April 24, 1956 O. H. BANKER 2,742,862

FLUID PUMP

Filed March 9, 1953 4 Sheets-Sheet 1

Fig. 1.

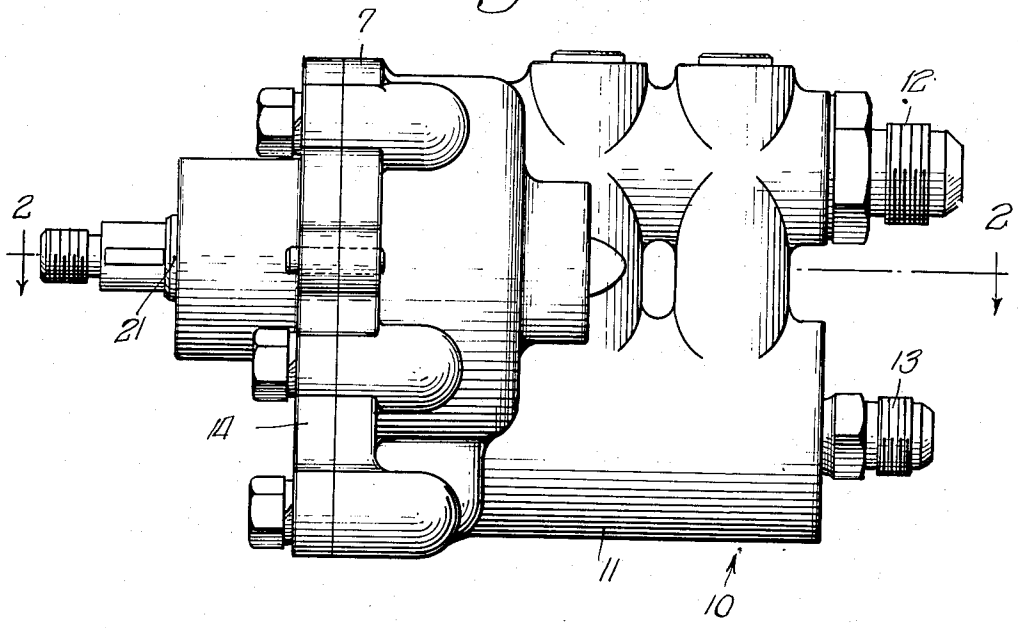
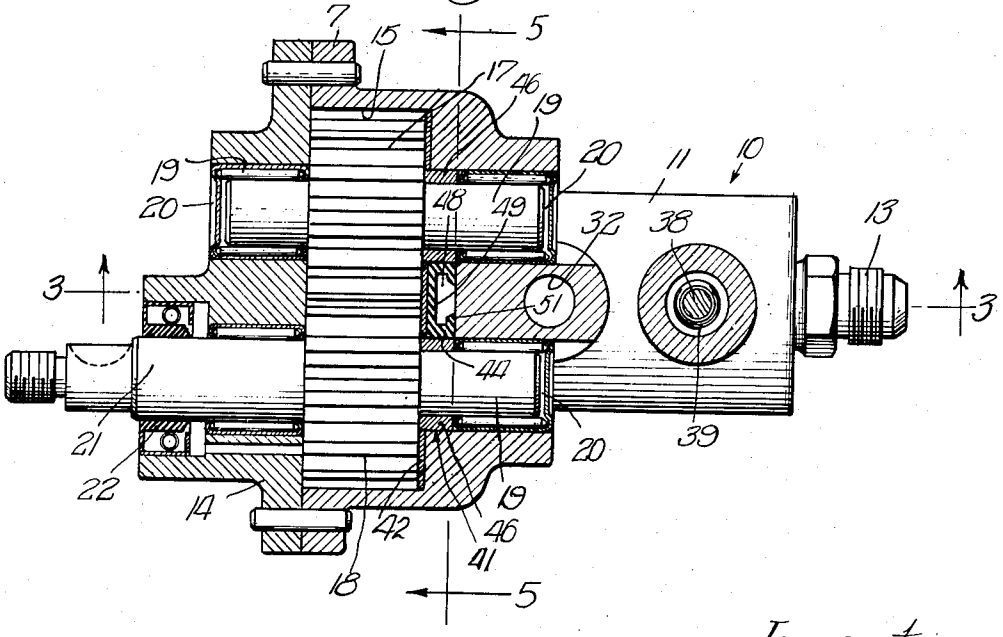



Fig. 2.



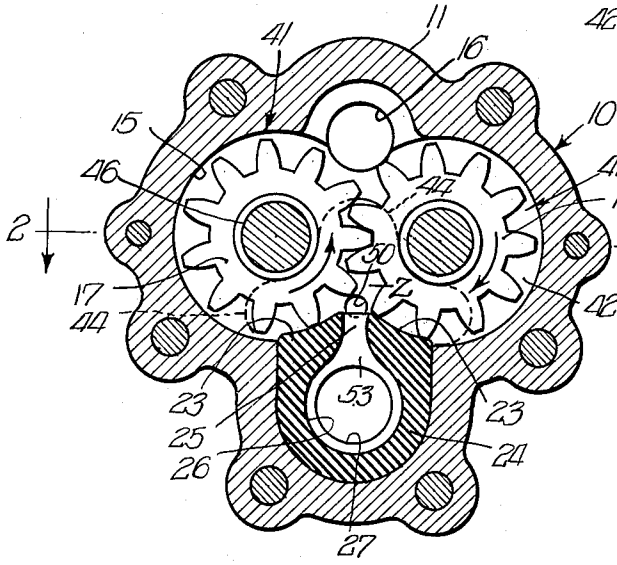

Inventor:
Oscar H. Banker,
By Cromwell, Geist & Warden
Attys

April 24, 1956 O. H. BANKER 2,742,862

FLUID PUMP

Filed March 9, 1953 4 Sheets-Sheet 2,

Fig. 4



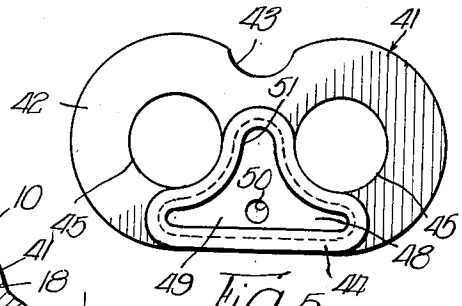




Fig. 5

Fig. 6.

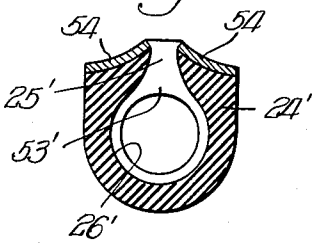
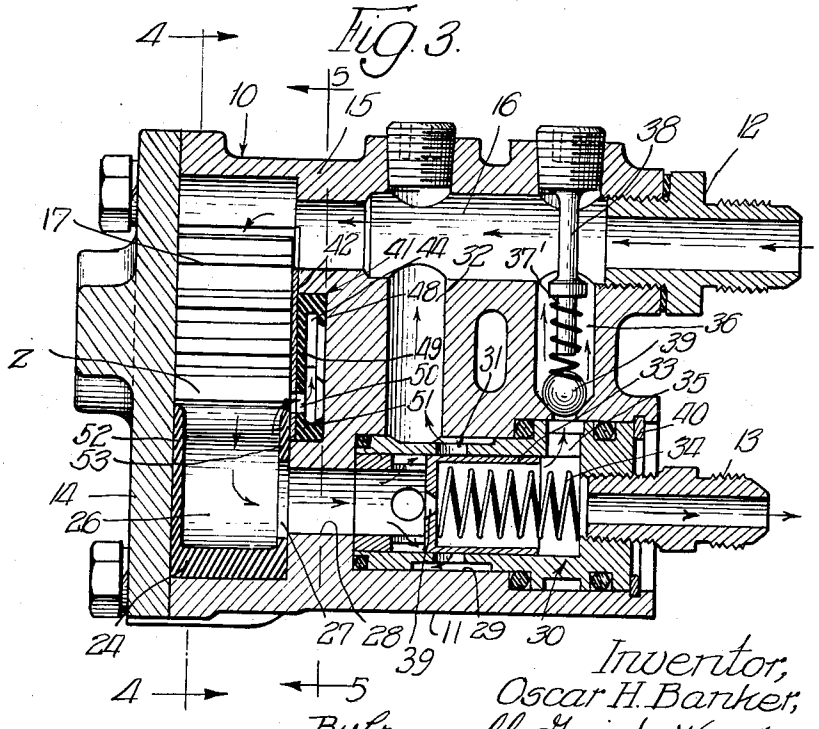



Fig. 3.




Inventor,
Oscar H. Banker,
By Cromwell, Greist & Warden
Attys.

April 24, 1956 O. H. BANKER 2,742,862

FLUID PUMP

Filed March 9, 1953 4 Sheets-Sheet 3

Fig. 7

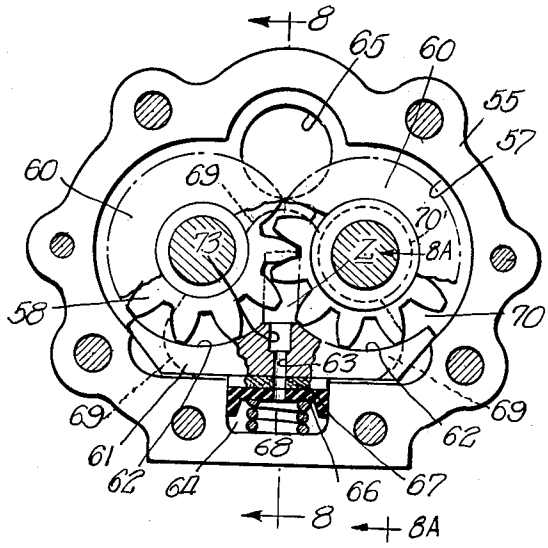



Fig. 8

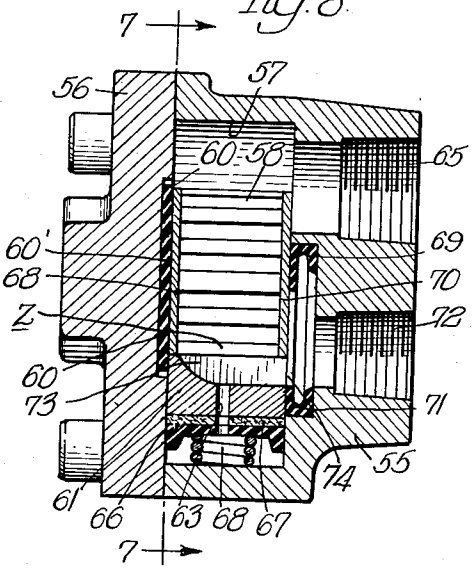



Fig. 9

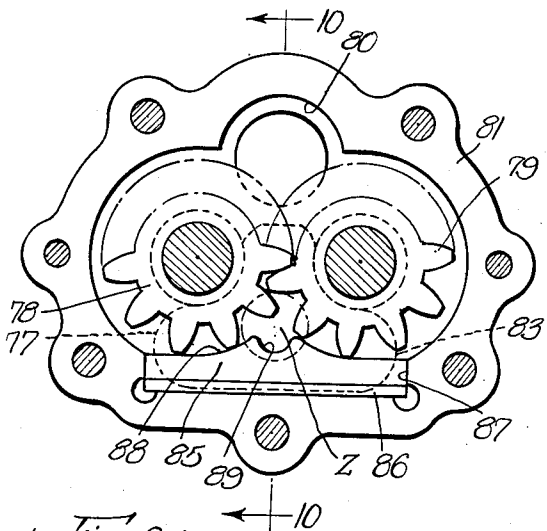



Fig. 10

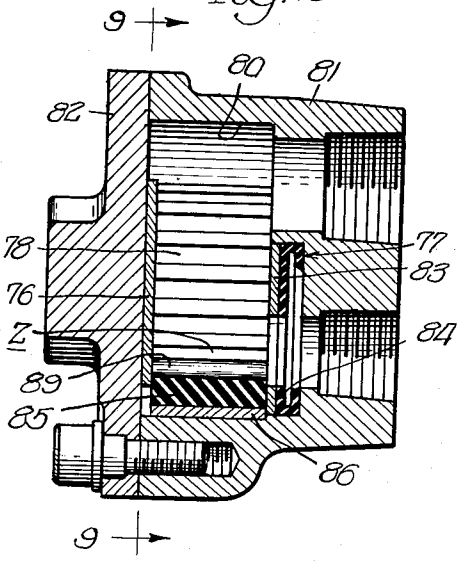
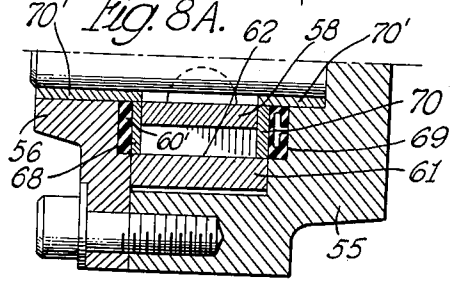



Fig. 8A.




INVENTOR.
Oscar H Banker,
BY
Cromwell, Bristol & Warden
attys

April 24, 1956 O. H. BANKER 2,742,862

FLUID PUMP

Filed March 9, 1953

4 Sheets-Sheet 4

Fig. 11

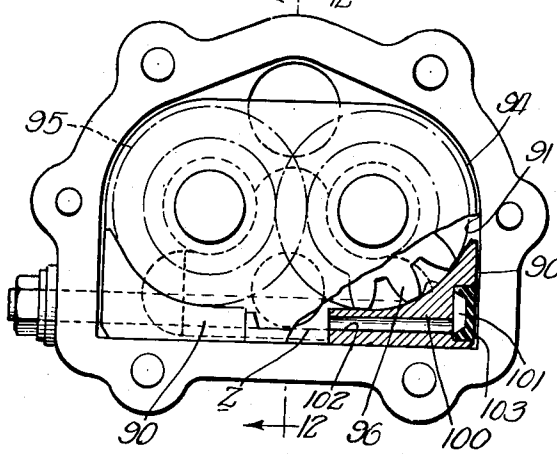



Fig. 12

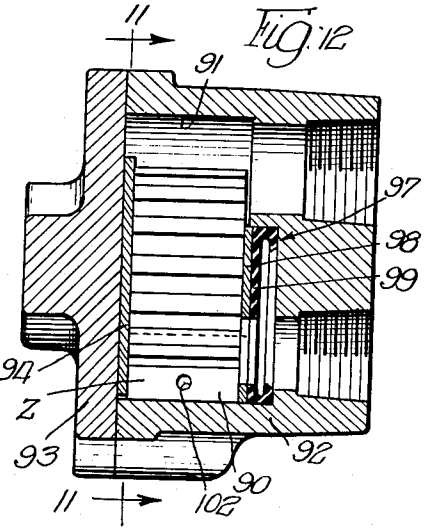



Fig. 13

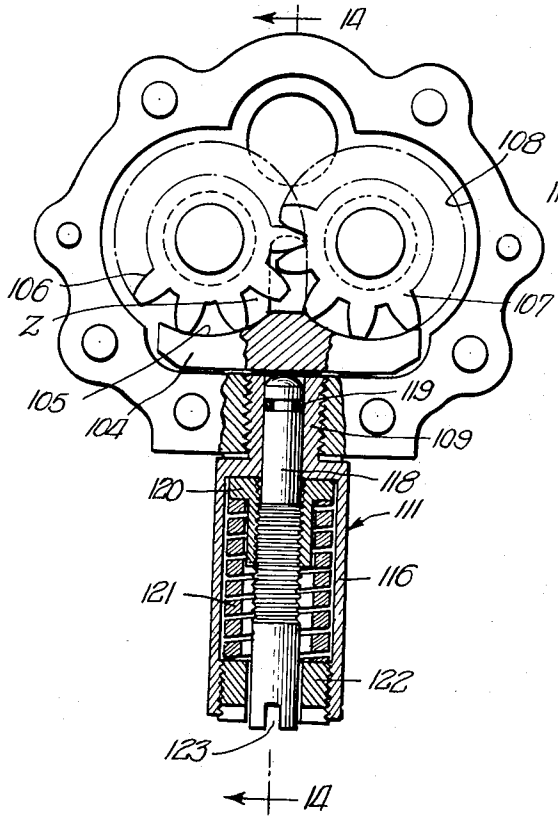
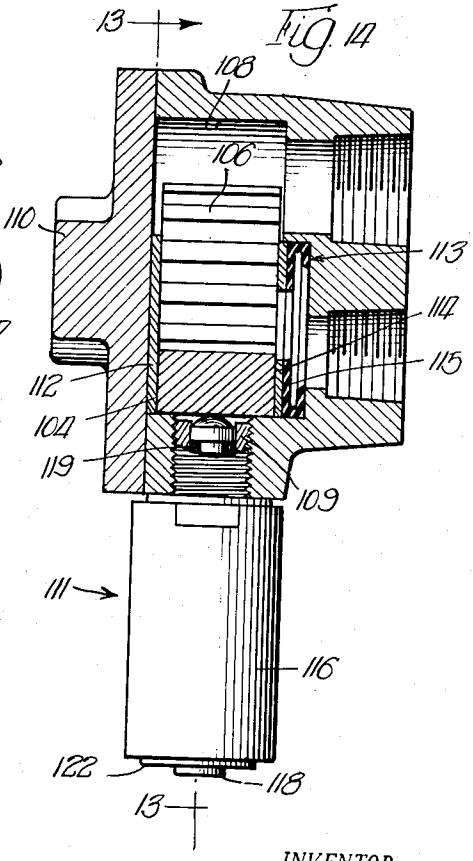



Fig. 14




INVENTOR.
Oscar H. Banker,
BY
Cromwell, Greist & Warden
Attys.

United States Patent Office 2,742,862 Patented Apr. 24, 1956



2,742,862

# FLUID PUMP

Oscar H. Banker, Evanston, Ill., assignor to New Products Corporation, Chicago, Ill., a corporation of Delaware

Application March 9, 1953, Serial No. 341,272

25 Claims. (Cl. 103—126)

The present invention relates to improvements in a gear pump which make the pump automatically self-sealing. A pump having the improved features is able to deliver pressures without leakage ranging from 50 pounds per square inch to over 1000 pounds per square inch. By virtue of the fact that high pressure liquid discharge can be had at relatively low speed drive of a pair of pump gears in a relatively small housing, and also the fact that close tolerance machining is not required, the pump is very compact and can be manufactured very inexpensively.

Generally speaking, it is an object of the invention to provide an improved gear pump in which peripheral and side surface sealing of the gears is performed by sealing members which engage the gears under forces derived directly from the pump discharge pressure.

It is also a general object of the invention to provide an improved gear pump of high volumetric and overall efficiency whose meshing gears are received in a housing with relatively wide clearance at the sides of the gears, and with comparably free radial clearance at the internal peripheral surface of the housing; thereby economizing in cost of manufacture by eliminating a close fit of the parts, and at the same time affording ample intake space around the gears.

A further and more specific object is to provide a gear pump of the sort referred to above, wherein fixed, hollow, fluid pressure responsive members of resilient material are associated in sliding sealing relation to a side and/or peripheral surface or surfaces of the pump gears adjacent the high pressure pump discharge zone. Those members, in most of the embodiments of the invention, are internally subject to the pump discharge pressure and are thrust by that pressure into engagement with the gear surfaces in question. The gears are thus effectively sealed at the high pressure discharge zone, yet liberal clearance exists between the unsealed portion of the gears and the housing pumping cavity other than its discharge zone.

Still another specific object is to provide an improved self-sealing and self-compensating gear pump featuring a resiliently expansible unit in sliding sealing engagement with side surfaces of the meshing pump gears, as described above, which unit has an internal pressure cavity of predetermined shape and size, substantially overlapping the sides of the gears outwardly of a high pressure discharge zone adjacent their meshing teeth. The internal area of a wall of the cavity facing the gears is substantially greater than the external area of the unit which is exposed at the pressure zone, so that a pressure differential is created to maintain the unit in tight sealing engagement with the gear side surfaces, for the purposes described in the preceding paragraphs.

A still further object is to provide an improved gear pump of the sort described above featuring, in certain embodiments thereof, a shaped discharge throat or discharge member of resilient material adjacent the pump discharge opening, the member being shaped to provide



arcuate gear tooth sealing shoulders positioned for radial wiping and sealing engagement with the teeth of the pump gears, over a substantial arc in each case. The shoulders are thrust into radial sealing relation to the gears by the discharge pressure, which is in most instances effective on the interior of the member, and this pressure also urges the member to laterally sealed engagement with the gear housing of the pump.

Yet another object is to provide a self-sealing gear pump incorporating a radially acting, gear tooth sealing member in combination with a gear side surface sealing member, both members being urged to sealing engagement with the gears by pressure equal to the pump discharge pressure at the meshing gear teeth zone.

A further object is to provide a pump which, in other modifications thereof, has arcuate concave tooth sealing shoulders thrust into peripheral engagement with the gear teeth by the action of a separate rear plunger subject to the pump discharge pressure; this pressure may be supplemented by mechanical spring force, if desired. One adaptation features a solid, block-like, but elastically deformable shoulder member radially engaging the pump gear teeth under the molding action of the directly applied discharge pressure at the high pressure zone.

In still another modification, peripheral gear tooth sealing action is performed by a pair of laterally spaced, internally chambered, concave surfaced sealing shoulders which occupy opposed corners of the housing interior; the shoulders are urged into engagement with the teeth by internal pressure equal to the pump discharge pressure.

Yet another embodiment according to the invention contemplates the use of an arcuate gear tooth sealing shoulder member or members yieldably urged radially against the gears by an adjustable spring biasing arrangement, which arrangement serves as a pump discharge pressure regulator, by enabling the sealing member or members to yield at a desired pre-set spring setting and thus by-pass liquid from the high pressure discharge zone of the pump cavity.

In any of the embodiments, it is an object to provide a gear pump as described in the preceding paragraphs in which the sealing members which engage the pump gears, particularly the radially acting members, may be metal clad to resist wear on the gear engaging surface or surfaces, and to prevent jamming into the gear teeth. Use of such wear means may be dispensed with in low pressure pumps, but is practically indispensible in heavy duty types.

The foregoing statements are indicative in a general way of the nature of the invention. Other and more specific objects will be apparent to those skilled in the art upon a full understanding of the construction and operation of the improved pump.

Various modified embodiments of the invention are presented herein for purpose of illustration. It will be appreciated that the invention may be incorporated in still other modified forms coming equally within the scope of the appended claims.

In the drawings:

Fig. 1 is a side elevational view of the improved pump, in accordance with one embodiment thereof;

Fig. 2 is a view in longitudinal cross section along a line generally corresponding to line 2—2 of Figs. 1 and 4, generally showing the lateral sealing member for the pump gears;

Fig. 3 is a cross sectional view through the pump on line 3—3 of Fig. 2, illustrating details of the improved, side-acting gear sealing arrangement, and of the discharge side of the pump;

Fig. 4 is a view in transverse section along line 4—4 of Fig. 3, further showing the improved discharge throat sealing provisions of the invention;

Fig. 5 is a view in front elevation of the side gear surface sealing member of the improved pump, the member being viewed as from line 5—5 of Figs. 2 and 3;

Fig. 6 is a view in transverse section, similar to Fig. 4, showing a metal clad discharge throat sealing member in accordance with a slightly modified adaptation of the invention;

Fig. 7 is a view in transverse vertical section, partially broken away, and approximately as viewed along line 7—7 of Fig. 8, illustrating pump housing components of a modified form of the invention, particularly as regards the radially acting gear tooth sealing provisions adjacent the pump discharge side;

Fig. 8 is a view in vertical longitudinal section along a line corresponding to line 8—8 of Fig. 7;

Fig. 8A is a view in vertical section along line 8A—8A of Fig. 7;

Fig. 9 is a view similar to Fig. 7, and as viewed along line 9—9 of Fig. 10, showing a further modified embodiment of the invention involving a block-like discharge throat sealing device;

Fig. 10 is a view in longitudinal vertical section approximately along line 10—10 of Fig. 9;

Fig. 11 is a view in transverse section, along a line corresponding to line 11—11 of Fig. 12, illustrating yet another modified embodiment of the invention, featuring laterally spaced, radially acting gear teeth sealing shoulders;

Fig. 12 is a view in longitudinal vertical section along line 12—12 of Fig. 11;

Fig. 13 is a view generally similar to Fig. 11 showing a still further modified form of the invention, featuring an adjustable spring pressure regulating action at the radially acting gear tooth sealing surfaces; and

Fig. 14 is a view in vertical longitudinal section along a line corresponding to line 14—14 of Fig. 13.

Although the above figures disclose pumps of a well-known sort having gears with external meshing teeth, the principle of the invention is also adaptable to a gear pump of the outside-inside type, featuring a larger, internally toothed gear and a smaller, externally toothed gear in mesh therewith.

Referring to Figs. 1–6 inclusive, of the drawings, the reference numeral **10** generally designates a housing or casing for the improved pump in accordance with one form of the invention. It consists of an appropriately chambered gear housing and intake-discharge passage member or body **11**, at the right, having intake and discharge fittings **12**, **13**, respectively, communicating with its interior at vertically spaced levels. An end or side closure and bearing plate **14**, at the left, is bolted to housing body **11**.

Housing **10** provides a pump gear cavity **15** to which liquid is supplied through an intake passage **16** in alignment with intake fitting **12**. Meshing pump gears **17**, **18** are located in this cavity, their shafts **19** being journalled by roller bearings in bearing receiving openings **20** at either side of the gear cavity. Appropriate cages mount the bearings in the openings, in well known fashion.

It will be noted, particularly by reference to Fig. 4, that a substantial radial clearance exists between the outer extremities of the teeth of gears **17**, **18** and the inner peripheral wall of housing cavity **15**. Close tolerance machining and fitting of parts is thus eliminated. The pump is driven through a shaft **21** on gear **18**, as illustrated in Fig. 2, leakage at this point being prevented by the use of a conventional seal **22**.

In accordance with this form of the invention, and as best illustrated in Fig. 4 of the drawings, the teeth of gears **17**, **18**, adjacent the central, restricted, discharge zone or space Z of pump chamber **15**, have sliding, pressure sealing engagement with laterally spaced arcuate shoulder surfaces **23** of a discharge throat insert **24** of special shape and non-metallic composition. Referring



to Figs. 3 and 4, insert **24** is provided with an intake throat **25** between shoulder surfaces **23**, which throat opens downwardly from high pressure discharge zone Z. Throat **25** communicates downwardly with an enlarged, generally cylindrical interior **26** of insert **24**, and this space in turn opens laterally, through a port **27** of substantial size in the insert, to a discharge passage **28** in housing body **11**. The insert **24** is an elastomer unit fabricated of rubber or like elastic or rubber-like material and is snugly fitted in a recess in the body which downwardly adjoins its gear pumping chamber **15**. Other gear side sealing means, to be described, coact with insert **24** in the automatic, self-pressurized sealing of gears **17**, **18** in accordance with the invention. However, a description of the rest of the pump body structure which adjoins the discharge passage **28** appears in order in the interest of continuity. Illustration and description of such structure are dispensed with in connection with the other modifications shown in Figs. 7–14, but it is to be understood that similar provisions will be associated with those forms.

Housing body **10** is provided, in alignment with the passage **28**, with an enlarged cylindrical bore **29** to which the passage opens. This bore receives a fixed tubular valve insert sleeve which is generally designated **30**. The insert has a plurality of radial ports **31** leading to a transverse by-pass duct **32** in the body, by which excess liquid may be returned to intake passage **16**. This is done under the control of a hollow, centrally apertured pressure regulator plunger **33** slidably mounted in the valve sleeve **30**.

Plunger **33** is adapted to yield rearwardly against the force exerted by its internal biasing spring **34**, exposing radial ports **31** so that part of the liquid is by-passed back to the pump intake under a condition of excess pressure.

Valve sleeve **30** has a further radial passage or passages **35** and an annular groove, whereby its hollow interior is communicated with a transverse pressure relief passage **36** in the valve body. Emergency flow of liquid through passage **36** to intake passage **16** is controlled by a ball check **37**; this is held in sealing position by a biasing spring **37'** encircling a stem **38** threadedly engaged with housing body member **11**. The force of spring **37'** exceeds that of plunger biasing spring **34**. Ported valve sleeve **30** is sealed in bore **29** by annular O-rings in known fashion, and the sleeve is held in place in the bore by a split snap ring **40**.

The normal discharge flow of the pump is through passage **28**, a central aperture **39** in the inner radial face of plunger **33** and the plunger interior, to discharge fitting **13**, being regulated and controlled by the plunger check valve and by-pass means just described.

As indicated above, there is associated with the resilient discharge throat insert **24** further means to provide a side sealing of the gears **17**, **18**; such means takes the form of a plate-like unit, generally designated **41**, which is best illustrated, per se, in Figs. 2, 3 and 5 of the drawings. Its relation to the gears and insert **24** is also indicated in Fig. 4.

Unit **41** comprises a flat metallic wear plate or disk **42** shaped in general conformity with the outline of the gear cavity **15**, as can be seen by comparing Fig. 5 with Fig. 4. An approximately semi-circular notch **43** is formed at the upper center of this member to fully expose intake passage **16** to the pump cavity. A hollow pressure responsive member **44** of molded rubber, or other elastic, rubber-like material is fitted in a correspondingly shaped recess in the rear of plate **42**, and may be vulcanized thereto. Plate **42** is provided with laterally spaced circular openings **45** adapted to receive bushings **46** (see Figs. 2 and 4) in which the gear shafts **19** are received. These bushings laterally confine the member **44** against the inflative force normally present in its interior, as it is otherwise confined by the plate recess.

Member **44** is small in relation to the area of the asso-

ciated plate 42. It is specially molded in an outline like that shown best in Fig. 5. It is of relatively small internal volume, for quick pressurization; nevertheless, it is of sufficient size that its forward wall 49 which has surface engagement with plate 42 will exert force on the latter over an area laterally overlapping the side surfaces of gears 17, 18 substantially, as shown in Fig. 4, i. e., laterally outwardly of pressure zone Z. Discharge pressure is communicated with the interior 48 of the sealing unit pressure member 44 through a small opening 50 in plate 42 and the wall 49 of member 44.

It is seen from the foregoing that a differential exists between the hydraulic force of the discharge pressure zone Z, acting in a direction to urge unit 41 away from the gears 17, 18, and an opposite force, attributable to the same pressure and acting within member 44 to urge plate 42 into sealing engagement with the gear surfaces. The greater area is exposed to the discharge pressure; it increases as the discharge pressure of the pump increases.

The rear wall of member 44 is left mostly open for molding purposes, but the internal pressure on a rear inturned perimetral lip 51 is sufficient to insure against leakage in this zone, which in any event would not be particularly objectionable, maintaining the member firmly against the surface of casing body 11 which it rearwardly abuts.

Figs. 3 and 4 of the drawings show that the discharge pressure zone Z is defined by the casing end plate 14, the plate 42 of side unit 41, and the vertical space between the fully meshed gear teeth, at the top of the zone, and the teeth which wipe past the shoulder surfaces 23 of throat insert 24. The pressure in throat insert 24 continually urges the sealing shoulders 23 against the peripheral surfaces of the gear teeth. It also continually urges the front and rear walls of the insert, specially designated 52 and 53 in Fig. 3, against the casing end plate 14 and body 11, respectively. There is thus a dual hydraulic pressure acting at the vertical overlap of insert 24 and side sealing unit 41, preventing leakage at this overlap area.

The improved pump is efficient in operation and very economical to manufacture. Hand cranking alone, of its power input shaft has produced an instantaneous discharge at a pressure as high as 50 pounds per square inch. In an actual run it was found that operating pressure within member 44 causes its outer walls to bulge and thereby exert greater, wedge-like force on the outer portions of the wear plate 42. This seals the gears even more effectively than the direct central transverse force. Furthermore, since the gears are free and clear in cavity 15 except at zone Z, a back pressure cannot be built up to effectively oppose the pressure at the sealed area.

Throat insert 24 is shown in Fig. 4 as a one-piece, unsheathed elastic unit, its shoulder 23 in direct contact with gear teeth 17, 18. This is satisfactory for low pressure pumping. However, metal wear elements should be bonded to the shoulder surfaces for high pressure, heavy duty performance, and Fig. 6 shows such a sheathed insert, here designated 24', the wear plates being numbered 54. In other respects, the unit 24' is assembled with other pump components in the identical way described above and shown in Figs. 1–5; hence it is not deemed necessary to repeat the illustration or description. It may be assumed that the insert 24 shown in Figs. 3 and 4 represents companion insert 24', in its intended setting in a comparable high pressure or heavier duty pump. Corresponding parts are designated by corresponding reference numerals, primed.

Figs. 7 and 8 show a modified adaptation of the principle of the invention, particularly as it relates to the peripheral sealing of the gear teeth of a pump adjacent its discharge, high pressure throat zone or space. As related provisions have been omitted from Figs. 7 and 8 for the sake of simplicity. It may be assumed that if such provisions are desired, they may take the form illustrated in Figs. 2 and 3 of the drawings. The same is true of the other modifications illustrated in Figs. 9 and 10, in Figs. 11 and 12, and in Figs. 13 and 14, respectively.



Referring to Figs. 7, 8 and 8A, a hollow, chambered casing body 55 and end plate 56 enclose a shaped pumping cavity 57 in which pump gears 58, 59 are rotatively mounted, in an entirely conventional way, or as illustrated in Fig. 2. A metallic side sealing plate 60 engages one surface of gears 58, 59, and a resilient cushion disk 60' is interposed between plate 60 and casing end plate 56. Plate 60 is shaped in conformity with the upper contour of a block-like metallic sealing member 61 of width slightly greater than the gears, and fits above that block in face engagement with the gears. It serves as a radial spacer for sealing block 61 as well as a surface wear member, as will be described. Sealing member 61 is provided with arcuate sealing shoulders 62, across which the teeth of gears 58, 59 wipe over a considerable angular sweep; and the shoulders 62 are spaced on opposite sides of a downwardly extending pressure passage 63 in member 61. Passage 63 vertically communicates the high pressure discharge zone Z in pumping cavity 57 with a pressure plunger cylinder 64 formed at the bottom of pump body 55, in vertical alignment with the intake passage 65 to the cavity 57. A cupped plunger 66 and leather anti-extrusion disk 67 act upwardly in this cylinder against the lower surface of sealing member 61. If desired, a coil compression spring 68 may be provided to supplement hydraulic pressure in cylinder 64 urging the plunger and member 61 upwardly.

The side of the pump cavity 57 opposite shaped wear plate 60 is recessed at 71 for the reception of a hollow resilient, rubber-like pressure member 69 which is generally similar in structure to member 44 of unit 41. A metal, gear face wear plate 70 which, like plate 60, is shaped in conformity with the upper surface of sealing block 61, is disposed inwardly of member 69. Plates 60 and 70 are both fitted above the shoulder surfaces 62 of member 61 and are received on the bushings 70', so that in sealing the side surfaces of gears 58, 59 they at the same time act as spacers to limit the upward travel of sealing block 61 in radially sealing the gear teeth, as shown in Fig. 8A.

Radial tooth sealing block 61 is milled to provide a groove 73 opening laterally to the discharge passage 72 of casing body 55. Communication is had with that passage through an opening 74 in hollow pressure member 69.

The operation of the embodiment of Figs. 7 and 8 is believed to be obvious, in the light of the description in connection with Figs. 1 through 6. Plates 60, 70 seal the side surfaces of the gears under hydraulic pressure in member 69. The latter exerts this pressure at its upper portion and at its lower portion bears against the side of sealing block member 61 to assist in sealing in this area. Discharge pressure in zone Z is communicated through passage 63 to the cylinder 64 beneath the sealing block, urging the same upwardly. Coil spring 68 maintains sealing action, as when the pump is not in operation, or at very low pressure operation in which the peripheral engagement of the gear teeth with concave shoulders 62 may not be sufficient to insure 100% sealing at these surfaces.

The form of the invention illustrated in Figs. 9 and 10 puts the principle of the invention into practise in a slightly different way than the forms illustrated and described above. That is, internal hydraulic pressure on a sealing member which acts radially against the peripheries of the gear teeth is replaced by hydraulic discharge pressure acting externally on an elastically deformable sealing member. This causes the concave tooth sealing shoulder surface or surfaces of such member to mold themselves more tightly to and sealingly engage the outer tooth surfaces. The form of Figs. 9 and 10 is primarily intended for low pressure pumping, in which the danger

of jamming an elastic sealing surface in the gear teeth is not present.

Referring to Figs. 9 and 10, a side wear plate **76** and a side wear plate and sealing unit **77** are associated with opposite sides of a pair of meshing gears **78**, **79** in a pumping cavity **80**. The cavity is defined by a casing body **81** and end plate **82**, much in the same way as shown in Figs. 2 and 3; further illustration and description in this regard can be dispensed with. The gear engaging wear plate of unit **77** is designated **83**; its hollow, resilient pressure member is designated **84**.

A solid, elastomer thrust block **85** is employed to exert peripheral sealing action on the teeth of gears **78**, **79**. This type sealing member, in a crescent-shaped outline, may also be used as a sealing unit in an inside-outside type gear pump molding itself to and wiping against the external and internal meshing gear teeth under the discharge pressure of the pump.

As shown, member **85** is molded in block-like outline of an elastic, flowable material, such as rubber, synthetic rubber and the like, and a rigid metallic backing plate **86** rearwardly sustains the same. The thus constituted sealing unit is received in a bottom recess **87** adjoining pumping cavity **80** which is coextensive with the width of the gears. Elastic block **85** is laterally engaged at its sides, as are the gears **78**, **79**, by the side plate **76** and the plate **83** of pressure unit **77**.

Resilient sealing block **85** has concave shoulders **88** in peripheral wiping engagement with the teeth of gears **78**, **79**, those shoulders being under slight initial compression to seal against static leakage or leakage or very low pressure operation. The block is also formed to provide a medial recess **89** between these shoulders, in axial alignment with the discharge passage of housing body **81**.

The inherent flowability or moldability of the material of sealing block **85**, under the compression of the discharge pressure in zone Z, enables the shoulders **88** to maintain effective sealing engagement with the gear surfaces when the pump is in operation. The block molds itself snugly to the tooth periphery for this purpose. However, this arrangement is best suited for low pressure pumping installation, for if the elastic material of block **85** is excessively compressed it tends to jam into the space between the teeth, or else to wear at an unduly high rate.

The embodiment of the invention illustrated in Figs. 11 and 12 adopts the principle of an internally pressurized gear tooth sealing unit construction, as in forms of Figs. 1 through 6 and Figs. 7 and 8, but in a somewhat different setting. Here a pair of separate, laterally spaced, metallic sealing shoulders **90** are disposed, respectively, at opposite bottom corners of a pump gear cavity **91** in a pump casing **92**, the cavity being closed by an end plate **93**. A side sealing plate **94** is interposed between end plate **93** and the meshing gears **95**, **96**, and a side pressure sealing unit **97** is disposed in sealing relation to the opposite side surfaces of the gears. Unit **97** is composed of a wear plate **98** and a hollow resilient member **99**, both located in a recess in casing body **92**, as in the last described embodiment of the invention.

Each of the rigid metal sealing shoulders **90** is shaped to provide an arcuate sealing surface **100** of substantial length, a rear corner pressure cavity **101**, and a horizontal passage **102** leading to that cavity from a high pressure discharge zone Z of the pumping chamber **91**. A cup plunger or disk **103** is disposed in the pressure cavity **101** to seal the latter when it is pressurized, the disk being rearwardly engageable against the side wall of the pump chamber **91** under this condition. Shoulder members **90** are thus thrust laterally into engagement with the teeth of gears **95**, **96** for the desired sealing action. The shoulders are laterally engaged, along with gears **95**, **96**, by the side wear plates **94**, **98**, as in the preceding embodiment.

The further modified adaptation of the invention illustrated in Figs. 13 and 14 incorporates an improved pressure regulator feature enabling the pump to be set for a predetermined maximum pressure discharge, and to by-pass pressure above this critical pre-set pressure so that the output of the pump is uniform in this regard. In this form a block-like, tooth periphery sealing element member **104** is provided, which is fabricated of rigid metallic material. It is shaped to provide spaced arcuate shoulders **105** engaging the teeth of gears **106**, **107** mounted for rotation in a pumping cavity **108** provided by casing body **109** and end plate **110**.

Member **104** is urged for radial sealing engagement by a regulator spring unit, generally designated **111**, to be hereinafter described. It is sealingly engaged at one side thereof by a wear plate **112** and at the other side thereof by the pressure sealing unit **113**. Unit **113** is composed of a further wear plate **114** and a hollow, resilient, non-metallic member **115**, and is practically identical to the sealing units **77** and **97** previously described.

Regulator spring unit **111** comprises a vertically disposed tubular spring housing **116** having an upper, reduced diameter extension **117** which is threadedly mounted in the lower side of the body **109** of the gear casing, in vertical alignment with the center of the pumping cavity **108**. A stem **118** is slidably received in the bore of extension **117**, an O-ring **119** being mounted in a groove in the stem to engage the bore for sealing purposes.

A flanged sleeve or collar **120** is threaded on stem **118** within spring housing **116**, and a coil spring **121** upwardly abuts against the flange of sleeve **120**. This spring is rearwardly sustained by an adjustable nut **122** threaded in the lower end of housing **116**. Stem **118** has a kerf **123** in its lower end by which it may be rotatively adjusted.

The compression of spring **121** may be pre-set as desired by screwing stem **118** in sleeve **120**, whereby the latter exerts, through the stem, a desired upward spring force on sealing member **104**. This predeterminedly urges the member against the teeth of gears **106**, **107**. When the hydraulic pressure in discharge zone Z acting on member **104** passes a critical, predetermined value, it displaces the latter downwardly against the pre-set force of spring **121**, and a part of the liquid is by-passed between the gear teeth and the sealing surfaces **105** to the intake side of pump cavity **108**. This maintains discharge pressure at the desired value, regulated as desired by appropriate adjustment of the spring force.

Thus a pressure regulator feature is incorporated in a gear pump having the improved sealing provisions of the invention. As in the case of all of the various embodiments illustrated and described, a gear pump is provided which is automatically sealed by simple means which eliminate the need for close tolerance machining and interfitting of parts. Yet high pressures are developed at relatively low speeds of gear rotation. Hence the pump may be designed in small and very compact sizes to do work heretofore considered to be satisfactorily done only by pumps of materially greater cost, both as regards input and the cost of manufacture in an adequately large size for a specified job.

It is evident that the pressure regulator feature shown in Figs. 13 and 14 may also be afforded in the embodiment of the pump shown in Figs. 7 and 8. In such an arrangement the force of the spring should be only sufficient to create a balance of the opposing forces in zone Z and in the plunger cylinder. Should the discharge pressure acting to urge the sealing throat toward the gears become excessive, representing an undue load on a shaft or bearing, the effect can be offset by a reversal of rotation of the gear. The intake then becomes a discharge and the force of the spring, now opposed by discharge pressure, can be set to produce the desired radial force.

I claim:

1. A gear pump comprising a housing providing a pumping cavity and having intake and discharge passages communicating with said cavity and meshing gears rotatably mounted in the latter, said cavity having a dis-

charge pressure zone remote from said intake passage, which zone opens to said discharge passage, a discharge sealing unit partially defining and subject to pressure in said zone, said unit including a sealing member provided with a sealing surface yieldably engaging the peripheries of gear teeth approaching said zone, and means for effecting a seal between said member and the side surfaces of the gears, said means including discharge pressure responsive means associated with said member to maintain said member in sealing engagement with respect to said housing whereby said discharge pressure zone is effectively sealed.

2. A gear pump comprising a housing providing a pumping cavity and having intake and discharge passages communicating with said cavity and meshing gears rotatably mounted in the latter, said cavity having a discharge pressure zone remote from said intake passage, which zone opens to said discharge passage, a discharge sealing unit partially defining and subject to pressure in said zone, said unit including a sealing member provided with a sealing surface yieldably engaging the peripheries of gear teeth approaching said zone, and means for effecting a seal between said member and the side surfaces of the gears, said means including discharge pressure responsive means associated with said member to maintain said member in sealing engagement with respect to said housing, and a further sealing member maintained by said discharge pressure in sealing engagement with the side surfaces of said gears whereby said discharge pressure zone is effectively sealed.

3. A gear pump comprising a housing providing a pumping cavity and having intake and discharge passages communicating with said cavity and meshing gears rotatably mounted in the latter in loose fitting relation thereto, said cavity having a discharge pressure zone remote from said intake passage, which zone opens to said discharge passage, a discharge sealing unit partially defining and subject to pressure in said zone, said unit including a sealing member provided with a sealing surface yieldably engaging the peripheries of gear teeth approaching said zone, and means for effecting a seal between said member and the side surfaces of the gears, said means including discharge pressure responsive means associated with said member to maintain said member in sealing engagement with respect to said housing, and a further sealing member maintained by said discharge pressure in sealing engagement with the sides of said gears whereby said discharge pressure zone is effectively sealed.

4. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit provided with a sealing surface in yieldable engagement with the peripheries of gear teeth approaching said zone, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

5. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit provided with a sealing surface in yieldable engagement with the peripheries of gear teeth approaching said zone, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall, said means comprising a hollow member of resilient material having a pressure wall facing said gear side surfaces which is of an area sufficient to overlap said gear surfaces radially outwardly of said meshing gear teeth, said means having an opening through said pressure wall communicating the interior of said hollow member with said high pressure zone to impose the discharge pressure of said zone on a part of said pressure wall overlapping said gear side surfaces and thus urge said last side wall in sealing relation to said gear side surfaces whereby said high pressure discharge zone is effectively sealed.



6. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit provided with a sealing surface in yieldable engagement with the peripheries of gear teeth approaching said zone, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall, said means comprising a hollow member of resilient material having a pressure wall facing said gear side surfaces, said pressure wall having an opening therethrough communicating the interior of said hollow member with said high pressure zone, said last mentioned side wall constituting a rigid, plate-like wear member interposed between said gear side surfaces and said pressure wall and substantially overlapping said gear side surfaces adjacent said pressure zone whereby said high pressure discharge zone is effectively sealed.

7. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit provided with a sealing surface in yieldable engagement with the peripheries of gear teeth approaching said zone, said unit provided with means for urging said sealing surface into sealing engagement with the peripheries of said gear teeth, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

8. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit provided with a sealing surface in yieldable engagement with the peripheries of gear teeth approaching said zone, said unit provided with discharge pressure receiving means for urging said sealing surface into sealing engagement with the peripheries of said gear teeth, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

9. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit provided with a sealing surface in yieldable engagement with the peripheries of gear teeth approaching said zone, said unit provided with discharge pressure receiving means

having associated therewith resilient means for urging said sealing surface into sealing engagement with the peripheries of said gear teeth, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

10. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit provided with a sealing surface in yieldable engagement with the peripheries of gear teeth approaching said zone, said unit provided with resilient means urging said sealing surface into sealing engagement with the peripheries of said gear teeth, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

11. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit provided with a sealing surface in yieldable engagement with the peripheries of gear teeth approaching said zone, said unit provided with resilient means and having limiting means associated therewith for urging said sealing surface into sealing engagement with the peripheries of said gear teeth, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

12. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit provided with a sealing surface in yieldable engagement with the peripheries of gear teeth approaching said zone, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed, said side walls adapted to limit the extent of engagement brought about between the sealing surface of said unit and the peripheries of said gear teeth.

13. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit provided with a sealing surface in yieldable engagement with the peripheries of gear teeth approaching said zone, said unit provided with discharge pressure receiving means for urging said sealing surface into sealing engagement with the peripheries of said gear teeth, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed, said side walls cooperating with said sealing surface to limit the extent of engagement brought about between said sealing surface and the peripheries of said gear teeth.

14. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit provided with a sealing surface in yieldable engagement with the peripheries of gear teeth approaching said zone, said unit provided with discharge pressure receiving means having associated therewith resilient means for urging said sealing surface into sealing engagement with the peripheries of said gear teeth, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed, said side walls cooperating with said sealing surface to limit the extent of engagement brought about between said sealing surface and the peripheries of said gear teeth.

15. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by an elastomer unit provided with a sealing surface in yieldable engagement with the peripheries of gear teeth approaching said zone, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

16. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a rigid metallic unit provided with a sealing surface in yieldable engagement with the peripheries of gear teeth approaching said zone, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

17. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit including a pair of arcuate, concave surfaces in yieldable engagement with the peripheries of gear teeth approaching said zone and being in outwardly concentric relation to the peripheries of said teeth, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

18. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit comprising a pair of arcuate, concave surfaces in yieldable engagement with the peripheries of gear teeth approaching said zone and being in outwardly concentric relation to the peripheries of said teeth, the innermost ends of said

surfaces defined by upwardly projecting lips separated by an indentation, said lips adapted to be flexed into sealing engagement with said gear teeth in response to discharge pressure, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

19. A gear pump in accordance with claim 15, in which said unit is of hollow cup-like form and has openings communicating the interior thereof with said discharge pressure zone and discharge passage.

20. A gear pump in accordance with claim 15, in which said unit is of hollow cup-like form and has openings communicating the interior thereof with said discharge pressure zone and discharge passage, and a rigid external metal sheath mounted on the sealing surface thereof for engagement with said gear teeth.

21. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit including a rigid metallic member provided with an arcuate sealing surface for yieldable sealing engagement with the peripheries of gear teeth approaching said zone, said member having an internally positioned deformable means in communication with said pressure zone to move said member into sealing engagement with said gear teeth in response to discharge pressure, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

22. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit including a pair of rigid metallic members each positioned to one side of said zone and each provided with an arcuate sealing surface for yieldable sealing engagement with the peripheries of gear teeth approaching said zone, each of said members having an internally positioned deformable means in communication with said pressure zone to move said member into sealing engagement with said gear teeth in response to discharge pressure, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

23. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit provided with a pair of arcuate, concave sealing surfaces in yieldable engagement with the peripheries of gear teeth approaching said zone and being in outwardly concentric relation thereto, said unit provided with means for urging said sealing surfaces into sealing engagement, said means including an elastically deformable member behind said unit communicating with said pressure zone, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed, the bottom edges of said side walls resting on said sealing surfaces to limit the extent of engagement brought about between said surfaces and the peripheries of said gear teeth.

24. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit provided with a pair of concave arcuate sealing surfaces adapted to engage the peripheries of gear teeth approaching said zone, a plunger, means for moving said plunger into contact with said unit to move the sealing surfaces thereof into engagement with the peripheries of said gear teeth, resilient means for resisting movement of the sealing surfaces and plunger away from the peripheries of said gear teeth, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

25. A gear pump comprising a pump casing providing a pump cavity having meshing gears rotatable therein and having intake and discharge passages communicating therewith, said gears in part defining a high pressure discharge zone of said cavity at the meshing teeth thereof, said discharge zone being further defined by a unit including a pair of concave arcuate sealing surfaces adapted to engage the peripheries of gear teeth approaching said zone, a plunger, means for moving said plunger into contact with said unit to move the sealing surfaces thereof into engagement with the peripheries of said gear teeth, resilient means for resisting movement of the sealing surfaces and plunger away from the peripheries of said gear teeth, said means for moving the plunger comprising a sleeve threaded on said plunger and a fixed abutment on the casing against which the sleeve is adapted to bear, said resilient means comprising a second abutment on the casing and a spring compressed between the sleeve and the second abutment, and opposed side walls in sealing engagement with the sides of said gears, one of said side walls including deformable discharge pressure responsive means to urge a side surface of said unit in sealing engagement with the opposite side wall whereby said high pressure discharge zone is effectively sealed.

**References Cited in the file of this patent**

UNITED STATES PATENTS

| | | |
|---|---|---|
| 2,044,873 | Beust | June 23, 1936 |
| 2,105,259 | Oshei | Jan. 11, 1938 |
| 2,146,395 | Horton | Feb. 7, 1939 |
| 2,147,777 | Oshei | Feb. 21, 1939 |
| 2,211,154 | Oshei | Aug. 13, 1940 |
| 2,252,661 | Oishei | Aug. 12, 1941 |
| 2,622,534 | Johnson | Dec. 23, 1952 |
| 2,639,672 | Johnson | May 26, 1953 |
| 2,642,001 | Dale et al. | June 16, 1953 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 625,405 | Germany | Feb. 8, 1936 |