March 3, 1970 G. L. NOELL ET AL 3,498,232

GEAR PUMP WITH SEPARATING FORCE DISTRIBUTING ELEMENTS

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FIG_1

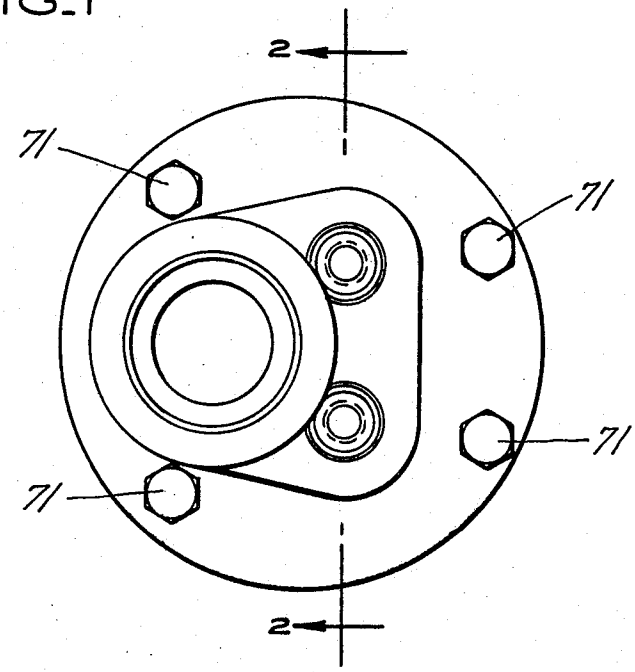
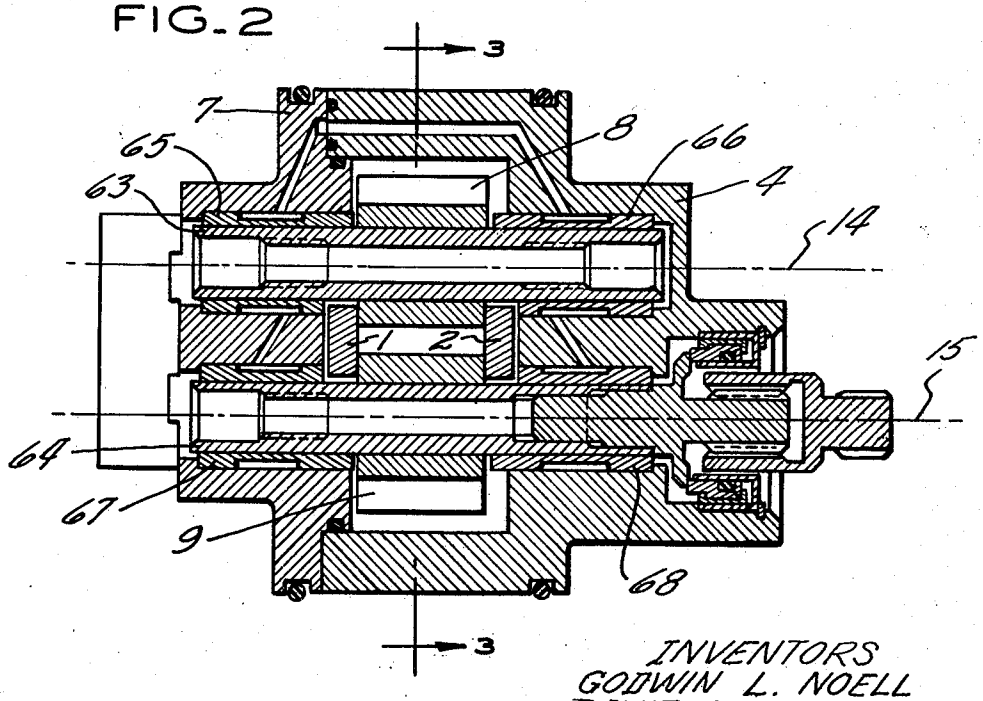


FIG_2



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GEAR PUMP WITH SEPARATING FORCE DISTRIBUTING ELEMENTS

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FIG. 3

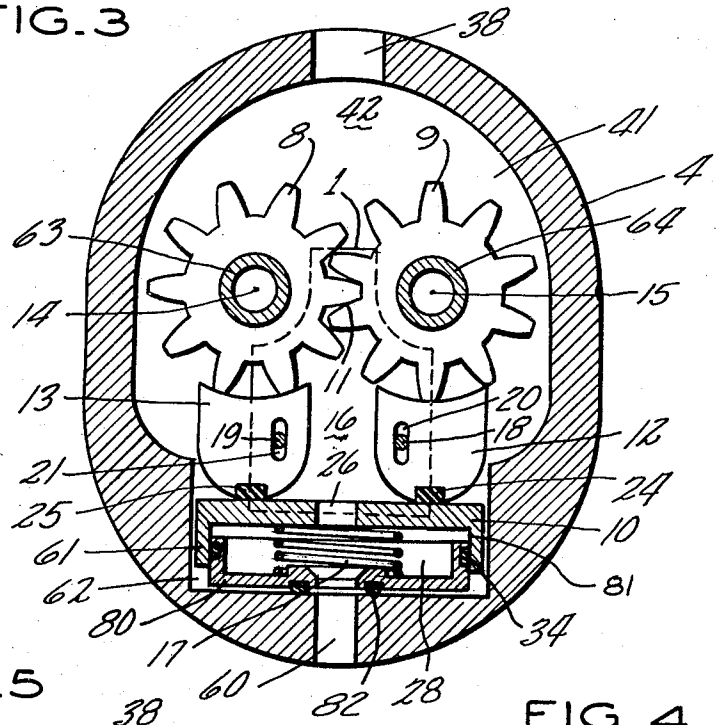


FIG. 5

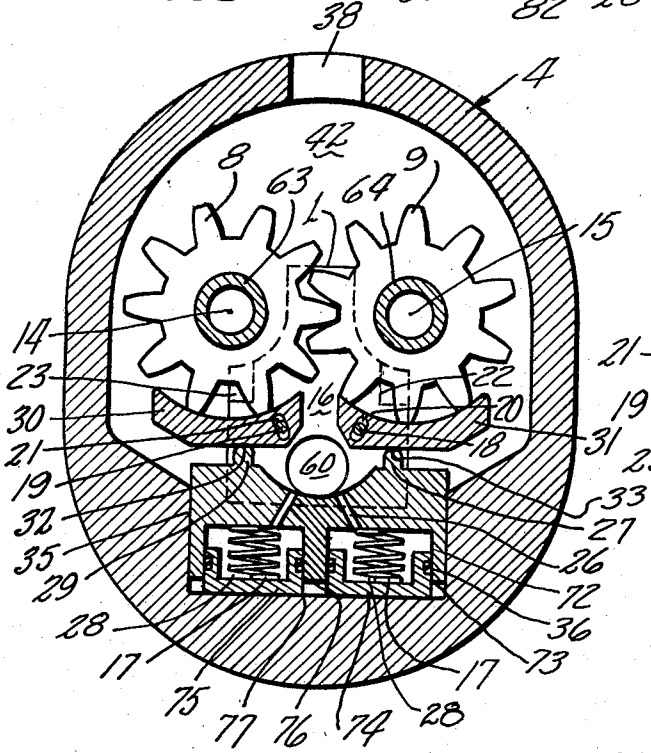
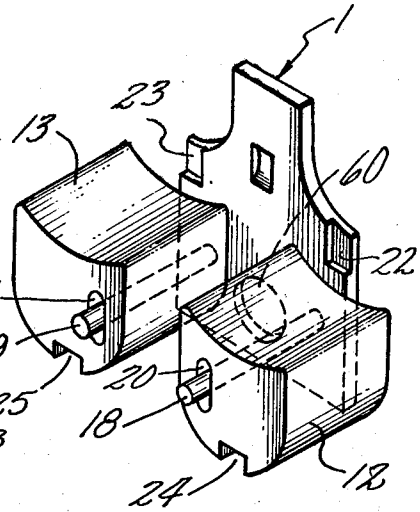


FIG. 4



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GEAR PUMP WITH SEPARATING FORCE DISTRIBUTING ELEMENTS

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FIG. 6

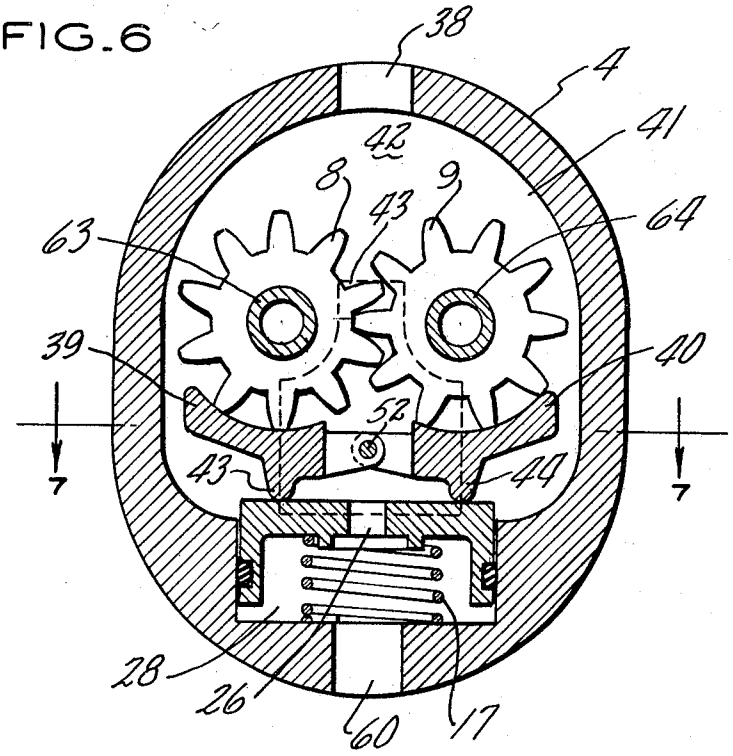
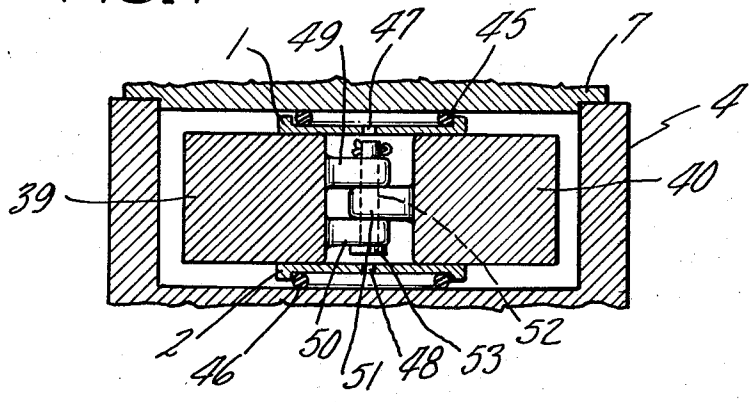


FIG. 7



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3,498,232

GEAR PUMP WITH SEPARATING FORCE DISTRIBUTING ELEMENTS

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Int. Cl. F04c 5/00, 17/10, 27/00
U.S. Cl. 103—126 7 Claims

ABSTRACT OF THE DISCLOSURE

A gear pump including a pair of sideplates having separate independently movable gear tooth peripheral sealing elements positioned therebetween to maintain pump volumetric efficiency; with each peripheral sealing element slideably pinned to the sideplates to reduce the discharge pressure generated separating loads imparted to the gears by distributing the separating force to the sideplates through the connecting pins as an opposed balanced force, or in the alternative connecting integral hinge abutments of the sealing elements with a hinge pin to cancel the separating force at the hinge pin.

BACKGROUND OF THE INVENTION

This invention pertains to gear pumps capable of delivering high output pressures at exceptionally high volumetric efficiencies wherein the pump comprises a housing with a pair of meshed toothed gears disposed therein having separate movable elements adjacent the pump outlet engaging the periphery of each gear in a one-to-one relationship to maintain continuous pheripheral sealing engagement during independent movement of the gears. The construction of a gear pump having separate movable elements trackably engaging the periphery of the driver gear and the driven gear respectively is described in U.S. Patent application Ser. No. 659,426, inventors Noell, Cygor and Sundberg, entitled "Gear Pump" filed on Aug. 9, 1967, now U.S. Patent No. 3,437,048, and assigned to the same assignee as the instant application. Reference may be had to said application for a detailed description and explanation of the construction and operation of a gear pump having a driver gear and a driven gear with separate trackable pivotable movable elements urged into engagement with the periphery of the driver gear and the driven gear respectively to maintain continuous peripheral sealing engagement during the independent movement of the gears.

The pump construction described in U.S. patent application Ser. No. 659,426 of inventors Noell, Cygor and Sundberg, entitled "Gear Pump" filed on Aug. 9, 1967, now U.S. Patent No. 3,437,048, utilizes separate movable elements that are pivotably disposed such that a vectored separating force having a vector direction normal to the sideplate separating force is transmitted through each separate element to the portion of the gear engaging the wiping surface of each movable element. The vectored separating forces are normally transmitted through the movable elements such that one-half the magnitude of the force is transmitted to the periphery of the gear teeth engaging the wiping surface of the movable element, and the other half is transmitted to the movable element pivot point. It has been found that due to the great magnitude of the separating forces, the transmission of these forces to the gear tooth tips adjacent the wiping faces of the movable sealing elements causes destructive wear, and hence reduces the operational life of the gear pump.

SUMMARY OF THE INVENTION

This invention pertains to a gear pump that has separate movable sealing elements engaging the periphery of each gear and incorporating sideplates positioned adjacent each lateral face of the gears and their associated movable elements with each movable ellement operatively secured to at least one sideplate by means of a through pin connected to the sideplate such that the movable elements separating forces are transmitted to the sideplate as a balanced force.

The gear pump organization of the instant invention has a sealing block separating force generated by the pressure in the pump discharge chamber, said force having vector direction transverse the sideplate separating force. In a one piece sealing block, the separating force stresses the member that connects the separate gear wiping face portions of the sealing block. In the case of structurally separate sealing blocks, each block is articulated about an axis remote from its wiping face. Gear pumps containing separate sealing elements are construted to develop a reaction force betwen the wiping face and periphery of the gear teeth to counter the moment produced by the separating force positioned about the axis of articulation. This reaction due to the great magnitude of the separating forces and the small area of contact between the gear tooth tips and the wiping faces of the movable elements causes destructive wear and rocking of the sealing elements each time a gear tooth leaves the wiping face. Hence, the articulated and highly loaded sealing block is free to enter the gear interstices while instantaneously shifting the contact zone to the next trailing gear tooth.

The undesirable moments produced by the action of the separating force on the movable elements can be eliminated or reduced by positioning the axis of articulation of each element at or near the plane of the resultant separating force vector. Alternate embodiments of this principle utilize either the sideplate or integral tensile members to balance the sealing block separating loads generated by the pressure in the pump discharge chamber.

An object of this invention is to substantially cancel the fluid discharge pressure generated separating forces and rocking moments applied to the paired movable sealing elements of a gear pump by slideably pinning each of said elements for articulated movement about an axis substantially in the plane of the resultant separating force.

Another object is to substantially cancel the separating force and rocking moment transmitted to the separate sealing elements of a gear pump by fitting a pin in each sideplate that engages a mating slot in its respective sealing block to thereby cause separating forces to be transmitted through said pins as opposed balanced loads to thereby place the sideplates in tension.

Another object is to cancel the separating forces and rocking moments by pinning the paired sealing blocks to each other to thereby provide articulated movement for each block by forming a hinge therebetween independent of any connection with said sideplates.

Another object is to prevent rocking of each sealing element by providing a reaction through a hinge whereby the block possessing stability at a given instant resists the motion of a paired and temporarily unstable sealing block.

Many other advantages and features of this invention will become manifest to those well versed in the art by making reference to the description which follows.

DESCRIPTION OF THE DRAWINGS

The following is a brief description of the drawings ac-

companying the detailed description of the instant invention.

FIGURE 1 is a front view of one form of pump incorporating the instant invention.

FIGURE 2 is a longitudinal sectional view along line 2—2.

FIGURE 3 is a sectional view along line 3—3.

FIGURE 4 is an exploded perspective view showing the load transfer pins attached to the sideplate and a first arrangement of the gear tooth peripheral sealing members positioned thereon.

FIGURE 5 is a detailed cross-sectional view in accord with this invention having a first alternate form of load transfer pin and sealing member arrangement.

FIGURE 6 is a detailed cross-sectional view in accord with this invention having a second alternate form of load transfer pin and sealing member arrangement.

FIGURE 7 is a fragmentary sectional view along line 7—7.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now the drawings, and first generally to all of the forms shown in the following description, wherein like parts are designated throughout by like numerals.

Referring to the example shown in FIGURES 1, 2, 3 and 4, there is provided a pump having a housing **4** defining therein a cavity **41** and a pair of sideplates **1** and and **2** positioned on opposite sides of housing **4** and secured in fluid tight relation to said housing and cover **7** by means of a plurality of bolts **71**. Rotatably mounted about axes of rotation **14** and **15** in cavity **41** of housing **4** are a pair of intermeshing gears **8** and **9** and engaging one another at an area of intermesh shown generally at **11** to form an inlet chamber shown generally at **42** and an outlet chamber shown generally at **16**. A plane positioned equidistant axes of rotation **14** and **15** and transverse a plane containing said axes of rotation is called herein a plane of symmetry. Discharge flow is routed from discharge chamber **16** through a large aperture **26** in platform **10** into a platform loading chamber **28** and thence through outlet port **60** in the pump housing. Shaft **63** and shaft **64** are journalled in bearings **65**, **66**, **67** and **68** respectively in housing **4** with a close running fit such that the axes of rotation **14** and **15** are maintained substantially parallel. Platform **10** has an upper portion having straight flat edges parallel to the lateral faces of gears **8** and **9**. Said lateral faces are spaced apart a distance identical to the thickness of gears **8** and **9** and the thickness of movable elements **12** and **13** such that sideplates **1** and **2** will simultaneously sealingly engage said straight flat edges and said lateral faces to limit fluid leakage from chamber **16** past said engaging surfaces to pump inlet chamber **42**. Platform **10** has a rectangular portion **61** integral with said upper portion and loosely received in trough **62** of housing **4**. A spacer piston **80** is received in bore **81** of platform **10**. Piston **80** slideingly sealingly engages bore **81** by means of "O-ring" seal **34**. Piston **80** sealingly engages housing **4** by means of "O-ring" seal **82**. Helical spring **17** disposed in loading chamber **28** urges platform **10** against movable sealing blocks **12** and **13** thereby causing said blocks to engage the perimeters of gears **9** and **8** respectively in a fluid sealing manner prior to the buildup of fluid pressure in chamber **28**. Seals **24** and **25** disposed along the interface of platform **10** and sealing blocks **12** and **13** similarly prevent leakage past the juncture of said platform and said movable elements from high pressure chamber **16** to inlet pressure chamber **42**. Seals **24** and **25** may be an elastomeric material, or alternatively integral parts of movable elements **12** and **13** arranged to provide a line contact seal with platform **10**.

Pivot pins **18** and **19** are fixed with respect to sideplates **1** and **2** as to motion transversed axes of rotation **14** and **15**, but are free to slide axially with respect to said sideplates at one or both pins ends. Slot **20** in block **12** and slot **21** in block **13** permit articulated movement and longitudinal movement of said blocks with respect to said pins; however, side loads applied to the blocks **12** and **13** by fluid pressure in chamber **16** are transmitted to pins **18** and **19** and thence to the sideplates **1** and **2** thereby placing the portion of the sideplates between said pins in tension and preventing application of the side load to the limited area of interface between the gear tooth periphery and the sealing blocks.

FIGURE 5 shows an alternate pin and sealing block arrangement for transmitting the sealing block separation loads to the sideplates. This first alternate construction also shows the use of undercuts in the areas **22** and **23** of sideplates **1** and **2** to prevent the buildup of high pressure between gears **8** and **9** and the mating wiping faces of sealing blocks **30** and **31**, except for a small arcuate segment of interface extending outward for at least the width of one gear tooth spacing from the inboard edge of the wiping faces. The effect of these undercuts is to minimize the gear circumference acted upon by discharge pressure thereby minimizing the gear journal loads, yet provide a large pressurized outboard area to urge the sideplates into sealing engagement with the gears. Additionally, the loading platform **10** has sealing protuberances **27** and **29** integral therewith serving to load sealing blocks **31** and **30** respectively and prevent leakage flow past the interfaces **32** and **33** into the pump inlet chamber **42**. Pins **18** and **19** are located inboard of protuberances **27** and **29** and axially slideably engage at least at one sideplate and simultaneously coact with slots **20** and **21** respectively of sealing blocks **31** and **30** to restrict the movement of said sealing blocks in a manner similar to that described in detail above for the first embodiment of the instant invention. The major axes of slots **20** and **21** lie along lines drawn radially from the gear centers, thereby permitting one component of the sealing block separating force to urge each block radially towards its respective gear axis of rotation while the remaining force component is transmitted through the pivot pins **20** and **21** to the sideplate thereby transmitting the transverse component of the separating force to the sideplate in a manner similar to that described for the first embodiment. The orientation of slots **20** and **21** permit the wiping faces of sealing blocks **31** and **30** to readily maintain peripheral sealing engagement following gear position changes resulting from journal wear shifting direction of the separating force vector. Additionally, since the slots **20** and **21** are roughly aligned with the separating force resultant vector generated by the pressure in the discharge chamber **16** the gears **8** and **9** move, due to journal clearance growth resulting from wear, in a direction which the sealing blocks **30** and **31** can follow without appreciably realigning the force distribution applied to the sealing blocks as balanced free bodies. Platform **10** has an upper portion having a pair of opposed flat surfaces positioned intermediate sideplates **1** and **2**. The lower portion of said platform is rectangular in shape and is received in trough **35** of housing **4**. "O-ring" seal **36** positioned intermediate bore **72** in platform **10**, and the periphery **73** of the cylindrical portion of spacer **74** and "O-ring" seal **75** positioned intermediate bore **76** and periphery **77** prevent the leakage of fluid from discharge chamber **16** into inlet chamber **42**. Helical springs **17** positioned intermediate platform **10** and housing **4** urge sealing blocks **30** and **31**, through platform **10**, into peripheral engagement with the tips of the teeth of gears **8** and **9** during the buildup of fluid pressure in chamber **16**. Fluid at discharge pressure communicated via passageways **26** to chambers **28** generate forces on platform **10** which supplement the initial spring preload forces urging the sealing blocks **30** and **31** into peripheral sealing engagement with gears **8** and **9**.

FIGURES 6 and 7 show a second alternate pin and sealing block arrangement for transferring to another portion of the pump structure the separating force com-

ponent of the resultant force imposed on the peripheral sealing juncture of the gears and the sealing blocks.

FIGURES 6 and 7 show a pump housing **4** having an inlet port **38** and an outlet port **60** and an interior cavity **41** in fluid communication with said inlet chamber **42** and said inlet port **38**. Sealing blocks **39** and **40** are respectively urged into fluid sealing engagement with an arcuate portion of the periphery of the tooth tips of pumping gears **8** and **9** respectively. The force to so urge said sealing blocks into peripheral sealing engagement with said gears is in part supplied by loading platform **10** having an upper surface in sealing and force transmitting contact with rocker like protuberances **43** and **44** on said sealing blocks **39** and **40** respectively. Aperture **26** connects expansible chamber **28** to discharge pressure to generate a force on platform **10** which is supplemented by spring **17** to generate a combined sealing force on platform **10** that is transmitted via sealing blocks **39** and **40** to gears **8** and **9**. Gears **8** and **9**, sealing blocks **39** and **40**, and platform **10** sealingly engage sideplates **1** and **2** which are urged towards each other by mechanical squeeze on compressible seals **45** and **46** positioned between said sideplates and housing **4** and housing cover **7**. Pressure confined by compressible seals **45** and **46** and referenced to discharge pressure by apertures **47** and **48** generates a force on plates **1** and **2** respectively that further urges said plates toward each other.

Sealing block **39** has thereon an integral pair of hinge abutments **49** and **50** spaced apart to receive therebetween a mated abutment **51** associated with sealing block **40**. Said abutments have therein an accurately aligned bore **52** of precise diameter closely fitted with a wrist pin **53** to permit a hinge motion and yet to permit negligible lateral clearances. This hinged configuration permits sealing block separating loads generated by the pressure in chamber **16** to cancel at the wrist pin without loading the sideplates.

Since the organization disclosed by said second alternate form of the instant invention cancels the separating forces independent of the use of the sideplates, the use of a very hard and brittle sideplate material can be considered for improved wear properties in view of the reduced sideplate tensile load and bending strength problems.

Further, a controlled moment about the wrist pin can be applied by offsetting the wrist pin from the plane of the resultant sealing block separating force generated by the pressure in chamber **16**.

Referring now to FIGURE 5, it can be seen that when gear **8** rotates counterclockwise and a gear tooth is just leaving the inboard edge of the wiping surface, support of the leaving gear tooth is lost and the sealing block may tend to instantaneously rotate about the next trailing tooth such that the inboard edge of the wiping surface will penetrate the envelope of the gear periphery and enter the interstice between the teeth. This condition generates a sealing block operational instability.

However, this mode of instability will be prevented by the hinged configuration since such motion would require an upward movement of wrist pin **53** which has negligible transverse play. Thus, the motion of block **39** would be instantly transferred to block **40** where a gear tooth is disposed to support the wiping surface inboard edge and prevent block **39** from so moving. The meshed gear relationship causes the inboard wiping surface edge of one block or the other to be supported at any given instant, thus transferring its support by way of the hinge to the otherwise unsupported counterpart to thereby prevent sealing block instability.

Separate alternate complementary pinned configurations for loading, sealing and stabilizing gear pump elements have been shown herein with respect to specific embodiments which are set out by way of illustration rather than limitation of the invention.

We claim:

1. A gear pump for pumping fluids at high pressure and volumetric efficiency comprising, a housing having a cavity therein and end closures, a pair of intermeshing gears, said gears disposed in said cavity and journalled in said housing such that the axes of rotation of said gears are positioned substantially parallel, a plane of symmetry located intermediate and equidistant said axes of rotation and positioned transverse a plane containing said axes of rotation, a plurality of movable peripheral sealing members, each member engaging the periphery of the tips of a plurality of teeth of one of said gears, a pair of side plates sealingly engaging the lateral faces of said gears and the corresponding sides of said movable peripheral sealing members to form a discharge chamber therebetween, said discharge chamber containing the high pressure produced by the rotation of said gears such that said high pressure generates side loads on said movable peripheral sealing members, hinge means operatively interrelating said movable sealing members and said side plates to cause said side loads to be transmitted to a portion of said hinge means other than the limited area of interface between said movable sealing elements and the periphery of said gear teeth.

2. A gear pump for pumping fluids at high pressure and volumetric efficiency comprising, a housing having a cavity therein and end closures, a pair of intermeshing gears, said gears disposed in said cavity and journalled in said housing such that the axes of rotation of said gears are positioned substantially parallel, a plane of symmetry located intermediate and equidistant said axes of rotation and positioned transverse a plane containing said axes of rotation, movable peripheral sealing members engaging the periphery of the tips of a plurality of teeth of each of said gears, a pair of sideplates sealingly engaging the lateral faces of said gears and the corresponding sides of said movable peripheral sealing members to form a discharge chamber therebetween, said discharge chamber containing the high pressure resulting from rotation of said gears, side loads generated by said high pressure on said movable peripheral sealing members, means operatively connected to said sideplates and coacting with said movable peripheral sealing members such that said side loads are transmitted to said sideplates.

3. A gear pump, as described in claim **2**, wherein said means operatively connecting said movable sealing members comprises a plurality of elongated members slideably engaging said side plates, elongated slots formed in said movable sealing members with the major axes of said slots positioned parallel to said plane of symmetry such that said elongated members coact with said slots to transmit the side loads impressed on said movable sealing members through said elongated members to said side plates.

4. A gear pump, as described in claim **3**, wherein said elongated members are pins slideably positioned in said sideplates with a single pin disposed in a single elongated slot so that said slots coact with said pins to transmit said side loads to said pins such that the area intermediate said pins is placed in tension.

5. A gear pump, as claimed in claim **2**. wherein said means operatively connecting said movable sealing members comprise a plurality of elongated members slideably engaging said side plates, elongated slots formed in said movable sealing members with the major area of said slots inclined to said plane of symmetry and extending along lines projecting radially through said axes of rotation such that said elongated memers coact with said slots to transmit the component of said separating force traverse said plane of symmetry impressed on said movable sealing members through said elongated members to said side plates.

6. A gear pump, as claimed in claim 5, including recesses in said sideplates located on the surface of said sideplates in sealing engagement with the lateral surface of said gears and positioned adjacent the pump discharge chamber to thereby connect all but an arcuate segment substantially one gear tooth spacing in width to pump inlet conditions.

7. A gear pump, as claimed in claim 1, wherein said hinge means operatively interrelating said movable sealing members comprises an integral protuberance extending from each of said movable sealing members towards said plane of symmetry, said protuberances mated to slideably receive an elongated member therethrough such that said interconnected sealing members generate a hinge motion while simultaneously coacting to cancel said side loads at said elongated member.

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U.S. Cl. X.R.

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