

Nov. 13, 1962

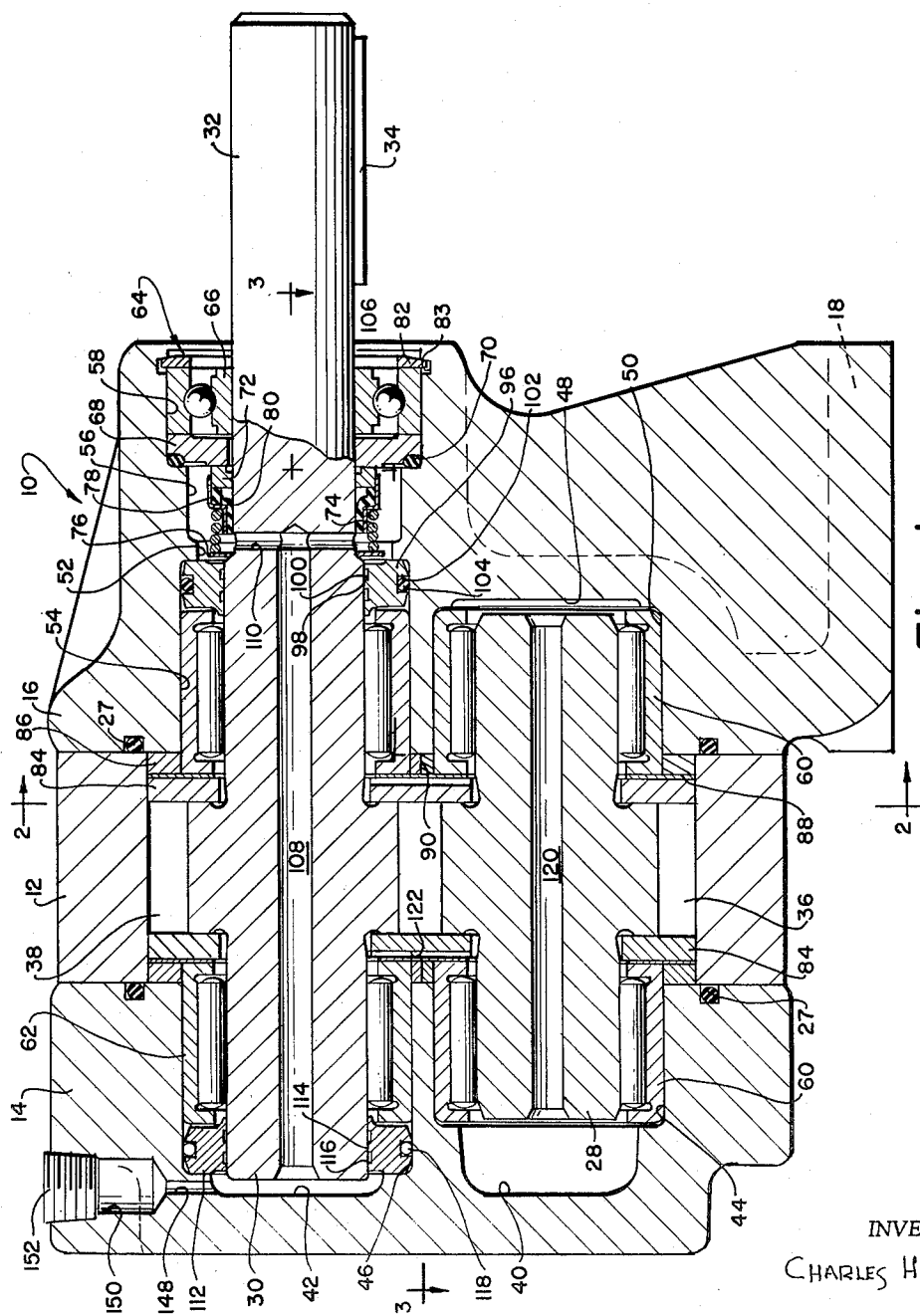
C. H. HART

3,063,378

PUMP CONSTRUCTION

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Fig. 2

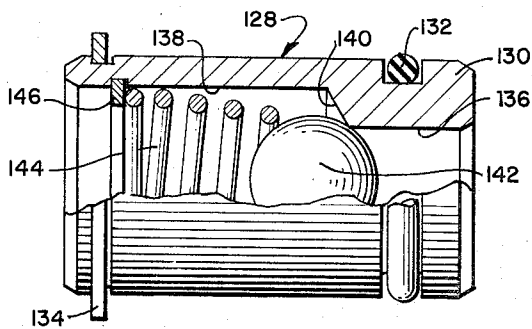
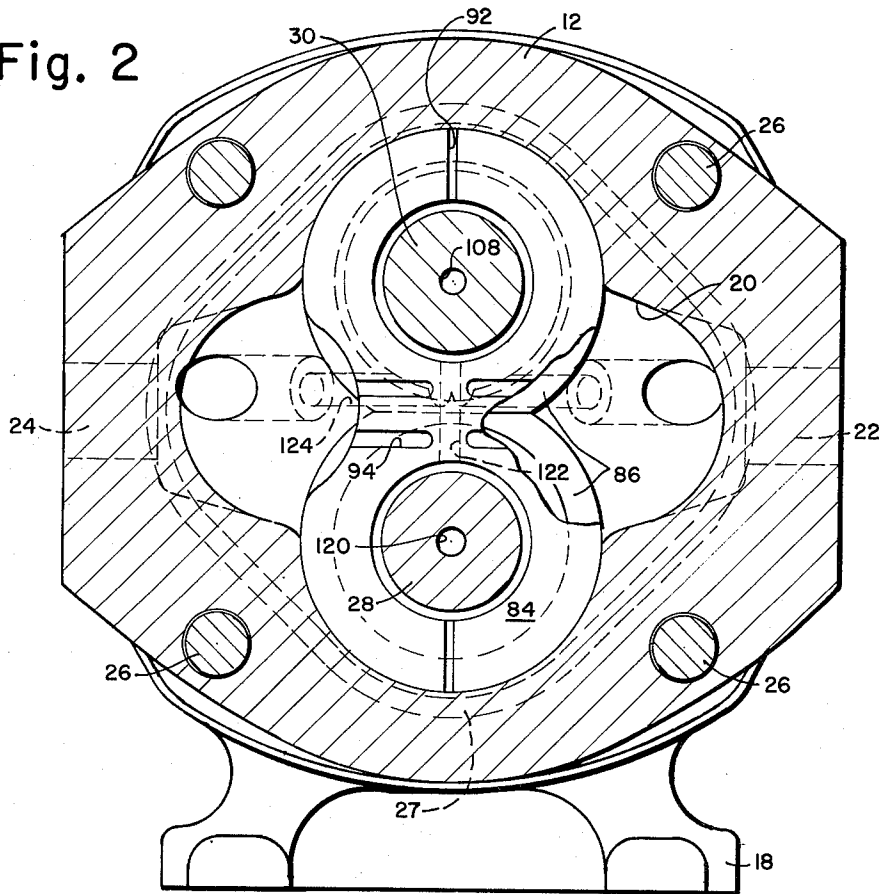


Fig. 4

INVENTOR

CHARLES H. HART

BY *Lushman, Darby & Lushman*

ATTORNEYS

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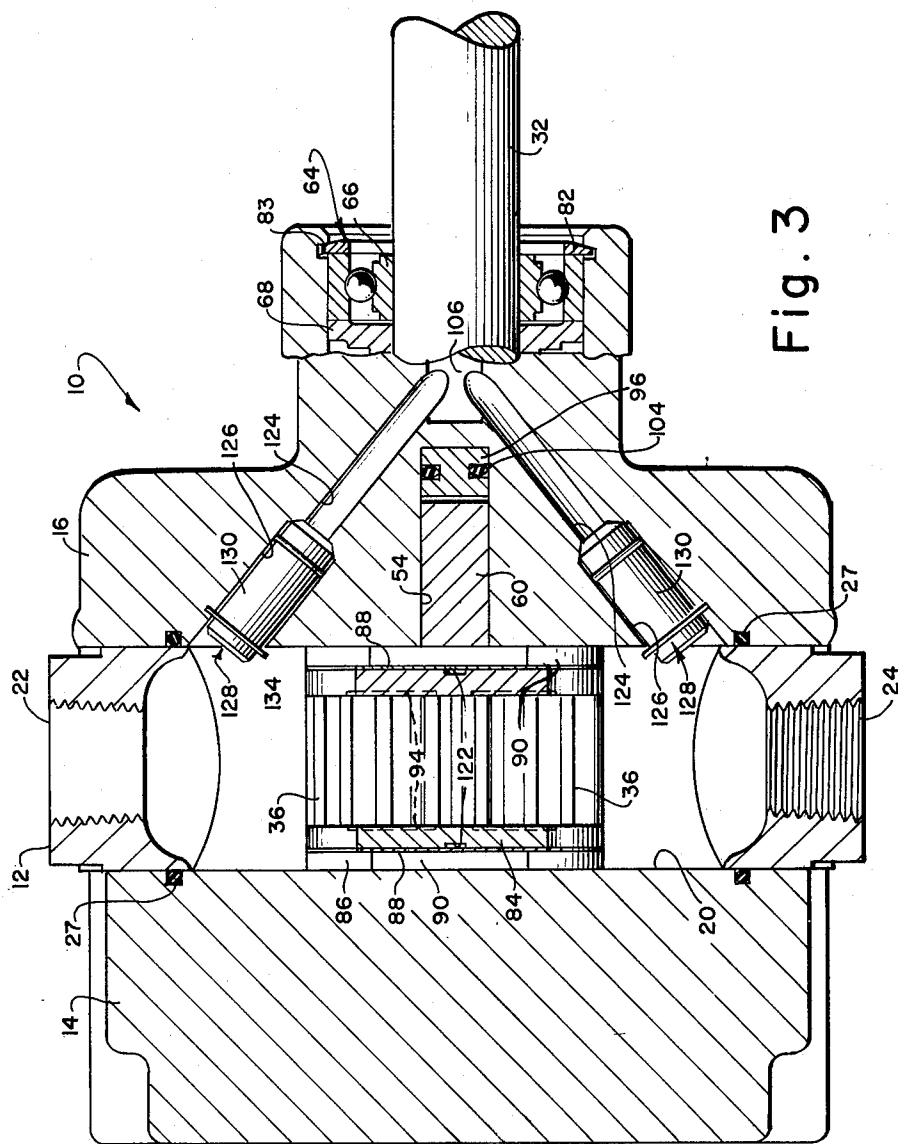


Fig. 3

INVENTOR
CHARLES H. HART

BY *Lushman, Derby & Lushman*
ATTORNEYS

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PUMP CONSTRUCTION

Charles H. Hart, Woodland Hills, Calif., assignor to General Metals Corporation, Adel Precision Products Division, Huntington, W. Va., a corporation of California

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9 Claims. (Cl. 103—126)

This invention relates to pumps and more particularly to high pressure hydraulic pumps of the type embodying a pair of interengaging rotary pump elements such as gears or the like.

Gear type high pressure hydraulic pumps are well-known and usually embody a pump housing having a gear chamber therein provided with a communicating inlet and outlet. Journalled in the housing is a pair of parallel shafts having meshing gears thereon disposed within the gear chamber. One of the shafts constitutes an idler shaft which is disposed wholly within the housing while at least one end of the other shaft extends outwardly of the housing for connection with an electric motor or other instrumentality for imparting rotary motion to the pump.

The prior art pumps, particularly those designed to operate at high pressures, present the problem that the outwardly extending end of the driven shaft cannot be readily journaled and sealed against the high internal operating pressures. It is desirable in those pump installations designed to operate with hydraulic fluid such as oil or the like, to also utilize the hydraulic fluid to lubricate the bearings of the shafts within the housing. Thus, where high operating pressures exist within the housing these high operating pressures will likewise be transmitted to the bearings. It will also be noted that with respect to the driven shaft having one end extending outwardly of the housing, these high pressures will act upon the driven shaft in an unbalanced manner insofar as the axial component is concerned. Moreover, there is also a high pressure applied to the sealed bearing supporting the outwardly extending end of the driven shaft.

In actual practice, it has been found that the most common reason for failure in prior art high pressure hydraulic gear pumps is due to the problem set forth above. While there have been several proposals to alleviate this problem, none have proven entirely satisfactory. For example, it has been proposed to seal off the high pressure within the housing around the internal shaft bearings and to communicate the remaining space within the housing to the low pressure side of the gear chamber so that such low pressure would be applied to the sealed bearing assembly supporting the outwardly extending end of the driven shaft. This arrangement is costly and involves the provision of several dynamic high pressure seals which are difficult to maintain in an effective condition.

An object of the present invention is to provide a pump having improved interior sealing means operable to alleviate the problem set forth above in a simple and effective manner.

Another object of the present invention is the provision of a pump of the type described having improved means therein for sealingly preventing communication of hydraulic fluid under high operating pressure from communicating interiorly with the sealed bearing assembly supporting the outwardly extending end of the driven shaft.

Still another object of the present invention is the provision of a pump of the type described having improved means for minimizing the unbalance of the axial hydraulic pressure forces acting on the driven shaft.

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Another object of the present invention is the provision of a pump of the type described having improved means for supporting the gears within the gear chambers of the housing.

Still another object of the present invention is the provision of a pump of the type described which is simple in construction, efficient in operation and economical to manufacture and maintain.

These and other objects of the present invention will become more apparent during the course of the following detailed description.

The invention may best be understood with reference to the accompanying drawings, wherein an illustrative embodiment is shown.

In the drawings:

FIGURE 1 is a vertical sectional view of a pump embodying the principles of the present invention;

FIGURE 2 is a sectional view taken along the line 2—2 of FIGURE 1;

FIGURE 3 is a sectional view taken along the line 3—3 of FIGURE 1; and

FIGURE 4 is an enlarged detailed view of one of the check valve assemblies of the pump.

Referring now more particularly to the drawings, there is shown therein a pump, generally indicated at 10, embodying the principles of the present invention. The pump includes the usual housing which, as shown, is of three-part construction including an intermediate or center section 12 and opposed end sections 14 and 16. It will be understood that the housing may be suitably adapted for any particular use. For example, as shown, the housing section 16 is provided with a horizontally extending base flange 18 which is suitably apertured to receive mounting bolts to attach the pump to a horizontal surface. The base flange could be eliminated in favor of an annular flange of the type which would enable the housing to be connected in line with a driving instrumentality such as an electric motor or the like.

As best shown in FIGURE 2, the central housing section 12 has a cavity extending therethrough which defines with the adjacent surfaces of the end sections 14 and 16 a pump chamber 20. Extending through the central housing section 12 into communication with the pump chamber 20 is a pair of openings 22 and 24, such openings serving as the inlet and outlet of the pump depending upon the direction of operation. As shown, the openings extend radially outwardly through the central housing section and are interiorly threaded to receive a suitable fluid conduit connector. It will be understood that these openings which communicate with the external plumbing to be used with the pump may be suitably modified to accommodate the requirements of the particular installation involved.

The housing sections are maintained in axially aligned abutting relation by any suitable means, such as a plurality of circumferentially spaced bolts 26 extending through the sections 12 and 14 and threadedly engaged in the housing section 16. A sealed engagement between the housing sections is obtained by the use of O-rings 27 mounted in suitable grooves formed in the inner surfaces of the outer housing sections. The grooves are preferably of rounded-corner square configuration of a peripheral distance equal to the peripheral distance of the O-rings so that the latter may be inserted therein. With this arrangement, a maximum bolt strength is provided with a minimum of space and material.

Disposed within the housing is a pair of parallel shafts 28 and 30, the shaft 28 constituting an idler shaft which is disposed wholly within the housing and the shaft 30 constituting a driven shaft which has one end portion thereof, indicated at 32, of reduced diameter, extending

outwardly of the housing. As shown the end portion 32 of the driven shaft 30 may be provided with suitable means, such as key 34, for connecting the same to the output shaft of an electric motor or other suitable driving instrumentality.

The shafts 28 and 30 have integrally formed thereon or otherwise fixedly secured thereto a pair of cooperating pump elements preferably in the form of conventional spur gears 36 and 38 disposed within the gear chamber 20. It will be understood that the present invention is not limited to gear type pumps but is equally applicable to other types of pumps which operate on the same general principle as gear pumps, that is, pumps which embody a pair of cooperating rotary pump elements.

The present invention is more particularly concerned with the manner in which the shafts 28 and 38 with their gear type pump elements 36 and 38 respectively are mounted within the housing so as to be lubricated by the hydraulic fluid pumped and at the same time controlling such fluid for purposes of lubrication so as to prevent leakage outwardly of the housing. The this end, the housing section 14 has formed therein a pair of parallel bores 40 and 42 which communicate with the gear chamber and extend inwardly a substantially equal distance. Formed in each of the bores 40 and 42 is a counterbore 44 and 46. The housing section 16 is provided with a first bore 48 which is in alignment with the bore 40 and has a counterbore 50 formed therein in alignment with the counterbore 44. As shown, the bore 48, like the bores 40 and 42, terminate in the section 16 and the latter is also provided with a parallel bore 52 which is disposed in alignment with the bore 42 and extends completely through the housing section so as to receive the outwardly extending end 32 of the driven shaft 30. The bore 52 is provided with an interior counterbore 54 which is in alignment with counterbore 46. In addition, a pair of exterior counterbores 56 and 58 are formed in the outwardly extending portion of the bore 52.

Mounted on opposite sides of the gear 36 on the idler shaft 28 is a pair of bearing assemblies 60 which may be of any suitable construction and, as shown, are of the needle or roller bearing type. The bearing assemblies 60 are adapted to engage within the counterbores 44 and 50 respectively with their inner ends projecting slightly therefrom and serve to rotatably support the idler shaft 28. In a like manner, a pair of similar bearing assemblies 62 are provided on opposite sides of the gear 38 of the shaft 30; the bearing assembly 62 extending within the counterbore 46 and 54 and serving to rotatably support the portion of the driven shaft adjacent the gear 38 within the housing. The outwardly extending portion 32 of the driven shaft 30 is supported by a sealed bearing assembly, generally indicated at 64. The sealed bearing assembly may be of any conventional construction and, as shown, embodies a conventional roller bearing assembly 66 engaged within the counterbore 58 in engagement with a stationary inner annular sealing element 68, the latter being provided with an exterior O-ring 70 which engages the inner periphery of a counterbore to prevent leakage adjacent the outer periphery thereof. Leakage along the outer periphery of the shaft 30 is prevented by means of a rotating annular sealing element 72 which rotatably engages the inner portion of the element 68 and is resiliently urged into such engagement by means of a coil spring 74 acting upon a washer 76 and a rigid casing 78 containing a sleeve type resilient seal 80 disposed in engagement with the member 72. The entire assembly is maintained in operative position by any suitable means such as a split ring 82 engaging within an annular groove 83 formed in the outer end of the counterbore, the split ring 82 engaging the ball bearing assembly 66 to retain the same against outward movement. Again it will be understood that the sealed bearing assembly 64 as described above is merely exemplary and that any conventional arrangement may be employed.

The gears 36 and 38 are supported for intermeshing rotational movement within the gear chamber 20 by means of a pair of wear plates 84 disposed in abutting relation to the side edges of the gears and two pairs of cooperating, spacer rings 86, the wear plates and spacer rings both fitting closely within the upper and lower portions of the interior periphery of the pump chamber. Where necessary, shim plates 88 of a shape substantially equal to the shape of the wear plates 84, may be interposed between the wear plates 84 and spacer rings 86 so as to retain the gears 36 and 38 against axial movement within the housing. Each wear plate 84 and associated shim plate 88 constitute together rigid wear plate means. The spacer rings 86 are provided with abutting flat surfaces 90 and are arranged to support the gears 36 and 38 against radial displacement with respect to the central section 12 of the housing by receiving the inner ends of the associated bearing assemblies 60 and 62.

With the arrangement described above, it can be seen that the gears 36 and 38 are supported within the gear chamber in a manner which prevents both radial and axial displacement so that a proper meshing relation between the two gears is at all times maintained. It will be understood that the pumping action achieved by the meshing gears is of a conventional nature and therefore need not be described in detail herein. It is sufficient to state that when the shaft 30 is rotated in a counter-clockwise direction, as viewed in FIGURE 2, the opening 22 will serve as an inlet for the gear chamber 20 and the opening 24 will serve as an outlet. Of course, the portion of the gear chamber adjacent the inlet will be at low pressure while the portion of the gear chamber adjacent the outlet will be at high pressure.

It will be seen that the side edges of the teeth of the gears 36 and 38 will be in engagement with the inner surfaces of the wear plates throughout their entire path of rotation. The gear housing is shaped to provide upper and lower arcuate portions which cooperate with and engage the tips of the gear teeth. The gear chamber adjacent the nip of the meshing gear teeth are enlarged radially outwardly into communication with the associated opening. In this way, the wear plates 84, shims 88 and spacer rings 86 are interposed between the gear chamber and the bearing assembly 60 and 62. The engagement of the wear plates, shims, and spacer rings is such that leakage of high pressure fluid from the gear chamber to the bearing assemblies will occur.

For the purpose of communicating the hydraulic fluid, as for example, oil or the like, with the bearing assemblies 60 and 62 to lubricate the same, there is provided in the gear engaging surfaces of the wear plates adjacent the upper and lower portions thereof, as shown in FIGURES 1 and 2, a vertically extending radial groove 92. As shown, there are four such grooves each extending from the outer periphery of the associated wear plate and communicating with one of the shaft openings thereof. The shaft openings of the wear plates have a diameter greater than the diameter of the associated shaft so that the fluid flowing through the grooves can pass between the interior periphery of the shaft openings and the exterior periphery of the shaft to the associated bearing assembly. In addition, the gear engaging surfaces of the wear plates adjacent the central portion thereof have formed therein a plurality of horizontally extending grooves 94. As shown, there are two pairs of such grooves, each pair extending in parallel relation from the outer periphery of the associated wear plate and terminating adjacent the central portion thereof. Each pair of grooves serves to provide a hydraulic escape for the meshing gears depending upon the direction of rotation of the gear shafts.

The hydraulic fluid which is allowed to pass into the bearing assemblies for the purpose of lubrication is maintained in a pressure-equalized condition within the housing and means is provided for sealingly preventing this high pressure hydraulic fluid from communicating with

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the sealed bearing assembly 64. To this end, a first annular sealing member 96 is disposed within the pump housing adjacent the shaft end portion 32. As shown, the member 96 includes a central opening 98 which rotatably receives the shaft 30 and is provided with a pair of shallow annular grooves 100 for the purpose of providing a more effective hydraulic seal therewith. The outer periphery of the annular member 98 includes an annular groove 102 having an O-ring 104 of rubber or the like positioned therein for engaging the interior periphery of counterbore 54. The annular sealing member 96 forms with the exterior periphery of the adjacent shaft end portion and with the sealed bearing assembly 64 a low pressure chamber 106 within the pump housing. This chamber communicates with the inner end of the shaft 30 by suitable passages formed in the shaft 30, such as axial passage 108 extending from the inner end thereof to the end portion 32 and radially extending passages 110 having their inner ends communicating with the inner end of the axial passage 108 and their outer ends communicating with the chamber 106.

The end of the axial passage 108 adjacent the end of the shaft 30 is sealed from the high pressure hydraulic fluid surrounding the adjacent bearing assembly 62 by means of an annular sealing member 112, similar to the member 96 previously described. Thus, the member 112 includes a central opening 114 which rotatably receives the inner end of the shaft 30, the inner periphery of the opening having a pair of annular grooves 116 provided therein. The outer periphery of the annular member 112 has an O-ring seal 118 mounted within an appropriate groove formed therein for engagement with the inner end of the counterbore 46.

It can be seen that the annular sealing members 96 and 112 serve to prevent the high pressure hydraulic fluid which communicates with the bearing assemblies from communicating directly with the sealed bearing assembly 64 supporting the outwardly extending shaft end portion 32. The housing, excluding the gear or pump chamber, is thus divided into a high pressure chamber which communicates with the bearing assemblies 60 and 62 and a low pressure chamber which communicates with the sealed bearing assembly 64.

The hydraulic fluid within the high pressure chamber within the housing is hydraulically balanced and equalized by the provision of an axial passage 120 extending completely through the idler shaft 28 and a pair of vertically extending grooves 122 formed in the outer surface of the wear plates 84 with its ends communicating with the shaft receiving openings of the wear plates.

In order to insure that the chamber 106 in communication with the sealed bearing assembly 64 is maintained in a low pressure condition, the chamber is communicated with the pump housing inlet or the low pressure side of the pump or gear chamber. To this end, a pair of inwardly converging passages 124 are bored or otherwise formed in the housing section 16, each bore or passage 124 having its inner end communicating with the counterbore 56 and its outer end portion counterbored as indicated at 126 and disposed in communication with the pump or gear chamber defined by the intermediate housing section 12. Disposed within each counterbore 126 is a check valve assembly 128 which may be of any suitable construction.

As best shown in FIGURE 4, each check valve assembly includes a cylindrical housing 130 having its outer periphery grooved adjacent one end to receive an O-ring seal 132 for engaging the inner periphery of the associated counterbore 126. The exterior periphery of the cylindrical housing 130 adjacent its opposite end, is grooved to receive a split ring 134 which cooperates with a groove formed in the associated counterbore 126 to retain the housing within the counterbore. Extending through the cylindrical housing is a main passage or bore

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136 having a counterbore 138 formed in one end thereof so as to form in the central portion of the housing a frusto-conical shoulder 140 defining a valve seat. Mounted within the counterbore 138 is a ball valve 142 which is urged into engagement with the valve seat 140 by means of a coil spring 144 having one end in engagement with the ball and its opposite end in engagement with a split ring 146 engaged within an appropriate groove formed in the interior periphery of the counterbore 138. While it is preferred to utilize a check valve unit of the type described above, it will be understood that other check valve arrangements may be employed, if desired.

Operation

When the apparatus of the present invention is utilized as a fluid pump, the shaft end portion 32 is suitably connected to a source of rotative power, such as an electric motor or the like, through key 34 or the like. As previously indicated, when the shaft 30 is rotated in a counter-clockwise direction, as viewed in FIGURE 2, the opening 22 then serves as an inlet for the gear chamber 20 and the opening 24 will serve as an outlet. The high pressure fluid contained within the pump chamber is communicated with the bearing assemblies 60 and 62 through the openings 94 in the manner previously described. It is contemplated that the pump will operate effectively at pressures of 2000 p.s.i. and up at the output side. It will be understood that there will be some pressure drop in the hydraulic fluid contained within the high pressure chamber within the housing which serves to lubricate the bearings 60 and 62 due to the restrictions through which the fluid passes into the chamber.

It will be noted that the axial passage 120 in the idler shaft 28 serves to equalize the pressure acting on the ends of the shaft so that it will be maintained in a hydrodynamically balanced condition during operation. This high pressure fluid is sealingly prevented from communication with the inner end of the drive shaft 30 through the operation of the sealing elements 96 and 112. It will be noted that while the hydraulic fluid contained within the low pressure chamber 106 acts upon the shaft 30 in a somewhat unbalanced condition axially, the effects of this unbalanced condition are reduced to a minimum due to a minimization of the pressure of the fluid acting in the axial direction and a minimization of the differential area which such pressure may act upon. Thus, the passage 108 serves to maintain an equal pressure on the inner end of the shaft 30 and on the passages 110. The only unbalance is the result of low pressure fluid acting on an area which is equal to the area of the shaft portion 32 minus the cross-sectional area of the passage 108 and the longitudinal sectional area of the passages 110.

Of primary importance is the fact that this low pressure acts on the sealed bearing 64 rather than the high pressure fluid utilized for purposes of lubricating the bearing assemblies 60 and 62. With low pressure fluid acting on the sealed bearing assembly the latter will give many years of trouble-free operation and thus, with the present invention, the biggest source of failure in the prior art pump assemblies is effectively eliminated or reduced to a minimum.

It can be seen that if the pressure in the chamber 106 should exceed a predetermined value, as for example, 20-25 p.s.i., the check valve 142 associated with the passage 124 communicating with the inlet opening 22 will move away from the associated seat 140 to permit flow of fluid from the chamber 106 to the pump chamber until a desired pressure condition within the chamber is obtained. It will be noted that the check valve communicating with the outlet effectively prevents communication of the high pressure fluid in the outlet with the low pressure chamber 106.

It will be understood that the arrangement is such that when the shaft end portion 32 is rotated in the

opposite direction the same operation will occur. In this case, shaft 30 is rotated in a clockwise direction, as viewed in FIGURE 2 and the opening 24 serves as an inlet while the opening 22 serves as an outlet. The check valve communicating with the outlet prevents communication of the high pressure fluid with the low pressure chamber 106 while the other check valve prevents a pressure over a predetermined desired amount from building up in chamber 106.

It will also be understood that the apparatus of the present invention may be utilized as a hydraulic motor in which case fluid under pressure is introduced into the gear chamber through either of the openings 22 or 24 and rotative energy can be taken off of the shaft 32. For this purpose, there is formed in the housing section 14 a bore 148 with its inner end in communication with the bore 42 and its outer end portion provided with a counter-bore 150 which is interiorly threaded to receive a removable plug 152 or the like.

It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that the foregoing specific embodiment has been shown and described only for the purpose of illustrating the principles of this invention and is subject to extensive change without departure from such principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

What is claimed is:

1. A high pressure hydraulic pump comprising a pump housing having a pump chamber and an inlet and outlet communicating with said chamber, a driven shaft disposed in said housing, said driven shaft having one end portion extending outwardly from said housing and an opposite end portion disposed within said housing, a sealed bearing assembly in said housing supporting said one end portion of said driven shaft, an idler shaft disposed in said housing in parallel relation to said driven shaft, a pair of meshing pump elements mounted on said shafts intermediate the ends thereof within said gear chamber, bearing means on opposite sides of each of said pump elements rotatably supporting said shafts within said housing, said bearing means being communicated with the high pressure side of said gear chamber to receive high pressure hydraulic fluid therefrom during operation for purposes of lubrication, said idler shaft having an opening extending axially therethrough hydraulically communicating with the associated bearing means to balance the axial forces of the high pressure hydraulic fluid acting on said idler shaft, first annular sealing means having an exterior peripheral portion sealingly engaging said housing and an interior peripheral portion sealingly engaging said driven shaft at a position thereon disposed between said sealed bearing assembly and the adjacent bearing means, said first annular sealing means and said sealed bearing assembly defining with the portion of the housing and driven shaft extending therebetween a low pressure chamber, said housing having passage means formed therein communicating said low pressure chamber with said inlet so as to maintain the pressure within said low pressure chamber acting on said sealed bearing assembly relatively low during operation, second annular sealing means having an exterior peripheral portion sealingly engaging said housing and an interior peripheral portion sealingly engaging said driven shaft at a position thereon disposed between the said opposite end thereof and the adjacent bearing means, said second annular sealing means defining with said housing a sealed space surrounding the extremity of the opposite end portion of said driven shaft, said driven shaft having passage means formed therein for communicating said low pressure chamber with said sealed space so as to maintain the pressure acting on the opposite end of said driven shaft within said housing relatively low during operation.

2. A pump as defined in claim 1 wherein said housing includes a pair of parallel side walls and a peripheral wall extending therebetween defining said pump chamber, each of said bearing means including a portion extending within said pump chamber, a spacer ring associated with each bearing means, each of said spacer rings being disposed within said pump chamber in engagement with the peripheral wall thereof and in surrounding engagement with the portion of the associated bearing means extending within said pump chamber, the pair of adjacent spacer rings on each side of said pump elements having abutting flat peripheral surfaces, each pair of adjacent spacer rings having first aligned surfaces engaging the associated side wall of said pump chamber and second aligned surfaces disposed in alignment with the adjacent ends of the associated bearing means, and rigid wear plate means disposed within said pump chamber in engagement with the peripheral wall thereof and in abutting engagement between the aligned second surfaces and ends of each adjacent pair of spacer rings and associated bearing means respectively and the adjacent side of said pump elements.

3. A pump as defined in claim 2 wherein said rigid wear plate means comprises a pair of rigid wear plates each having a vertical groove formed in the pump element engaging surface thereof and extending radially from the outer periphery to the inner periphery thereof adjacent each of said shafts.

4. A pump as defined in claim 3 wherein said rigid wear plate means includes shims between said wear plates and the associated spacer rings and bearing means ends.

5. A pump as defined in claim 1 wherein said housing also includes passage means formed therein for communicating said low pressure chamber with said outlet and check valve means in said inlet and outlet communicating passage means for permitting communication between said low pressure chamber and said inlet when the pressure in said low pressure chamber exceeds a predetermined value and for preventing communication between said outlet and said low pressure chamber.

6. A pump as defined in claim 1 wherein said first and second annular sealing means each comprises an annular member having said interior peripheral portion formed integrally thereon, said interior peripheral portion including a cylindrical surface having a pair of shallow, annular grooves formed therein and an O-ring seal mounted in the outer periphery of said annular member constituting said exterior peripheral portion.

7. A high pressure pump comprising a pump housing having a pair of parallel side walls and a peripheral wall extending therebetween defining a pump chamber and an inlet and outlet communicating with said pump chamber, a driven shaft disposed in said housing, having one end portion extending outwardly therefrom, an idler shaft disposed in said housing in parallel relation to said driven shaft, a pair of meshing pump elements mounted on said shafts intermediate the ends thereof within said pump chamber, bearing means on opposite sides of each of said pump elements rotatably supporting said shafts within said housing, each of said bearing means including a portion extending within said pump chamber, a spacer ring associated with each bearing means, each of said spacer rings being disposed within said pump chamber in engagement with the peripheral wall thereof and in surrounding engagement to the portion of the associated bearing means extending within said pump chamber, the pair of adjacent spacer rings on each side of said pump elements having abutting flat peripheral surfaces, each pair of adjacent spacer rings having first aligned surfaces engaging the associated side wall of said pump chamber and second aligned surfaces disposed in alignment with the adjacent ends of the associated bearing means, and rigid wear plate means disposed within said chamber in engagement with the peripheral wall thereof and in abut-

ting engagement between the aligned second surfaces and ends of each adjacent pair of spacer rings and associated bearing means respectively of the adjacent side of said pump elements.

8. A pump as defined in claim 7 wherein said rigid wear plate means comprises a pair of rigid wear plates each having a vertical groove formed in the pump element engaging surface thereof and extending radially from the outer periphery to the inner periphery thereof adjacent each of said shafts.

9. A pump as defined in claim 8 wherein said rigid wear plate means includes shims between said wear plates and the associated spacer rings and bearing means ends.

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