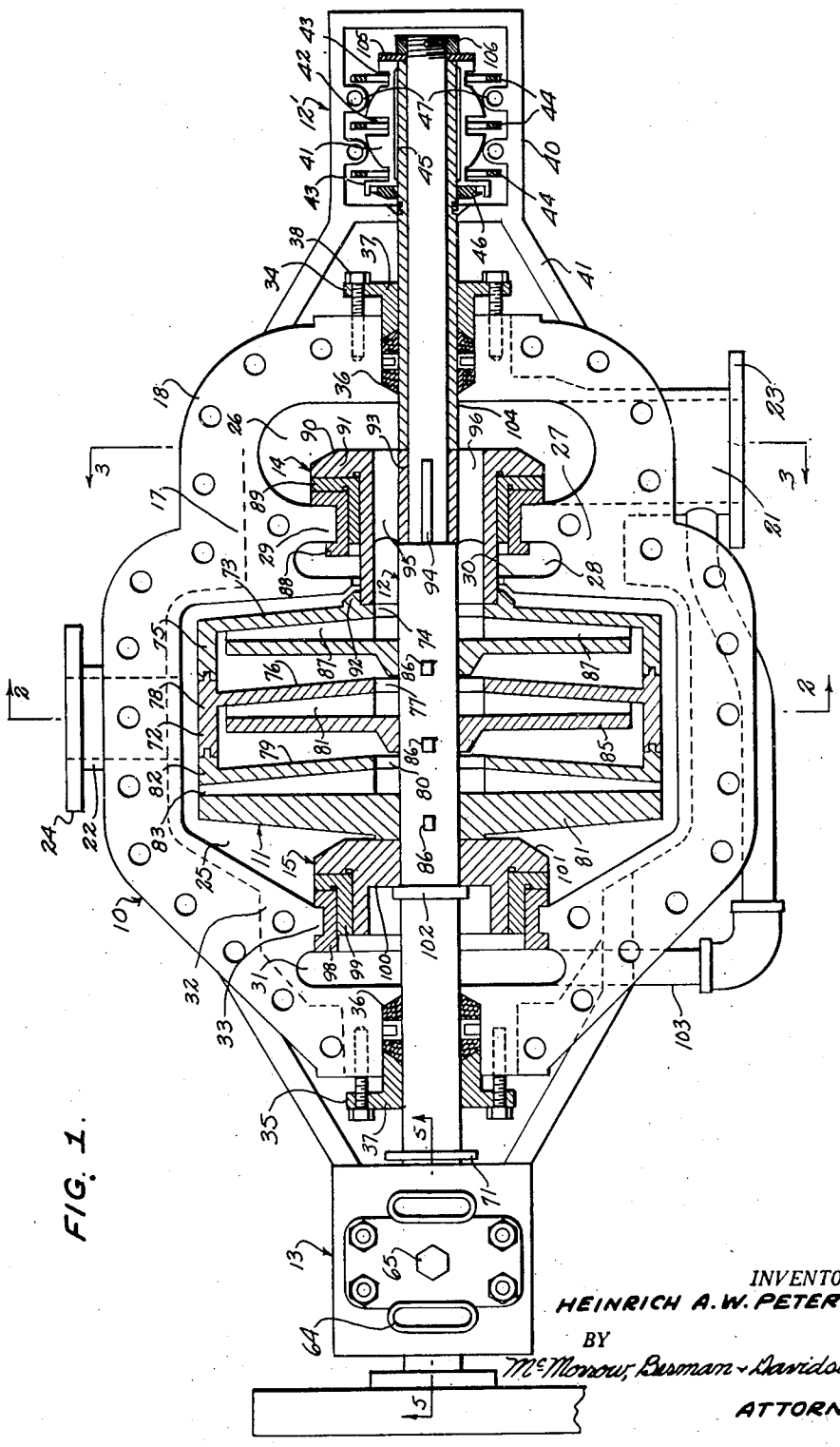


FIG. 1.

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Filed July 2, 1948 3 Sheets-Sheet 2

FIG. 3.

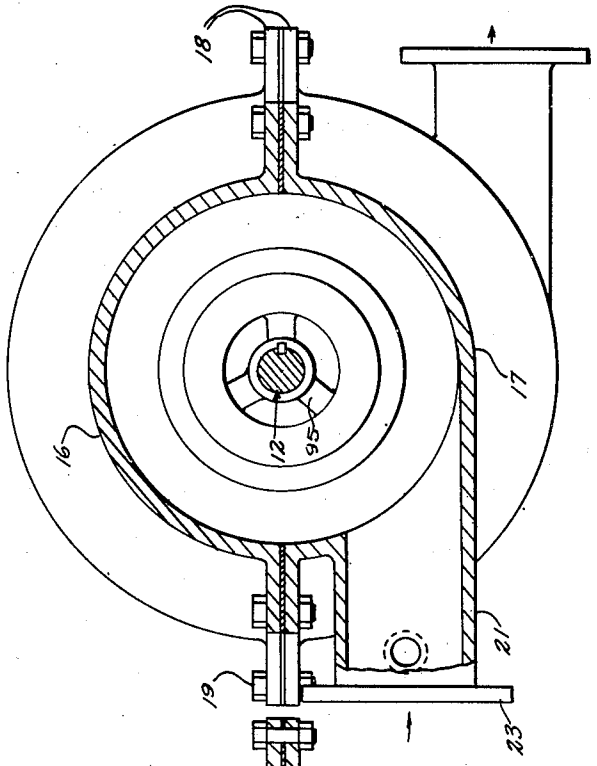
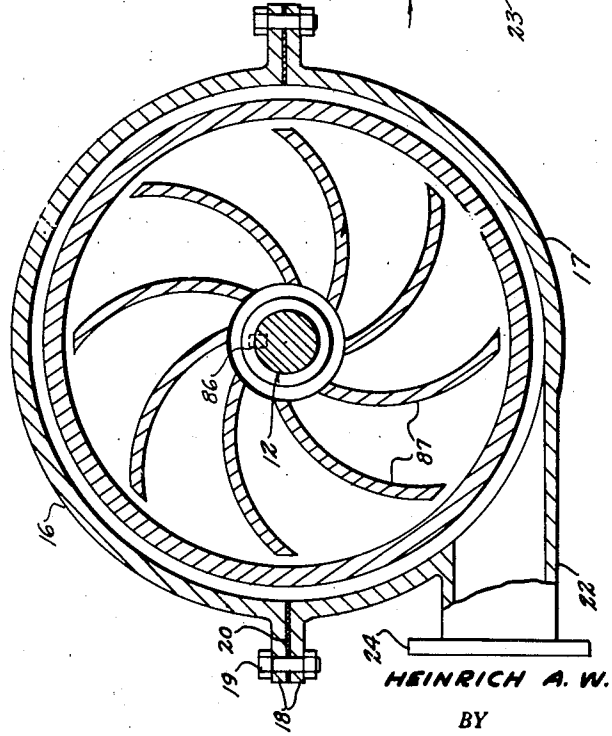


FIG. 2.



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FIG. 4.

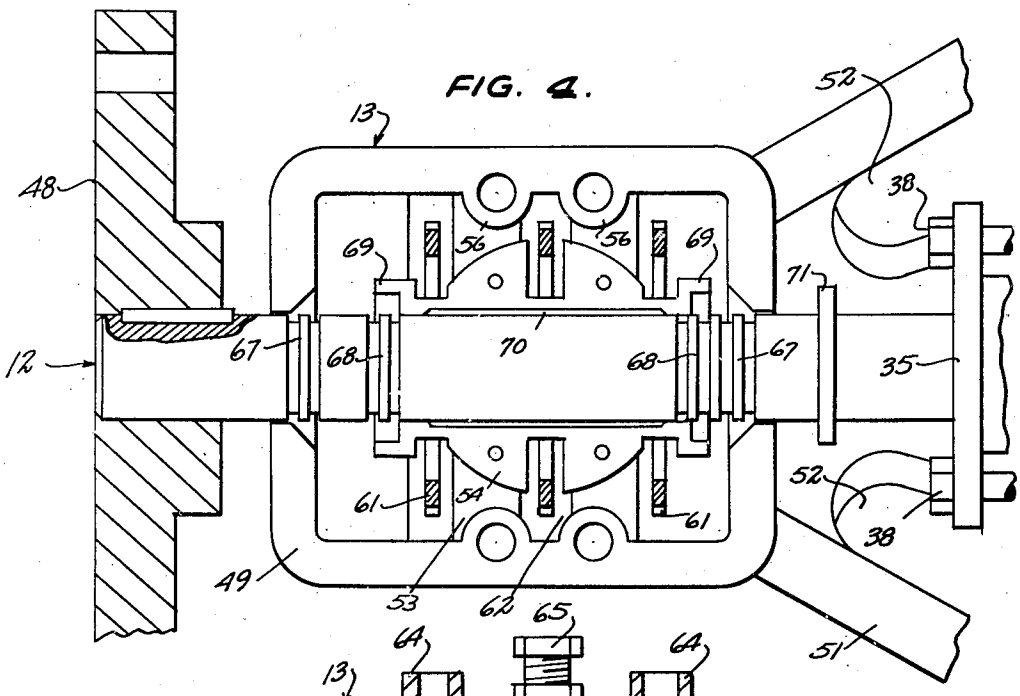


FIG. 5.

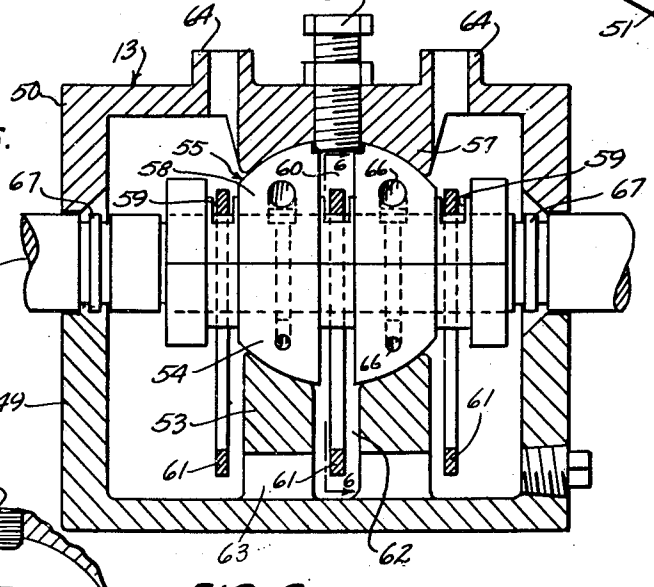
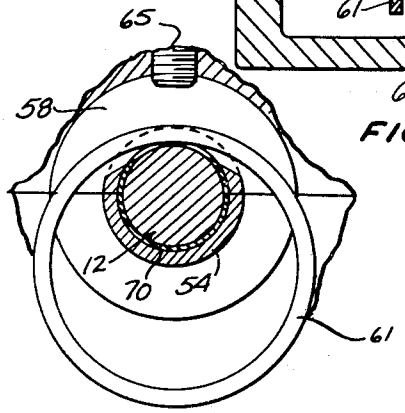


FIG. 6.



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HYDRAULIC PUMP

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Application July 2, 1948, Serial No. 36,771

5 Claims. (Cl. 103—108)

1

This invention relates to improvements in hydraulic pumps and more particularly to an improved multi-stage rotary pump for handling liquids such as water, oil, etc.

It is among the objects of the invention to provide an improved multi-stage rotary pump, the efficiency of which is greatly increased over the efficiency of conventional rotary pumps by the elimination of back leakage between the stages of the pump, which operates without material end thrust on the pump shaft and includes an improved thrust bearing construction for the shaft, is self-priming, of extremely simple, strong and durable construction, economical to manufacture, and is operable at conventional pump speeds by conventional driving means, such as an electric motor.

Other objects and advantages will become apparent from a consideration of the following description and the appended claims in conjunction with the accompanying drawings, wherein:

Figure 1 is a longitudinal medial cross-section through a pump illustrative of the invention, the cross-section being taken on a substantially horizontal plane.

Figure 2 is a transverse cross-section taken substantially on the line 2—2 of Figure 1.

Figure 3 is a transverse cross-section taken substantially on the line 3—3 of Figure 1.

Figure 4 is a longitudinal, medial cross-section on an enlarged scale of one of the end bearings of the pump.

Figure 5 is a longitudinal medial cross-section on a substantially vertical plane of the pump bearing illustrated in Figure 4.

Figure 6 is a transverse cross-section of a fragmentary portion of a pump bearing taken substantially on the line 6—6 of Figure 5.

With continued reference to the drawings, the improved pump comprises, in general, a two part housing 10, a composite rotor 11 mounted on a pump shaft 12, which extends longitudinally through the housing 10 and is journaled in the end bearings 12 and 13 and a pair of thrust bearings 14 and 15 surrounding the pump shaft in the housing 10.

The housing 10 comprises two symmetrical, substantially semi-cylindrical portions providing an upper portion 16 and a lower half or portion 17. The two portions 16 and 17 are provided with outwardly extending marginal flanges 18 apertured to receive bolts 19 spaced apart around the housing to firmly secure the two parts together, a suitable gasket 20 preferably being interposed between the flanges to render the housing leak-proof. An intake conduit 21 extends tangentially from the lower portion 17 of the housing near one end of the latter and an outlet conduit 22 extends tangentially from the same lower portion of the housing near the midlength location thereof. Both of these conduits are provided on their outer ends with respective annular flanges 23 and 24 for the attachment of suitable pipe lines or other conduits thereto. It will be noted from an inspection of Figures 2 and 3 that both the inlet and the outlet conduit enter the lower portion 17 of the housing near the bottom of the latter. The two housing parts 16 and 17 have somewhat tapering end portions and provide, when operatively connected together, an internal cylindrical main chamber 25 and a circular intake chamber 26 separated from the main chamber by an internal annular wall 27 having a circular chamber 28 therein, said wall 27 providing at one side of the chamber 28 a bearing retaining rib 29 surrounding the inner part of the thrust bearing 14 and at the opposite side of chamber 28 an annular lip 30 surrounding an inner part of the thrust bearing. The housing also provides internally thereof a circular leakage chamber 31 spaced from the end of the main chamber 25 opposite the intake chamber 26 by an internal wall 32 providing a thrust bearing retaining rib 33 for the thrust bearing 15. The thrust bearing retaining ribs and thrust bearings disposed one at each end of the main pump chamber retain liquid in the chamber and render the pump self-priming.

2

The pump shaft 12 extends coaxially through the chambers 25, 26, 28 and 31, through the thrust bearings 14 and 15, through the ends of the housing 10 and through the shaft bearings 12' and 13 disposed one at each end of the housing. The ends of the shaft-receiving bore in the housing are counter-bored to receive respective packing assemblies 34 and 35. Each of these packing assemblies includes a body 36 of packing material in the inner end of the respective counter-bore, a packing gland 37 received in the outer end of the counter-bore and secured to the corresponding end of the housing by cap screws 38 which are effective, when tightened, to move the associated packing gland inwardly of the housing to compress the packing material 36 in the conventional manner.

The shaft bearing 12' comprises a substantially semi-cylindrical housing 40 spaced from the adjacent end of the main housing 10 and secured thereto by a strut 41 of semi-conical shape provided with suitable opening to provide access to

the packing gland cap screws 38. This strut is preferably formed integrally with the bearing housing and the associated main housing portion but may be formed separately and suitably secured to the main housing, if desired. The bearing housing 40 is provided internally with a substantially central boss having in its upper surface a partly spherical seat for the semi-spherical, self-aligning bearing bushing 41. This bearing bushing is provided with a central groove 42 and with semi-cylindrical end portion having grooves 43 which grooves receive respective oiler rings 44. The bearing bushing 41 is provided with a shaft receiving bore which has a lining 45 of suitable bearing material, such as Babbitt metal or bronz. The upper half of the self-aligning bearing is provided with slots in the corresponding grooves 42 and 43 so that the oiler rings 44 lie on the top of the shaft and carry oil from the bottom of the lower housing portion 12' to the top of the shaft for distribution through the bearing. An oil slinger washer 46 is secured on the shaft adjacent the inner ends of the bearing bushing to prevent leakage of oil through the shaft receiving aperture in the inner end walls of the upper and lower bearing housing parts. Each bearing housing part is also provided internally thereof with apertured lugs 47 extending inwardly from its side walls, the apertures in the lugs of the lower portion of the housing preferably being internally screw-threaded to receive end bolts which secure the two portions of the bearing housing together.

The front bearing 13 is illustrated in detail in Figures 4, 5 and 6 and is substantially identical with bearing 12' except that bearing 13 is especially constructed for the passage of the shaft 12 entirely therethrough to receive on its outer end one part 48 of a flexible coupling by means of which a driving motor is operatively connected to the pump shaft.

The housing of the bearing 13 comprises a lower semi-cylindrical portion 49 and an upper semi-cylindrical portion 50 fitting upon and secured to the lower portion 49. The lower portion is secured to the corresponding end of the main housing by a suitable strut 51 of semi-conical shape having openings 52 therein providing access to the cap screws 38 of the front packing assembly 35. This part of the housing has in its bottom an upstanding boss 53 having in its upper surface a partly spherical seat for the lower, semi-spherical portion 54 of the substantially spherical self-aligning bearing bushing, generally indicated at 55. The upper portion 50 of the bearing housing is detachably secured to the lower portion 49 by bolts extending through apertured lugs provided internally of the upper portion and threaded into internally screw-threaded apertures or wells provided in corresponding lugs 56 provided in the lower portion 49 of the bearing housing and is provided internally with a downwardly extending boss 57 projecting from the top wall thereof and provided in its lower end with a partly spherical seat for the upper portion 58 of the generally spherical self-aligning bearing 55.

The two bearing portions 54 and 58 are provided with cylindrical end portions having annular grooves 59 therein and the intermediate portions of the bearing is provided with an equitatorial groove 60. The upper sides of these grooves are slotted into the shaft receiving bore of the bearing bushing and respective oiler rings 61 are mounted in the grooves to carry oil from the lower part of lower housing portion 49 to the shaft. The lower boss 53 is provided with a medial groove 62 receiving the middle oiler ring 61 and with a transverse oil passage 63 connecting the bottom of the groove 62 with the lubricant-receiving chambers in each end portion of the bearing housing. Lubricant is supplied to the interior of the housing through apertured bosses 64 on the top wall of the upper housing portion 50 and a suitable abutment bolt 65 extends through the center of the upper housing portion boss 57 into a suitable opening in the top of the upper bearing bushing 58 to prevent the bearing bushing from rotating in the housing while providing sufficient freedom of movement of the bushing in the housing for self-aligning purposes.

The two parts of the bushing are secured together by fastening elements such as Allen screws operatively disposed in registering openings 66 provided in the upper and lower parts of the bushing. Within the housing and near the opposite ends thereof the shaft 12 is provided with a pair of spaced-apart annular grooves each pair providing between them an oil slinger ring 67 to prevent the lubricant from flowing out of the bearing housing around the shaft, and similar rings 68 are provided on the shaft within the flanged end portion 69 of the two part bearing bushing 65. The two parts of the bearing bushings are provided with liners 70 of suitable bearing material, such as Babbitt metal or bronz, around the shaft-receiving bore in the bushing and adequate lubricant is supplied to these linings by the oiler rings 61, as is clearly apparent from an inspection of Figure 5. An annular ring or shoulder 71 is provided on the shaft between the bearing 13 and the packing assembly 35 to prevent any liquid from the pump from flowing along the shaft and into the bearing.

The pump shaft 12 is accurately journaled in the housing 10 by means of the two bearings 12' and 13, and is sealed to the housing against leakage by the packing assemblies 34 and 35.

The pump rotor 11 is secured on shaft 12 within the cylindrical pump chamber 25 and comprises a substantially cylindrical outer casing and a number of internal impellers equal to the number of pump stages desired.

The casing 72 of the pump rotor is made up of several parts for convenience in manufacture and assembly. In the arrangement illustrated, there are three parts including a rear part, an intermediate part and a front part. The rear part has a circular rear wall 73 provided with a central aperture 74 constituting an inner passage for liquid into the rotor, and an annular wall 75 extending forwardly from the outer edge of the end wall and provided in its front edge with an annular groove. The intermediate portion comprises a circular wall 76 having a central aperture 77 providing a fluid passage from the first to the second stage of the pump and has an annular wall 78 peripherally of the circular intermediate walls 76 which annular wall is provided on its rear edge with an annular tongue received in the groove in the front edge of annular wall 75 of the rear portion and in its front edge with an annular groove receiving an annular tongue provided on the rear edge of the front portion of the rotor. The front portion of the rotor comprises a circular inner wall 79 provided with a central aperture 80 constituting a fluid passage from the second to the third or final stage of the pump, with a thick outer front end

wall 81 provided with a central aperture closely receiving the shaft 12, and with an annular wall 82 having the annular tongue on its rear edge seated in the front end groove of the annular wall 78. Between the adjacent surfaces of the walls 79 and 81 the annular wall 82 is provided with a slot 83 through which the fluid passes from the pump rotor into the main chamber 25. From the main chamber, the fluid passes through the outlet conduit 22 which extends from the housing and communicates at its inner end with the main pump chamber. Within the cylindrical casing 72 are two circular impeller walls 84 and 85, respectively positioned adjacent to the rear end wall 73 and the intermediate wall 76 but spaced therefrom.

These impeller walls are provided with central apertures closely receiving the corresponding portion of the shaft 12 and are secured to the shaft against rotation relative thereto by suitable means, such as the Woodruff keys 86. A similar Woodruff key also preferably connects the front wall 81 with the pump shaft. Impeller blades or vanes 87 are disposed transversely of the space between each impeller wall 84 and 85 and the corresponding rear wall 73 and intermediate wall 76 and between the front wall 81 and the inner front wall 79. These impeller blades are preferably formed integrally with the walls at the opposite sides of the spaces in which they are provided and are preferably spirally curved, as illustrated in Figure 2, in conventional form.

With the above construction the entire rotor is rotated by the shaft in the main chamber 25 of the pump and as it rotates liquid flows in through the rotor inlet opening 74 adjacent the shaft, is forced radially outwardly by the first set of impeller blades or vanes into the space between impeller wall 81 and intermediate wall 76 from which it flows to the second stage through intake opening 77 and is again forced radially outwardly by the impeller blades 87 disposed between the impeller wall 85 on the intermediate wall 76 into the space between the impeller wall 85 and inner front end wall 79 from which it flows through the inlet opening 80 into the space between the inner and outer end wall 79 and 81 and is forced radially outwardly by the corresponding impeller blade and discharged through the space between the outer edges of the front end wall 81 and the annular wall 82. The velocity of the fluid is thus built up in several stages in the rotor and the fluid is discharged at high velocity from the rotor into the main pump chamber 25 where its dynamic energy or momentum is converted into hydraulic pressure for discharge of the liquid at high pressure through the outlet conduit 22.

The thrust bearing 14 comprises an annular ring 88 of somewhat U-shaped cross-sectional shape having an outwardly opening annular groove receiving the bearing retaining rib 29 provided by the two portions of the main housing. A pressure ring 89 of right angle cross-sectional shape has its cylindrical portion closely fitting the inner surface of the annular wall of the retaining ring 88 and its annular flange bearing upon the outer surface of the flanged inner end of the ring 88. An inner bearing member 90 has an elongated cylindrical portion journaled in the cylindrical portion of the pressure ring 89 and extending inwardly into contact with the outer surface of the rear end wall 73 of the rotor and has a thickened annular flange 91 bearing on the outer surface of the annular flange of the pressure ring 89. An annular rib 92 is provided on the outer surface of rear rotor wall 73 surrounding the corresponding end of inner bearing member 90 to maintain this member centered relative to the aperture 74. The inner bearing member 90 also includes a cylindrical hub 93 received on the reduced rear end portion of the shaft 12 and secured to the shaft against relative rotation by a suitable key 94. It will be noted that the key 94 is somewhat shorter than the hub so that leakage of fluid will not occur along this key. Hub 93 is connected to the cylindrical portion of the inner member by suitable angularly spaced spokes 95, as particularly illustrated in Figure 3.

With the above arrangement, fluid entering the front intake chamber 26 through the intake conduit 21 flows through the space 96 between the cylindrical portion of the inner bearing member 90 and the hub 93 thereof to the rotor inlet opening 74 in the rear wall 73 of the rotor. Liquid under pressure can leak from the main chamber 25 into the intermediate chamber 28 but cannot leak in any important quantity past the thrust bearing 14 to the inlet chamber 26 as the annular flanges of the thrust bearing members 88, 89 and 90 are held together with sufficient pressure to preclude any important leakage of fluid through the bearing. Any insignificant amount of fluid leaking through this thrust bearing serves to lubricate the bearing and returns to the inlet chamber 26 from which it is again fed into the pump rotor. The outer and inner parts 88 and 90 of the thrust bearing are preferably formed of a suitable bearing material, such as bronz, and the intermediate portion 89 of a hard material such as stainless steel or tool steel to provide good bearing surfaces between the three parts of the bearing. As the intermediate part is rotatable relative to both the inner part and the outer part, the rotational speed between contacting bearing surfaces of the thrust bearing is greatly reduced thereby contributing to long life and satisfactory service of the bearing.

The thrust bearing 15 is interposed between the main pump chamber 25 and the leakage chamber 31 and comprises an outer ring of U or channel shaped cross-section having an outwardly opening intermediate groove receiving the bearing retaining rib 33 of the pump housing at the front end of pump chamber 25, an intermediate pressure ring 99 of right angular cross-section and an inner ring 100 having a cylindrical portion journaled in the cylindrical portion of the pressure ring 99 and a thickened annular flange 101 bearing upon the outer surface of the annular flange of the pressure ring. The outer and inner rings of each bearing are preferably formed of a suitable bearing material, such as bronz, and the intermediate pressure ring 99 is formed of a hard material such as stainless or tool steel to provide suitable bearing surfaces.

The inner ring 100 is provided with a central aperture which closely fits the shaft 12 and is held against forward longitudinal movement on the shaft by an abutment ring or flange 102 provided on the shaft. Any liquid leaking from the pump chamber 25 through bearing 15 to the leakage chamber 31 is returned through a suitable conduit 103 to the intake conduit 21 of the pump. No important quantity of liquid can leak through the improved thrust bearing however, the amount of leakage being only sufficient to lubricate the bearing.

The parts of the rotor 11 are firmly held together and the inner ring 90 of the thrust bear-

ing 14 is held in operative assembly with the rotor by a tubular sleeve 104 which surrounds the reduced end portion of shaft 12 between the rearward end of the hub 93 of inner ring 90 and abutment washer 105 which surrounds the rear end of the shaft and is forced against the end of sleeve 104 by a nut 106 threaded onto the externally screw-threaded rear end of the shaft. When the nut is tightened the inner ring 100 of the thrust bearing 15 is forced against the annular shoulder 102 and the inner ring of thrust bearing 14 is forced against the rear wall of the rotor so that the rotor, the inner rings of the two thrust bearings and the sleeve are all rigidly assembled on the shaft and secured against rotation relative thereto.

By rotating the outer casing 72 of the rotor with the rotor impellers, a leak proof connection can be made between the various stages of the pump so that no liquid will leak back from a higher to a lower stage thus decreasing the efficiency of the pump. The improved pump is thus highly efficient, is simple in construction and extremely easy to assemble, avoids any leakage of liquid around the pump shaft and is extremely durable in use.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. A multi-stage, rotary hydraulic pump comprising a hollow housing having a cylindrical pump chamber therein and two secondary chambers disposed one at each end of said pump chamber and separate therefrom, one of said secondary chambers being larger than the other and constituting an intake chamber for said pump and the other of said secondary chambers constituting a leakage chamber, means hydraulically connecting the leakage chamber to the intake chamber, a pump shaft extending through said housing, a rotor on said shaft within said pump chamber, two self-aligning bearings disposed one at each end of said housing rotatably supporting said shaft, two thrust bearings within said housing disposed one at each end of said pump chamber and operatively interposed between said shaft and said housing, an intake conduit extending through said housing to said inlet chamber, and an outlet conduit extending from said pump chamber through said housing, said rotor comprising an outer cylindrical casing rotatable with said shaft and impellers in said casing.

2. A multi-stage rotary hydraulic pump comprising a hollow housing having a cylindrical pump chamber therein and two secondary chambers disposed one at each end of said pump chamber and separate therefrom, one of said secondary chambers being larger than the other and constituting an intake chamber for said pump and the other of said secondary chambers constituting a leakage chamber, means hydraulically connecting the leakage chamber to the intake chamber, a pump shaft extending through said housing, a rotor on said shaft within said pump chamber, two thrust bearings within said housing disposed one at each end of said pump chamber and operatively interposed between said shaft and

said housing, an intake conduit extending through said housing into said inlet chamber, and an outlet conduit extending from said pump chamber through said housing, said rotor comprising a rear end wall, an intermediate wall, an outer front end wall, an inner front end wall, a multi-part annular wall extending peripherally around said end walls and said intermediate walls and having a circumferential opening therethrough between said outer and inner front end walls, two impeller walls disposed one adjacent said rear end wall and one adjacent said intermediate wall, and impeller vanes disposed between said rear end wall and said intermediate wall and the respective impeller walls and between said outer and inner front end walls.

3. A multi-stage rotary hydraulic pump comprising a hollow housing having a cylindrical pump chamber therein and two secondary chambers disposed one at each end of said pump chamber and separate therefrom, one of said secondary chambers being larger than the other and constituting an intake chamber for said pump and the other of said secondary chambers constituting a leakage chamber, means hydraulically connecting the leakage chamber to the intake chamber, a pump shaft extending through said housing, a rotor on said shaft within said pump chamber, means supporting said shaft for rotation in said housing, two thrust bearings within said housing disposed one at each end of said pump chamber and operatively interposed between said shaft and said housing, an intake conduit extending through said housing to said inlet chamber, and an outlet conduit extending from said pump chamber through said housing, said rotor comprising a cylindrical outer casing secured on said pump shaft and providing at one end a liquid inlet opening around said shaft and at its opposite end a circumferential liquid outlet opening, and at least one impeller in said casing rotatable therewith.

4. A pump shaft and rotor assembly comprising a shaft having an annular shoulder thereon and a reduced end portion spaced from said shoulder, a cylindrical casing having a front wall surrounding and closely fitting said shaft and bearing against said shoulder, a rear wall having a shaft receiving opening larger than said shaft, a multi-part annular wall surrounding said shaft between said front wall and said rear wall, internal walls and pump vanes within said casing, a bearing ring having a cylindrical hub receiving the reduced portion of said shaft and an outer cylindrical wall annularly spaced from said hub and connected thereto by radial spokes with said outer wall bearing at one end against said casing rear wall and surrounding the shaft receiving opening in the latter, a cylindrical sleeve receiving the reduced portion of said shaft bearing at its inner end against said hub, and a nut threaded onto said shaft and bearing against the outer end of said sleeve to compress said rotor, said bearing ring and said sleeve between said shoulder and said nut.

5. A multi-stage, rotary hydraulic pump comprising a hollow housing having a cylindrical pump chamber therein and two secondary chambers disposed one at each end of said pump chamber and separate therefrom, one of said secondary chambers being larger than the other and constituting an intake chamber for said pump and the smaller of said secondary chambers constituting a leakage receiving chamber, a pump shaft extending through said housing, a rotor on said

shaft within said pump chamber, means supporting said shaft for rotation in said pump housing, two thrust bearings within said housing disposed one between said pump chamber and said pump intake chamber and the other between said pump chamber and said leakage chamber and operatively interposed between said shaft and said housing, an intake conduit extending through said housing to said inlet chamber, an outlet conduit extending from said pump chamber through said housing, and a conduit connecting said leakage chamber with said pump intake conduit.

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