

[54] **VARIABLE SEALED HYDRAULIC PUMP OR MOTOR**

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[51] Int. Cl.**F01c 19/08, F03c 3/00, F04c 27/00**

[58] Field of Search.....**418/131-135, 171, 418/179; 277/26; 267/162**

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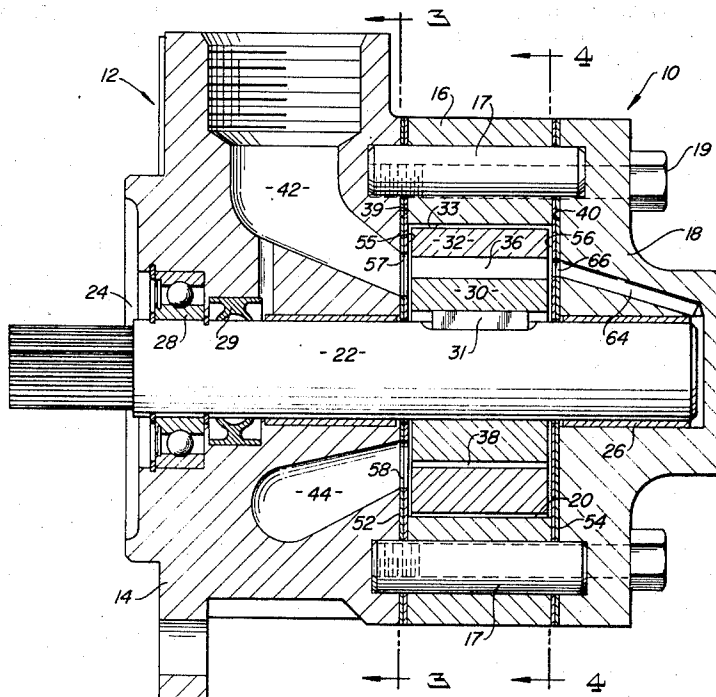
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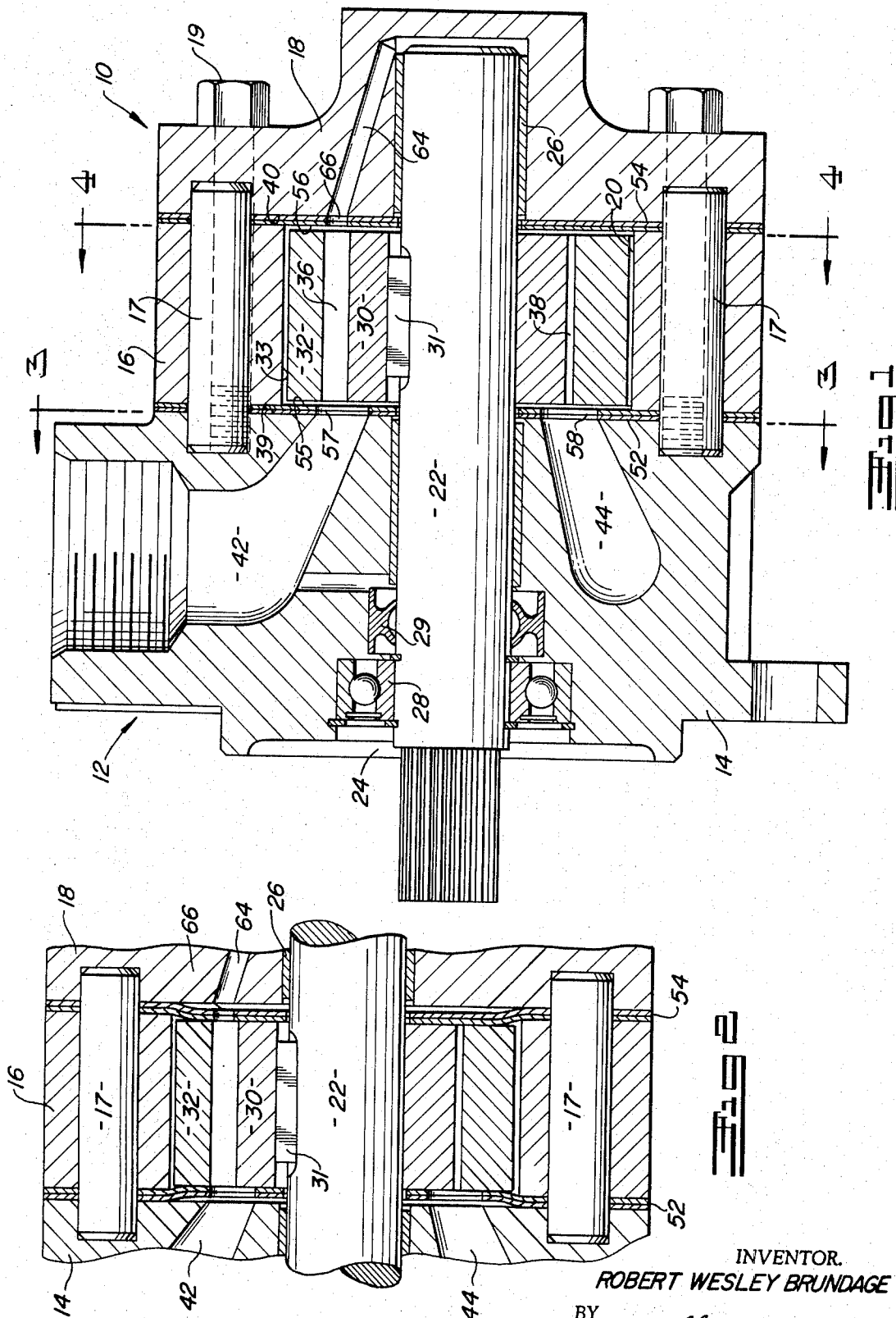
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ABSTRACT

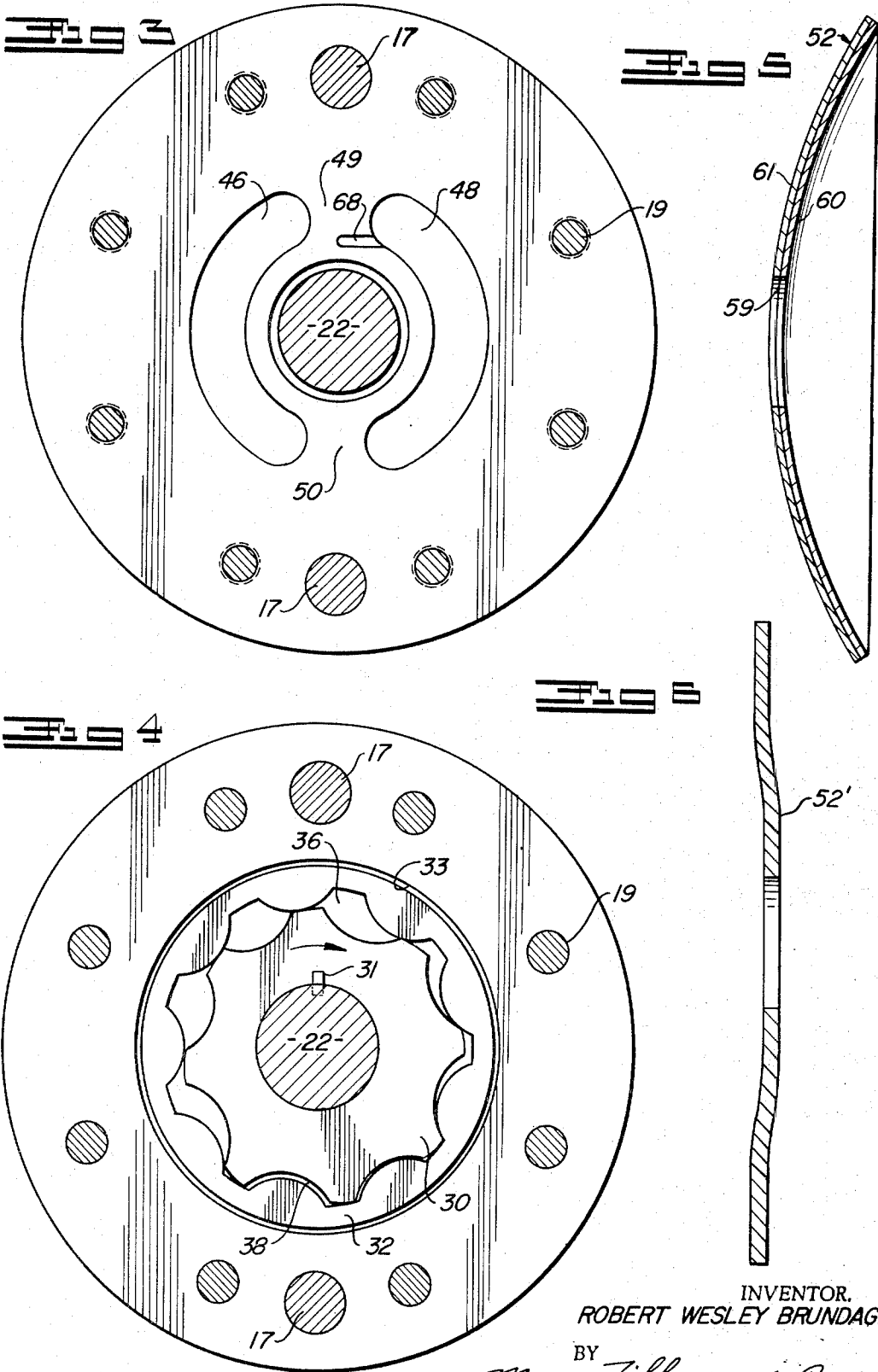
An internal gear pump employs plates at opposite ends of the gears with the plates normally slightly spaced from the axial ends of the gears but deformable into sealing relationship with the gears in response to pressure and/or temperature. The outer periphery of the plates is fixed to the housing and, in the preferred embodiment, the plates are bi-metallic so that as they heat they move to close the space. High pressure is communicated to the side of the plates remote from the gears so as to pressure bias the plates toward the gears. The plates provide an automatic adjustment of the running clearances as the temperature and/or pressures of the device change.

14 Claims, 10 Drawing Figures





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Fig. 7

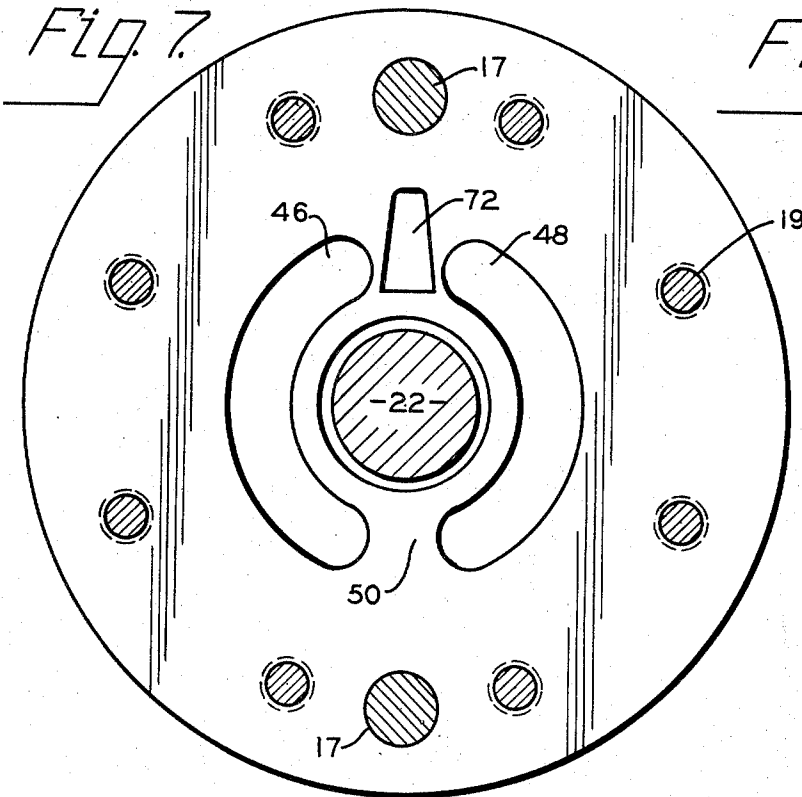


Fig. 9

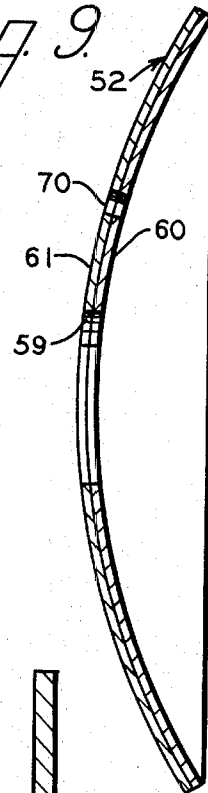


Fig. 8

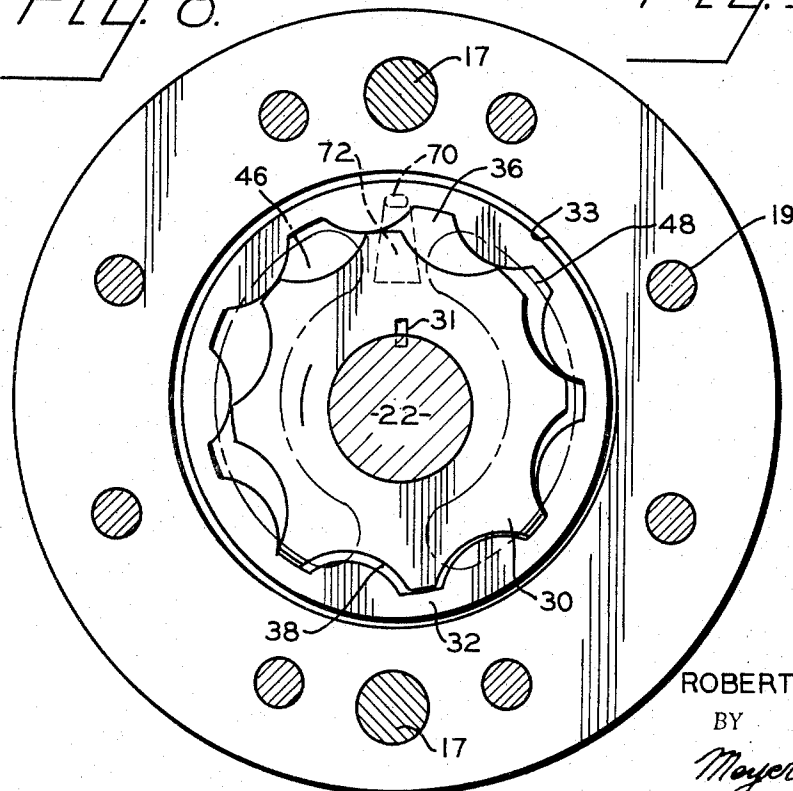
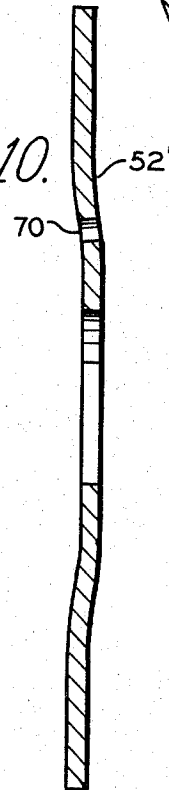


Fig. 10



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VARIABLE SEALED HYDRAULIC PUMP OR MOTOR

This application is a continuation in part of my co-pending application Ser. No. 883,769, filed Dec. 10, 1969 now abandoned.

This invention relates to the field of hydraulic devices and, more particularly, to an improved sealing arrangement for high pressure pumps or motors.

The invention is particularly applicable to internal gear or gerotor type pumps and it will be described with particular reference thereto, although it will be appreciated that the invention has broader applications and may be employed with other types of hydraulic devices such as vane type or external gear type devices.

For purposes of simplicity of disclosure, the invention will be described primarily in relation to a pump and reference will be made to inlet and outlet ports, inlet and outlet manifolds and increasing and decreasing volume chambers, all of which will be at low and high pressures respectively. It will be appreciated that, as applied to a hydraulic motor, the relationship of the low and high pressures will be reversed. Moreover, as will be understood, reversal of direction of rotation of the hydraulic device will merely reverse the inlet and outlet ports and manifolds and the low and high pressure chambers.

Hydraulic devices of the type to which this invention is applicable are normally comprised of a housing and a shaft extending into and rotatably supported in the housing in suitable bearings. A plurality of displacement members such as an internally toothed ring gear and an externally toothed pinion gear rotate with the shaft in a bearing surface eccentric to the axis of the shaft to define a plurality of increasing and decreasing volume pumping chambers. Inlet and outlet manifolds are formed in the housing and communicate with these chambers. Normally, when functioning as a pump, the chambers decreasing in volume communicate with a discharge port and are at high hydraulic pressures while the chambers which are increasing in volume communicate with an inlet port and are at relatively low hydraulic pressures.

As is well known, hydraulic devices of this type normally employ some form of sealing members which cooperate with the axial faces of the displacement members to close the axial ends of the increasing and decreasing volume chambers. In one elemental form, these sealing members may simply comprise the side walls of the chamber in which the gears are disposed. With such an arrangement, there invariably will be, and indeed must be, a clearance between the axial faces of the gear members and the opposed surfaces of the housing. This clearance remains essentially fixed during operation of the pump and constitutes a leakage path through which fluid may flow in amounts proportional to the pressures employed. This leakage primarily occurs adjacent the open mesh position of the gears. It is well known that, with a fixed clearance, the overall efficiency of the device is at its optimum when a relatively viscous hydraulic fluid is employed at moderate pressures. It is equally well known that hydraulic fluids such as oil become substantially less viscous as the temperature of the fluid increases so that, even at moderate pressures, a hydraulic device employing fixed clearances will become less efficient during prolonged operation because the fluid becomes heated and less

viscous resulting in increasing amounts of oil leaking through the fixed clearance. Obviously, such an arrangement is unsatisfactory for a hydraulic device which must have a relatively high efficiency while being operated either over substantial periods of time or at relatively high pressures thereby severely limiting the applications to which fixed clearance devices may be employed.

To remedy the foregoing problem, as well as others, the prior art has evolved a pressure sealed arrangement in which the hydraulic pressures of the device are employed automatically to adjust the clearance between the gear faces and the surfaces closing the increasing and decreasing volume chambers. Typical of such pressure sealed arrangements are my prior U.S. Pats. Nos. 3,034,448, 3,127,843, 3,198,1277 and 3,240,158, all of which disclose an arrangement in which a sealing member is integrally connected to a shaft with both the shaft and sealing member being axially movable under hydraulic pressure to pressure seal the axial ends of the increasing and decreasing volume chambers. As described more specifically in those patents, this pressure sealing is achieved by using the high pressure fluid of the device to urge one axial face of the sealing member toward the opposing axial face of the rotating gears thereby to reduce the clearance therebetween. It is well known that with such pressure seal arrangements, much improved efficiencies of operation can be achieved both at high pressures and with hydraulic fluids having low viscosity. However, one major shortcoming of such arrangements is that pressure sealed pumps draw excessive horsepower during cold weather operation. Moreover, these arrangements do not provide compensation for variations in viscosity of the hydraulic fluids.

The present invention contemplates a hydraulic device which combines the desirable attributes of both the fixed clearance hydraulic devices and the pressure sealed devices while eliminating the undesirable features of both.

In accordance with the present invention, there is provided a hydraulic device of the type heretofore described but in which fixed sealing members close the axial ends of the increasing and decreasing volume chambers and are either pressure sensitive or temperature sensitive or both so that the clearance therebetween is varied in accordance with either or both of these factors. Thus, with the present invention the hydraulic device functions as a fixed clearance device over a certain range of pressures and temperatures but operates as a pressure sealed device either as the pressure increases or the temperature of the hydraulic fluid increases or both.

More specifically, the preferred embodiment of this invention contemplates the use of a bi-metallic plate or disc which is positioned at at least one axial end of the rotating gear members. This plate normally cooperates with the gears to define a fixed running clearance along the axial end faces of the rotating gears. However, in accordance with one aspect of the invention, the bimetallic plate is responsive to the temperature of the hydraulic fluid such that as the temperature increases the plate will deform toward the end face of the gear members thereby decreasing the clearance at the shaft line and over an area of the gear faces with a resultant

decrease in the leakage of fluid in the device. Normally one such plate is provided at each axial end of the gears.

In accordance with still another aspect of the preferred form of the invention, the high hydraulic pressure is communicated to a selected area (preferably adjacent open mesh of the gears) between the housing and the bi-metallic plate so that even when the temperature of the hydraulic fluid is low, as the pressure of operation increases, this pressure causes the plate to deform into engagement with the rotating gears proportionately with the increase in pressure thereby to decrease fluid leakage and maintain the efficiency of the device.

In the preferred form of the invention, the plate (or plates) is secured at its outer periphery to the housing with only a portion of the area of the plate being deformed into sealing relationship with the gears. In other words, the plate is held in a fixed clearance relationship to the gears at the outer diameter of the gears while moving into engagement with the gears from the inner diameter progressively outwardly as the pressure and/or temperature increases.

In accordance with another aspect of the invention the area is communicated to high pressure by means of a port in the plate located just radially short of the ring gear root diameter and approximately on the neutral axis at open mesh so that the force deforming the plate toward the gears is proportional to the pressure in the chamber at open mesh. The area over which this pressure is effective is limited by a recess in the end wall of the housing communicating with this port.

With preferred embodiment, a hydraulic device is provided which is capable of operating both at no load for long periods and efficiently over a wide range of temperatures and pressures. For example, the disclosed device is capable of maintaining an overall efficiency of 90 percent while operating at pressures from 200 to 3000 psi and at temperatures ranging from 30° F. to 180° F.

It is the principal object of this invention to provide a hydraulic device which combines the desirable operating characteristics of both a fixed clearance and a pressure sealed device.

It is a further object of this invention to provide a hydraulic device in which the clearances in the device are varied as the temperature and pressures in the device vary.

Another object is to provide a hydraulic device of the type described wherein a fixed sealing plate is provided which changes the end clearances proportional to temperature and/or pressures of the device.

Another object is the provision of a hydraulic device of the type described wherein a sealing plate is provided wherein a portion of the side of the plate remote from the gears and adjacent open mesh is communicated to the pressure in the open mesh chambers.

It is a more specific object of the invention to provide a hydraulic device which is capable of operating both at no load for long periods and efficiently over a wide range of pressures and temperatures.

Other objects, features and advantages of the invention will become more apparent upon a complete reading of the following description which, when taken with the attached drawings, discloses but a preferred embodiment of the invention.

Referring now to the drawings wherein like reference numerals indicate like parts in the various views:

FIG. 1 is a cross sectional view perpendicular to the neutral axis of a hydraulic device illustrating a preferred embodiment of the present invention with the clearances of the device being exaggerated for the purposes of clarity;

FIG. 2 is an enlarged fragmentary view showing the relationship between the sealing plate and the gear faces;

FIG. 3 is a sectional view along line 3—3 of FIG. 1;

FIG. 4 is a sectional view along line 4—4 of FIG. 1;

FIG. 5 is a cross sectional view of the sealing plate in its relaxed form;

FIG. 6 is a cross sectional view similar to FIG. 5 showing an alternate form of the sealing plate in its relaxed form;

FIGS. 7, 8, 9 and 10 are views similar to FIGS. 3, 4, 5 and 6 but showing an alternative embodiment of the invention.

Referring now more in detail to the drawings wherein the showings are for the purpose of illustrating a preferred embodiment of the invention only and not for the purpose of limiting the same, there is illustrated in FIG. 1 a pump assembly indicated generally by the reference numeral 10. This pump assembly includes a housing 12 comprised of three separate elements, a port housing portion 14, a bearing spacer portion 16 and a rear cap portion 18. The three portions of the housing are interconnected by dowel pins 17 and bolts or fasteners 19. The bearing spacer portion 16 is generally ring shaped in configuration and cooperates with the other two housing portions 14 and 18 to define therebetween an internal fluid cavity 20.

A shaft 22 extends through an opening 24 in the housing portion 14 with the shaft extending through the cavity 20 and being journaled at its inner end by an appropriate sleeve bearing 26. Another bearing 28 supports the shaft 22 adjacent its outer extremity. A seal 29 is received over the shaft 22 with the seal being disposed in an appropriate recess in the housing portion 14.

An externally toothed gear member 30 is secured by a key 31 for rotation with the shaft about the longitudinal axis of the shaft 22. Received over the gear member 30 is an internally toothed ring gear member 32 which is supported for rotation about an axis spaced from the axis of the shaft 22. The bearing spacer portion 16 of the housing 12 has a generally cylindrical bearing surface 33 in which the internally toothed ring gear 34 is rotatably supported. The bearing member is secured against rotation by the bolts 19 and the dowel pins 17.

The gears 30, 32 cooperate in a manner well known in the art and which is described in detail in my aforementioned patents to which reference may be had for a detailed description. In brief, the ring gear 32 will have one tooth more than that of the gear member 30 with the teeth of the gears normally being in sliding sealing engagement so that, as the gear members rotate, they cooperate to define a plurality of pumping or fluid chambers 36, 38 which progressively increase and decrease in volume.

The width of the gear members 30, 32 is substantially less than the width of the fluid cavity 20 in which they are disposed so that a substantial clearance exists

between the end faces of the gear members and the end walls 39 and 40 of the housing portion 14 and 18 respectively.

An inlet port 42 and an outlet port 44 are formed in the port housing portion 14 of the housing 12. The inlet port 42 communicates at its inner end with a manifold port 46 formed in the wall 39 while the outlet port 44 communicates with a manifold port 48 also formed in the wall 39. The two manifold ports 46 and 48 are arcuate in configuration with the ends of the port being separated by land portions 49 and 50. As is well known in this art, the inlet manifold port is aligned with and normally communicates with the increasing volume chambers 36 while the outlet manifold port 48 is normally aligned with and in communication with the decreasing volume chambers.

In accordance with the preferred embodiment of this invention, it is contemplated that a sealing plate or disc 52 will be inserted in the clearance between the axial end face of the gear members 30, 32 and the wall surface 39. Similarly, a second sealing plate or disc 54 is inserted in the clearance space between the opposite axial end of the gear members 30, 32 and the wall surface 40. In the preferred form of the invention, the plates 52, 54 are of a radial dimension such that they extend between the bearing spacer 16 and the adjacent housing portions 14 and 18 with the dowel pins 17 and bolts 19 maintaining the plates connected to the housing. Also in accordance with the preferred form of the invention, the bearing spacer 16 has a dimensional axial width in excess of the dimensional width of the gear members 30, 32 so that with the plates assembled in the manner illustrated in FIG. 1, there exists between the axial end faces of the gear members 30, 32 and the adjacent surfaces 55, 56 on the plates 52, 54 a predetermined clearance for a purpose to be described in detail hereinafter.

The plate 52 includes manifold ports 57, 58 which align with the manifold ports in the wall 39.

The preferred form of the plates 52, 54 is illustrated in an exaggerated form in of FIG. 5. As shown in that Figure, each of the plates, in its free state, in dish shaped similar to a Belleville washer and has an opening 59 in the center through which the shaft 22 is received. The washer has the configuration of the conventional Belleville washer but comprises a bi-metallic lamination with one layer having a greater coefficient of thermal expansion than the other. Thus, the one layer 60 may be of a bronze material while the other layer 61 may be a material such as steel with the layer having the greater coefficient of thermal expansion being on the concave side of the washer.

As assembled, the washer is resiliently compressed to the shape of the flat plates 52, 54 shown in FIG. 1 with the steel layers being adjacent to the wall surfaces 39 and 40. The flattened washers tend to return to their free form with the result that the layer 60 is biased in a direction away from the axial end faces of these members. In this manner, a clearance which may be on the order of 0.0005 to 0.0002 inches is maintained between the surfaces 55, 56 of the plates 52, 54 and the axial end faces of the gear members 30, 32. The clearances shown in the drawings are greatly exaggerated for the purposes of clarity.

The pump operates in the following manner. When the pump is first started, the parts are in the relationship shown in FIG. 1. Since the hydraulic fluid has a relatively high viscosity when operation first commences, only a small amount of the fluid will flow through the clearance space between the plates 52, 54 and the axial end faces of the gears 30, 32. To avoid any build up of pressure on the shaft end from this leakage, there is provided a return passage 64 in the cap portion 18 which intercommunicates the inner end of the shaft 22 with a port 66 in the plate 54 which, in turn, is aligned with the increasing volume chambers 36.

Thus, as initially operated, the pump operates with satisfactory overall efficiency with high viscosity fluid and only a relatively small clearance resulting in only a minor amount of leakage through the clearance. Such leakage as may tend to occur across the face of the plates from pressure to return ports is minimal since that leakage path is substantially longer than it is across the gear teeth between pressure and return. As a result, satisfactory efficiency of operation will be achieved. However, as the fluid heats up and the viscosity of the fluid decreases, increased leakage will begin to occur across the gear teeth through the clearances and the efficiency will decrease.

To curtail this leakage and maintain efficiency, the bi-metallic plates 52, 54 automatically adjust the clearances. Thus, as the fluid is heated, so also the plates 52, 54 are heated. Since the bronze layer 60 tends to expand at a more rapid rate than the steel layer 61, each of the plates 52, 54 tend to assume a bowed configuration. However, the plates cannot bow toward the wall surfaces 39, 40 since they are already in engagement with those surfaces. Moreover, the resilience of the plates tends to resist any movement of the plates away from those wall surfaces. However, as the temperature level increases up to a predetermined point which is dependent on the particular construction of the plates, the plates will suddenly distort in a direction toward the axial ends of the gear faces 30, 32, thereby closing the clearances. In fact the plates may be resiliently biased toward the gears. This condition is shown in FIG. 2. As shown in that Figure, the clearance is reduced to zero at the shaft line and over a substantial area of the end faces of the gears thus decreasing the leakage of the hydraulic fluid and thereby optimizing the efficiency of the device.

Further increases in temperature then increase the force of the bias of the plates toward the gears. As it is impossible to have less than a zero clearance, the effect is that the plate progressively radially outwardly moves into zero clearance relationship with the gears.

The foregoing described the temperature responsive characteristic of the sealing plates 52, 54. In accordance with the invention, the device is either independently or in combination arranged to have a pressure responsive characteristic so that, even when the viscosity of the fluid remains relatively high, increased leakage due to increases in pressure of operation also may be controlled. This is accomplished by a groove in the wall 39 communicating with the high pressure manifold 48 and located opposite the open mesh position of the gears. This groove 68 extends over a sufficiently long arc and exposes a substantial portion of the

plate 52 adjacent open mesh to the high pressure of the device. As a result, the high pressure fluid introduced to the groove 68 opposes the resilient bias which normally maintains the plate 52 the wall 39. As the pressure increases, at a predetermined point, the fluid pressure will move the plate 52 against the resilient bias in the opposite direction inwardly toward the gear members 30, 32 and cause the plate to be deformed toward the axial end faces of the gear members in precisely the manner shown in FIG. 2. In this way, the clearance between the plate 52 and the gear members may be reduced to zero at the shaft line and over a substantial area of the gears particularly adjacent open mesh so that the flow of hydraulic fluid which had been leaking through that clearance is reduced and the efficiency of the device is greatly improved. As the pressure is reduced, the inherent resiliency of the plate 52 will cause it to move or snap back into its normal position thereby re-establishing the clearance. In a similar manner, high pressure may be introduced between plate 54 and surface 40 to bias that plate into engagement with the gears.

FIGS. 7-10 show an alternative embodiment of the invention wherein the hydraulic pressures communicated to the side of the plates adjacent the housing, instead of being at the full hydraulic pressure as described with reference to the embodiment shown in FIGS. 3-6, are proportional to the pressures in the open mesh chamber. It will be appreciated that the pressures in this chamber are constantly changing as the chamber switches from communication with the high pressure manifold to communication with the low pressure manifold and that for an instant while this chamber is in the course of switching from communication with one manifold to the other, it is not in communication with either manifold and in fact is a completely closed or sealed chamber except for the internal leakages in the device. Thus, during this instant, this pressure can vary anywhere from the full high pressure of the device to the low pressure of the device depending upon the amount of internal leakage in the device.

In the embodiment shown in FIGS. 7-10, the pressure groove 68 of FIG. 3 is eliminated and the plates 52 and 52' are provided with an opening or port 70 located approximately on the neutral axis of the pump on the open mesh side of the gears and further located radially outwardly from the axis of rotation of the internally toothed gear 32 so as to be just radially inside of the root diameter of the gear 32. The radial width of this opening 70 is less than the radial depth of the teeth of the gear 32 such that as the gear 32 rotates the opening 70 will be alternately communicated with the chambers as they revolve and cut off from communication with the chambers by the teeth of the gear 32.

Further in accordance with the invention, the end wall of the housing between the ends of the manifold 46, 48, that is to say the land 49, is provided with a triangular shaped recess 72 extending radially inwardly from the location of the port 70 to a point spaced radially outwardly from the opening in which the shaft 22 is rotatably supported. Furthermore, the circumferential edges of this recess 72 are circumferentially spaced from the circumferential ends of the manifolds 46, 48.

As the gears rotate, the pressure in the open mesh chamber, whatever it may be at any one instant, is com-

municated to the side of the plate 52 adjacent the end wall of the housing 52 and this pressure then biases the plate 52 against the axial ends of the gears adjacent open mesh of the gears by a force proportional to the pressure in the open mesh chamber which is the pressure tending to cause internal leakage in the pump.

It will be noted that at times the opening 70 is covered or closed by the teeth of the gear 32. Assuming in any one instant that the space defined by the recess 72 is at any given pressure, it will normally generally remain at this pressure until the next adjacent chamber comes into communication with the port 70. Thus, the sealing requirements of the chamber at open mesh position are always matched by the sealing pressure against the side of the plate 52 adjacent the housing end of the wall. If the device is operating at $\frac{1}{2}$ maximum pressure the pressure biasing or urging the plate toward the gears will be the same. The sealing pressure is thus equal to the pressure to be sealed.

It will be apparent from the foregoing that the bi-metallic construction of the plates 52, 54 provide a temperature responsive means for controlling the clearances in the device while the high pressure groove provides a pressure sensitive means for accomplishing the same result. The particular pressures and temperatures at which the plates operate to reduce the clearances may be altered depending on the particular materials employed and the amount of resiliency inherent in the washers. It has been found satisfactory to employ a plate having an overall thickness of 0.090 inches with the bronze layer having a thickness of 0.015 inches. With that arrangement, the plate will be deformed to decrease the clearances at a temperature of 180° F. and an operating pressure of 500 psi. Alternatively, the plates will deform at an operating temperature of 110° F. and an operating pressure of 3000 psi. Obviously, the plates may be designed to deform at other combinations of temperatures and pressures.

Several variations of the described preferred embodiment may be made. For example, the particular application for which the pump is to be designed may not be concerned with leakage resulting from the temperature effects on the viscosity of the fluid but may be primarily concerned with leakage resulting from relatively high pressure operation. In such circumstances, the bi-metallic construction of the plates may be omitted and a unitary metal construction may be used for the Belleville washer configuration. With that arrangement, the resilient bias of the plates away from the end faces of the gear members will be retained but the temperature responsive characteristics of the plates will be lost. The operation of the device will otherwise be as described as above. Thus, as the pressure builds up in the pressure groove 68, a level will be reached where the pressure will exceed the resilient bias of the plates and the plates will deform toward the axial end faces of the gears 30, 32 thereby decreasing the clearances and eliminating the leakage path therealong.

Still a further modification of the described arrangement may employ but a single one of the plates with the clearances along the other axial end face of the gear members being fixed.

A further modification of the described device may employ plates which are, in their relaxed or free state

form, in the shape of the plate 52' shown in FIG. 6. Such an arrangement would thus be neither temperature responsive nor pressure responsive although fluid pressure may be employed to maintain the plates in engagement with the axial end faces of the gear members during high pressure operation.

All the foregoing modifications, as well as the preferred embodiment, have in common an arrangement in which a portion of the plate is held against the displacement elements in sealing relationship on an area less than the total area of the displacement elements while a further and radially outward portion of the plates is held in a clearance relationship at the outer diameter of the displacement elements. In this way, the plates provide the necessary sealing relationship to avoid leakage across the paths most susceptible to leakage. The leakage path which remains available at the outer diameter because of the spaced clearance always present at that location, does not pose a problem since that leakage path is relatively long and does not affect the overall efficiency of the device.

Having thus described my invention, I claim:

1. In a hydraulic device comprised of a housing having a cavity therein having spaced opposing end walls, shaft means extending into said cavity through one of said end walls and rotatably supported in said housing, a plurality of displacement members in said cavity and rotatable with said shaft means and cooperating to define a plurality of axially open ended chambers which progressively increase and decrease in volume as said shaft means rotates to respectively take in and discharge hydraulic fluid, inlet and outlet ports in said housing and arranged to communicate with said increasing and decreasing volume chambers, the improvement comprising:

a sealing plate in the form of a washer disposed between at least one axial end of said members and one of said end walls and having an opening through which said shaft means extend;

the total axial width of said displacement members and said plate being slightly less than the spacing between said end walls to provide a running clearance;

one side of said plate being normally in engagement with the adjacent end wall of the cavity in said housing, and the other side of said plate being normally spaced from said one axial end face by said running clearance;

means rigidly securing the outer periphery of said plate to said housing;

means responsive to operating conditions of said device biasing the inner periphery of said plate toward said displacement members.

2. The improved device of claim 1 and including a plate at both axial ends of said displacement members.

3. The improved device of claim 1 and further including pressure groove means in said housing communicating the pressure of the device to the side of the plate normally in engagement with the adjacent side wall of the cavity whereby the fluid pressure acts against said plate to displace it toward said displacement members.

4. The improved device of claim 1 and including means responsive to the temperature of the hydraulic fluid for deforming said inner periphery of said plate into engagement with said axial end face.

5. The improved device of claim 1 and including means responsive to the temperature and means responsive to the pressure of the device for deforming said inner periphery of said plate into sealing engagement with said axial end face.

6. The improved device of claim 1 wherein said plate is of a bi-metallic construction.

7. The improved device of claim 6 wherein the metal of the plate on the side spaced from said one axial end face has a greater coefficient of thermal expansion than the metal comprising the plate's other side.

8. The improved device of claim 1 wherein said displacement members comprise:

an externally toothed gear supported on said shaft for rotation therewith,

an internally toothed ring gear surrounding said externally toothed gear and having teeth in sliding sealing engagement therewith,

said teeth defining said open ended chambers,

said plate means having a port therethrough located adjacent the open meshed position of said chambers and adapted to communicate the side of said plate, adjacent said housing with said open meshed chamber.

9. The improved device of claim 16 wherein said port is positioned radially less than the root diameter of said internally toothed ring gear but greater than the diameter of the tips of the teeth.

10. The improvement of claim 9 wherein the end wall of said housing at open mesh has a recess communicating with said port and extending radially inwardly short of said shaft opening and between but spaced from the circumferential ends of the inlet and outlet manifolds.

11. In a hydraulic device comprised of a housing having a cavity therein having spaced opposing end walls, shaft means extending into said cavity through one of said end walls and rotatably supported in said housing, a plurality of displacement members in said cavity and rotatable with said shaft means and cooperating to define a plurality of axially open ended chambers which progressively increase and decrease in volume as said shaft means rotates to take in and discharge hydraulic fluid, inlet and outlet ports in said housing and arranged to communicate with said increasing and decreasing volume chambers, the improvement comprising:

a sealing plate normally in the form of a dished washer disposed between at least one axial end of said members and one of said end walls and having an opening through which said shaft means extend; the total axial width of said displacement members and said plate being slightly less than the spacing between said end walls to provide a running clearance;

means rigidly securing the outer periphery of said plate to said housing, and biasing the inner periphery of said plate toward said one end wall by compressing said plate between an end wall and said securing means;

means responsive to operating conditions of said device for overcoming the bias of the plate and urging the inner periphery of said plate toward said displacement members thereby reducing said running clearance.

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12. The improved device of claim 11, wherein means communicate the high pressure between said plate and end wall whereby said operating conditions include the hydraulic pressure of the device.

13. The improved device of claim 11 wherein said plate is bimetallic whereby said operating conditions

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include the temperature of the device.

14. The improved device of claim 13 wherein means communicate the high pressure between said plate and end wall whereby said operating conditions additionally include the hydraulic pressure of the device.

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