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PRESSURE BALANCED SEAL-PACK FOR REVERSIBLE PUMPS AND MOTORS

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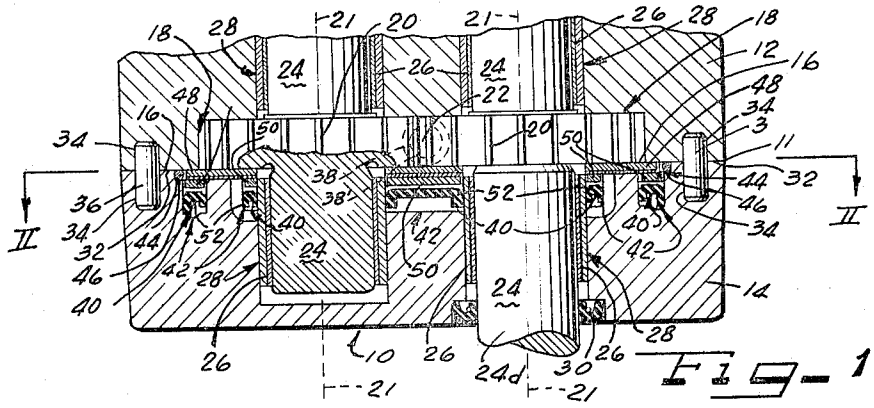


Fig- 1

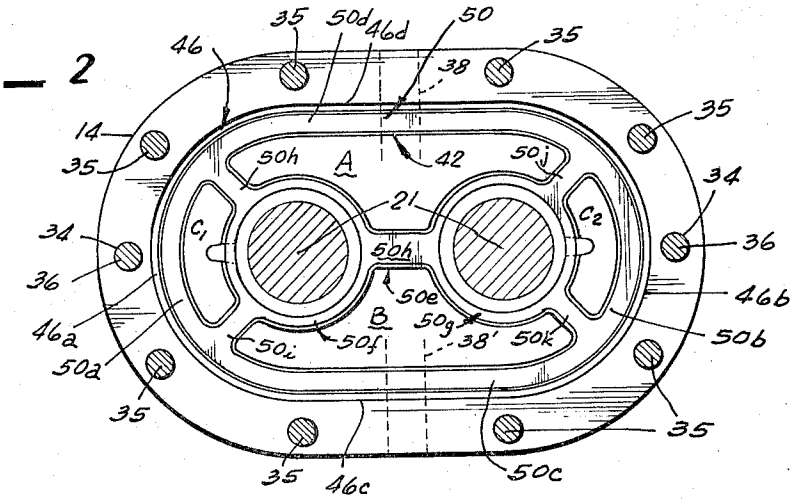


Fig- 2

Fig- 3

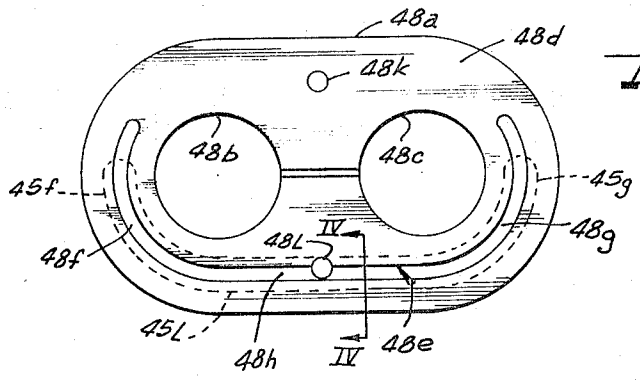
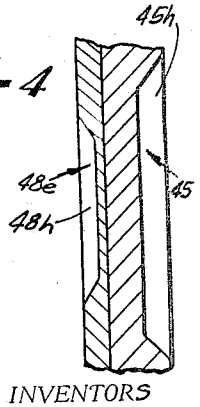


Fig- 4



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PRESSURE BALANCED SEAL-PACK FOR REVERSIBLE PUMPS AND MOTORS

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This invention relates generally to a pressure-loaded pump and more particularly to an improved presure-loaded pump having a fluid pressure seal which can be easily and quickly adapted for bi-directional operation of the pump by the use of novel pressure distributing means which are adjusted for distributing fluid pressure to selected different zones of the seal pack. The term "pump" is meant to encompass not only a fluid moving device, but also analogous fluid handling devices such as fluid driven generators or motors.

It is an object of the present invention to provide an improved pump construction.

Another object of the present invention is to provide a sealing arrangement for a pressure-loaded pump wherein a pressure plate may be hydraulically sealed without requiring the application of mechanical seal pressure to the sealing pack and said pump may be adapted for reverse operation.

It is a further object of this invention to provide a pump having a fluid seal pack which may be adapted for reverse operation without loss of pumping efficiency and without increased wear.

Another object of the invention is to provide a seal arrangement for such a pump which is uniquely adapted to bi-directional pump operation.

It is a particular object of the present invention to provide a gear pump which has a fluid-pressure seal pack which may be adapted to provide proper seal pack pressure for operation of the pump in either direction of fluid flow.

The organization and manner of operation of the invention, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which an exemplification of the invention is illustrated.

On the drawing:

FIGURE 1 is a fragmentary view, partly in section, with parts broken away, of a pump incorporating the principles of the present invention;

FIGURE 2 is an elevational view, partly in section, of the pump as seen from the line II—II in FIGURE 1;

FIGURE 3 is a plan view of a reversible wear plate incorporating features of the invention for use with the pump of FIGURES 1 and 2; and

FIGURE 4 is a fragmentary cross-sectional view taken on line IV—IV of FIGURE 3.

As shown on the drawings:

The present invention will be described in conjunction with a gear pump, however, the principles of the present invention are adaptable to other pumps and to other fluid transfer devices as well, the environment of a gear pump being chosen for definiteness of illustration.

Referring to FIGURE 1, there is shown a fluid transfer device of the gear pump type which is generally indicated by the numeral 10. The pump 10 includes a casing 11 comprising an upper casing member 12 and a mating lower casing member 14. The upper casing member 12 has a planar mating wall 16 which is intersected by a pair of tangential cylindrical bores 18 which extend normally from the wall 16 within the upper casing member 12 to form a figure 8-shaped recess or pumping chamber for

receiving fluid moving means comprising a pair of adjacent intermeshing generally disc-shaped gears 20. The gears 20 mesh at an area 22 corresponding to the narrow waist portion between the individual bores 18.

The gears 20 are each mounted for rotation about one of two parlallel axes 21 passing through the centers of the individual bores 18 by means of a pair of outwardly projecting axles 24 which extend normally from either planar surface of the gears 20 concentric with and along their respective axes 21 of rotation. These axles 24 are seated respectively within bearing sleeves 26 which are, in turn, mounted in cylindrical bores 28 on both upper casing member 12 and lower casing member 14. Both the bearing sleeves 26 and the bores 28 are concentric about axes 21.

One of the bores 28 in the lower casing member 14 passes through the casing member to form an opening 30, while the other bore 28 is enclosed by the casing 11. One of the axles 24 extends without casing 11 through hole 30 to form a drive shaft 24*d*. The drive shaft 24*d* is driven by a prime mover (not shown).

The upper and lower casing members 12 and 14 are fastened together so that the mating wall 16 is in sealing contact with a matching planar mating wall 32 of the lower casing member 14 about the outer periphery of the casing 11, by suitable fastener means, such as a plurality of bolts 35. A pair of spaced cylindrical pin bores 34 within the upper and lower casing members 12 and 14 within the mating walls 32 and 16 and a corresponding pair of pins 36 set therein operate to locate the casing members in correctly matched relation. A pair of oppositely positioned fluid ports 38, 38′, indicated in dashed circular outline, are provided at the opposite narrow waist portions of the cylindrical bores 18 adjacent the meshing area 22 of the gears 20.

Also depicted in FIG. 1 is seal means comprising a seal pack, generally indicated by the numeral 40, which is set into a pattern of recesses or grooves generally indicated at 42. A sealing O-ring 44 encircles the seal pack 40 and gears 20 and rests between the mating wall 16 in an oval groove 46. The groove 46 is disposed within the lower housing casing member 14 at the mating wall 32.

The pump 10 may consist of a single gear pair as depicted or may further comprise a second stage or set of gear pairs as is well known in the art. In the case of such a two-stage pump, two sets of gears 20 are joined to the upper axles 24 and two seal pack systems are provided. The present invention is equally adaptable to such a multi-stage pump.

Referring to FIGS. 1 and 3, the seal pack 40 comprises a bi-metal wear plate 48, a gasket or backing means 50, and a sealing web 52. The gasket 50 and the sealing web 52 are received and seated within the recess groove system 42 while the wear plate 48 rests above the groove system 46 in substantial contact with one planar surface of the gears 20. The web 52 is seated innermost in the groove 42 and is preferably constructed in a generally J-shaped configuration (in cross-section) of resilient material, such as rubber. The web 52 is under a nominal downward compression so as to urge the gasket 50 against the wear plate 48 in sealing contact therewith.

As is best shown in FIG. 2, the gasket 50 is seated within the recess groove system 42 and divides the area between the gear axis 21 and the oval groove 46 of the O-ring 44 into four compartments or zones designated by the letters A, B, C_1, and C_2. The oval groove or track 46 is in the shape of an ovaloid having two oppositely disposed arcing or curved semi-circular segments 46*a* and 46*b*, oppositely disposed about the minor axis of the track 46 and two merging straight legs 46*c* and 46*d* oppositely disposed about the track's major axis. The gasket 50 has a similarly shaped outer edge section located interior to

the track 46 and comprising two corresponding semi-circular segments 50*a* and 50*b*, and two merging straight leg segments 50*c* and 50*d*.

The gasket 50 further comprises, however, a rim-shaped member 50*e*, with circular segments 50*f* and 50*g* encircling and concentric with the bores 28 and the axles 24, and a bridge section 50*h* extending between the circular segments 50*f* and 50*g*. Four radial arms 50*h*, 50*i*, 50*j* and 50*k* extend radially outwardly from the circular segments, the arms 50*h* and 50*i* extending from the segment 50*f* to merge with the semi-circular segment 50*a* of the outer track section of the gasket 50 at equal angular displacements from opposite sides of the major axis of the oval track 46 and the arms 50*j* and 50*k* extending radially from the circular segment 50*g* at equal angular displacements on either side of the major axis of the oval. The arm segments 50*h* and 50*i*, together with the arc portions of the segments 50*a* and 50 therebetween define a generally keystone-shaped area or zone C_1. Similarly an oppositely disposed keystone-shaped area or zone C_2 is formed by arm segments 50*j* and 50*k* and the arc portions of segments 50*b* and 50*g* therebetween. Zone A is defined in an ox-yoke shape by the straight leg portion 50*d* and the merging curved sections of the semi-circular portions 50*a* and 50*b*, the radial arms 50*h* and 50*j*, the merging sections of the circular areas 50*f* and 50*g* and the bridge 50*e* of the gasket 50.

The zone B is shaped into a similar but oppositely disposed ox-yoke shape by the straight leg 50*c*, merging arc segments of the circular sections 50*a* and 50*b*, radial arms 50*i* and 50*k*, the curved section of the circling ring segments 50*f* and 50*g* and bridge 50*h*.

As may best be see nin FIGURE 3, the wear plate 48 which rests above the gasket 50 in the pump 10 comprises the unitary planar member having a complementary ovaloid outer periphery 48*a* and two large diameter circular holes 48*b* and 48*c* for allowing the passage of the axles 24 and 24*d* therethrough. Furthermore, in accordance with the invention, the wear plate 48 is provided with fluid pressure distribution means comprising a shallow handle-bar-shaped groove 48*e* upon its upper surface 48*d* and a groove 45 on the opposite face. The two grooves 48*e* and 45 are not symmetrical mirror images and it will be noted that the groove 45 is somewhat wider but shorter than 48*e*. The groove 48*e* has curved segments 48*f* and 48*g* partially encircling the axle holes 48*b* and 48*c* and a merging longitudinally extending leg portion 48*h* parallel to the major axis of the oval periphery 48*a* therebetween. Corresponding segments 45*f* and 45*g* and a leg portion 45*h* are provided in the groove 45. In order to communicate fluid from the pumping chamber to the opposite side of the plate, a pair of axial through openings 48*k* and 48L are positioned such as to provide access from the pumping chamber opposite the surface 48*d* of the wear plate 48 to the compartments or zones A and B in the assembled pump 10. The hole 48L is in communication with the grooves 48*e* and 45 along straight leg sections 48*h* or 45*h*.

In the assembled pump 10, the wear plate 48 is engaged by the gasket 50 on one face thereof which forms a motion surface. The axles 24 and 24*d* pass through the openings 48*b* and 48*c*. The opposite face constitutes a bearing or sealing surface 48*d* juxtaposed to the gears 20 as in FIGURE 1. The gasket 50 is urged by pressure bias against the underside of the wear plate 48 into sealing contact therewith by the pressure and urging of the sealing web 52 to thereby define the several pressure zones A, B, C_1, C_2. The wear plate 48 and the rest of pump 20 are designed to be generally symmetrical about the minor ovaloid. This allows the wear plate 48 to seat with either drive shaft 24*d* within the hole 48*c* and axle 24 within the hole 48*b* or vice versa.

Assuming the first arrangement and assuming the pump to be operated to pump fluid from port 38 to port 38', the hole 48L and straight leg portion 48*h* of the shallow groove 48*e* are in communication with the high pressure output area of the output port 38' and the hole 48*k* in communication with the low pressure input area of the input port 38. The holes 48*k* and 48L serve to transfer the fluid pressure existing at the wear plate face 48*d* facing the gears 20 to the underside of the wear plate, i.e., into, respectively, zones A and B, to thereby substantially equalize or balance the fluid pressure on both sides of the wear plate in these respective areas. The groove 48*e* allows for the transfer or communication of the output pressure of the plate 48 and serves to establish the outward pressure within the area above the keystone-shaped zones C_1 and C_2 defined by the gasket 50. The distribution of output pressure about the gears 20 as accomplished by the groove 48*e* is a generally desired pressure distribution for pressure loaded gear pumps.

In accordance with the invention, the wear plate 48 and gasket 50, as well as the web-receiving recess groove system 42, have been constructed to define symmetrical pressure zones A, B, C_1 and C_2 so that the pump 10 may be selectively reversed, i.e., the port 38' serving as the input port and port 38 serving as the output port.

Were this the case with conventional fluid pressure seal packs, the pressure distribution above and below the wear plate 48 would not be equalized or an undesirable pressure distribution about the gears 20 would result. However, the described pump may be easily adapted for reverse operation by simply turning the wear plate 48 so that the hole 48L and the groove 48*h* are in communication with the port 38' so that the axle opening 48*c* receives the axle 24 while the opening 48*b* receives the drive shaft axle 24*d*. In such arrangement of the wear plate, the pressure at the now output ports 38 is transferred not only to zone A but also to zones C_1 and C_2 via the groove 48*e*, while the zone B is maintained at only the input pressure by the hole 48.

Reversibility can be accomplished in accordance with several different procedures. For example, according to one mode, the wear plate 48 may be removed from the casing 14, whereupon the casing is rotated 180°, while the wear plate 48 is fixed in the same geometrical position as it was when it was removed. The wear plate 48 is then placed in register with the rotated casing 14 so that the position of the axle 24 will be alternated with the axle 24*d*. The lower casing 14 is then assembled with the wear plate 48 positioned therein to the casing member 12. With this mode, four geometric positions must be altered, however, the inlet and the outlet conduit-connecting points remain fixed. This is very desirable since current commercial designs frequently require separate sized openings for inlet and outlet ports on pumps and the fixed inlet and outlet connections therefore afford a decided advantage.

In accordance with a second mode of reversibility, the casing 14 is retained in fixed position while the wear plate 48 is rotated 180° in either direction. Likewise, the casing 12 is also rotated 180° in either direction, whereupon the casing member 14, the wear plate 48 and the casing member 12 are assembled together. In this mode, only two geometric positions must be altered and the inlet and outlet conduit connecting points change from top to bottom and vice versa. However, in this mode, the mounting and drive for the casing member 14 remains fixed, thereby affording versatility in this regard.

In a third mode of reversibility, the casing member 14 and the drive is retained in a fixed position, while the wear plate 48 is rotated 180° in either direction. The casing member 14 is then assembled with the wear plate 48 to the casing member 12. In this mode of reversibility, only one geometrical position is altered, namely, the wear plate 48. Accordingly, equal size passages for the inlet and the outlet are required. Additionally, because check valves are often required in externally mounted pumps to pressurize shaft seal cavities to prevent air from entering the pump intake, two check valves would be required. Moreover, the inlet and outlet con-

nections would be inverted although the casing member **12** would remain fixed, thereby fixing the mounting position.

An improved sealing arrangement for a pumping device has been provided in which a pressure plate may be hydraulically sealed without requiring the application of mechanical seal pressure to the sealing pack and which allows for easily achieved reversibility of the pump without loss of efficiency or excess wear. This sealing arrangement has been shown to be uniquely adaptable to bi-directional pump operation.

In summary, therefore, it will be noted that the sealing web which is of generally J-shaped cross-section and which is located in a counter-recessed groove pattern in one face of the cover within a generally ovaloidal recess confronting the pumping chamber of the casing is characterized by a structural configuration which is complementary to the corresponding recess means in which the web is fitted, namely, the recess means and the web include the generally ovaloidal continuous outer portion, a pair of substantially circular inner portions, and a cross channel joining the inner portions at the longitudinal center line. Further, a pair of cross channels join the inner portions to the outer portions at opposite longitudinal ends and are spaced symmetrically with respect to the longitudinal center line, thereby to form segregated zones including two elongated zones opposite the inlet and outlet sides of the pump and two end zones at opposite ends of the ovaloid.

When pressure from the pumping chamber axially opposite the zones is conducted through the aperture **48L**, the two end zones are selectively combined with one of the elongated zones, namely, that elongated zone which is positioned on the outlet side of the pump, thereby to form a major area receiving pressure at pump-generated pressures to counterbalance the pressures generated in the pumping chamber. The other of the elongated zones, therefore, forms a minor area which is communicated to the inlet side of the pump.

Because of the symmetrical disposition of the zones and the apertures **48***k* and **48L**, the entire seal pack may be selectively reversed and complete pressure balancing is afforded.

It will be apparent that many modifications and variations may be effected without departing from the scope and the novel concepts of the present invention.

We claim as our invention:

1. A pump having a casing with separated first and second ports for receiving and discharging a fluid comprising:

means within said casing for transferring said fluid between said ports, to thereby increase the pressure of said fluid in said casing;

seal means within said casing juxtaposed to said fluid transfer means and defining a pressure zone intermediate said ports, said seal means including pressure distribution means including a groove formed therein for distributing pressure from said first port to said intermediate pressure zone.

2. A pump comprising:

a casing having a first and a second fluid passage port;

a fluid moving means within said casing for transferring a fluid through said casing between said ports; and

a seal pack comprising:

a wear plate for seating in said casing with one surface juxtaposed to said fluid moving means;

a gasket in contact with another surface of said wear plate to define a plurality of zones; and

means including said wear plate for communicating fluid pressure at some parts of said upper surface of said wear plate to some of said zones when seated in said first orientation and for communicating fluid pressure from some parts of said upper surface of said wear plate to other of said zones when seated in said second orientation, said means including a groove defined in said wear plate.

3. A pump comprising:

a casing forming a fluid moving chamber and a first port and a second port thereto;

rotating means within said chamber for moving fluid in a first rotational direction from said first port to said second port, said means being reversible for moving fluid in an opposite rotational direction from said second port to said first port;

a seal pack juxtaposed to said rotating means within said casing chamber including:

a wear plate having a first planar surface forming a bearing surface facing said rotating means and an oppositely disposed second surface facing away from said rotating means;

zone defining means forming with said wear plate a plurality of pressure zones confronting said second surface in a symmerical pattern; and

means, including said wear plate, for communicating fluid pressure from said chamber near said first port to part of said pattern of zones and for communicating pressure from said chamber near said second port to another part of said pattern of zones to establish a first pressure pattern for use in said first rotational direction and said distribution means being adjustable to selectively establish a second pressure pattern for use with said second rotational direction.

4. A gear pump comprising:

a casing forming a figure 8-shaped fluid moving chamber and a first and a second port thereto;

a pair of intermeshing gears mounted for revolution within said chamber and rotatable in a first direction for moving fluid from said first port to said second port, said gears being rotatable in an opposite direction for moving fluid in an opposite direction from said second port to said first port; and

a seal pack including:

a wear plate positioned juxtaposed to said gears within said chamber and having a first planar sealing surface facing said gears and a second motion surface facing away from said gears; and

a gasket seated against said motion surface and having webbing forming a plurality of zones, said wear plate including a plurality of fluid pressure communication passages for communicating the fluid pressure in said chamber axially opposite to one of said zones adjacent said first port and for communicating the fluid pressure in said chamber axially opposite to one of said zones adjacent said second port and for selectively communicating other of said zones to either of said ports.

5. In a gear pump of the type having a casing formed with a groove system and a figure 8-shaped chamber housing a pair of intermeshing gears mounted for rotation therein for propelling a fluid between two ports, the improvement comprising:

a fluid pressure seal pack having:

a gasket and channel-shaped web for seating within the groove system of said casing and each having a generally ovaloid-shaped outer rim segment,

two interior circular ring segments with a merging bridge therebetween, and

radial arms extending from each of said circular ring segments at equal angular displacements on opposite sides of the major axis of said oval outer rim segment to merge with said outer rim and form together therewith a keystone-shaped zone about said major axis between said arms of each of said ring segments and an ox-yoke shaped zone between said bridge and the straight leg portions of said oval rim;

said web seating within the groove system behind said gasket for urging said gasket toward the adjoining gear side face;

a wear plate having an oval shape for seating in said casing in said chamber and having a sealing surface juxtaposed to said gears and an opposite motive surface in contact with said gasket,

said wear plate having pressure communication holes for communicating pressure from said chamber axially opopsite said zones into said zones, said wear plate further including a pressure communication groove formed in said sealing surface for allowing the communication of pressure between said keystone-shaped zones and one of said ox-yoke shaped zones on the outlet side of the pump, said wear plate further being selectively seated in reverse alignment upon said gasket in either of two orientations so as to allow such communication between said keystone-shaped zones and either one of said ox-yoke shaped zones.

6. A gear pump comprising:

a first casing member having a figure 8-shaped bore formed therein, said first casing member further including a first fluid passage port in communication with one side of the waist portion of said bore and a second fluid passage port in communication with the other side of the waist portion of said bore, and a second casing member having a surface mating against said first casing member and having a seal pack groove system formed in said surface;

a pair of intermeshing gears mounted for rotation within said figure 8-shaped bore; and

a seal pack seated within said second casing member and including:

an oval-shaped planar wear plate, said wear plate being symmetrical about its minor axis and major axes juxtaposed to said gears, four spaced fluid passage holes therein for allowing communication of fluid pressure from said bore axially to the opposite side of said wear plate, said holes being disposed adjacent said ports of said casing and one each at the opposite ends of said oval-shaped wear plate, said wear plate further including a groove formed in the bore-facing surface of said wear plate in communication with one of said ports and with both of said holes at opposite ends of said wear plate, said wear plate being reversibly positioned to communicate said groove with either of said ports;

a gasket seated within said groove system juxtaposed in sealing contact with said oval wear plate to form therewith four pressure zones, two of said zones being keystone-shaped and located under the opposite ends of said wear plate and being each respectively in communication with one of said end holes of said wear plate; and two of said zones being ox-yoke shaped areas located opposite the ports in communication with said bore by means of one of said holes of said wear plate.

7. In a reversible gear pump-motor unit, a pressure balanced seal pack comprising:

a wear plate of ovaloid configuration having:

a sealing surface on one side and a motor surface on its opposite side,

said sealing surface having a pressure sensing and pressure equalizing groove formed therein including a straight leg middle portion and curved end leg portions all spaced inward of one side margin of the plate,

said wear plate having an aperture extending therethrough axially at each of said end leg portions, and

a pair of openings formed in said plate to extend axially therethrough opposite the inlet and outlet side of the pump,

one of said pair of openings intersecting the straight middle leg portion of said groove, whereby said plate may be reversibly positioned in the unit.

8. A reversible gear pump motor unit comprising:

a casing having an inlet and an outlet and including a figure 8-shaped pumping chamber,

a cover for said casing having a counter-recessed groove pattern in one face thereof disposed within a generally ovaloidal recess and confronting said pumping chamber, and

a pressure balanced seal pack in said ovaloidal recess comprising:

a wear plate of ovaloid configuration having:

a sealing surface on one side and a motor surface on its opposite side,

said sealing surface having a pressure sensing and pressure equalizing groove formed therein including a straight leg middle portion and curved end leg portions all spaced inward of one side margin of the plate,

said wear plate having an aperture extend-therethrough axially at each of said end leg portions, and

a pair of openings formed in said plate to extend axially therethrough opposite the inlet and outlet sides of the pump,

one of said pair of openings intersecting the straight middle leg portion of said groove, whereby said plate may be reversibly positioned in said unit.

9. A reversible gear pump-motor unit as defined in claim 8 and further characterized by a sealing web of generally J-shaped cross-section in said counter-recessed portions of said cover,

said recess means and said web including:

a generally ovaloidal continuous outer portion,

a pair of substantially circular inner portions,

a cross channel joining said inner portions with one another at the longitudinal centerline, and

a pair of cross channels joining the inner portions to the outer portions at opposite longitudinal ends and spaced symmetrically with respect to the longitudinal centerline, thereby to form segregated zones including two elongated zones opposite the inlet and outlet sides of the pump and two end zones at opposite ends of the ovaloid, whereby said seal pack is reversible and said end zones are selectively combined with one of said elongated zones on the outlet side of the pump by said pressure sensing and pressure equalizing grooves to form a major area while the other of said elongated zones forms a minor area.

10. A reversible pump-motor unit comprising a casing having a pumping chamber,

a cover engaging said casing and having recess means formed therein for receiving a seal pack axially opposite said pumping chamber, and

a sealing web of generally J-shaped cross-section in said recess means of said cover,

said recess means and said web including a generally ovaloidal continuous outer portion, a pair of substantially circular inner portions,

said inner portions being joined by a center bridge extending longitudinally,

two cross channels joining the inner portions to the outer portions at the respective ends of the web and disposed symmetrically with respect to the longitudinal axis to form segregated zones including two elongated zones opposite the inlet and outlet sides of the pump and two end zones,

a pressure plate,

said sealing web having a long leg and a short leg each having portions engaging and sealing against the sides of said recess means and forming with said cover a pressure pocket,

the bight portion of said web between said legs engaging an adjoining motive surface of the pressure plate,

means conducting fluid at pump generated pressure to said pocket for hydraulically sealing the pressure plate, and a pressure sensing and pressure equalizing groove formed in said plate having a longitudinally extending leg and two curved end legs all spaced inwardly from one side margin of said pressure plate, said groove having an axial opening extending through said pressure plate at each end leg, said pressure plate having two axial openings for disposition opposite the inlet and outlet sides of the pump, one of said openings intersecting the long leg of said groove, whereby said seal pack may be selectively reversed and said pressure sensing and equalizing groove will selectively join the two end zones with one of said elongated zones to form a major area on the outlet side of the pump while the remaining

elongated zone forms a minor area in communication with the inlet side of the pump.

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