May 30, 1972 R. F. RASMUSSEN 3,666,382

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FIG. 1

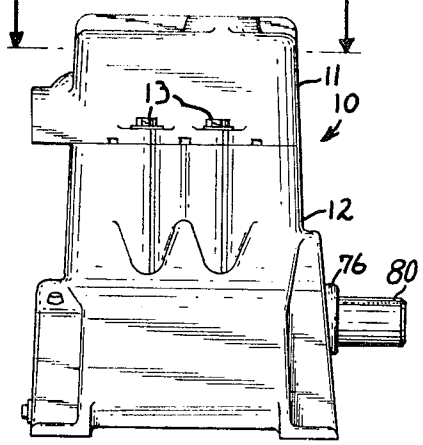


FIG. 2

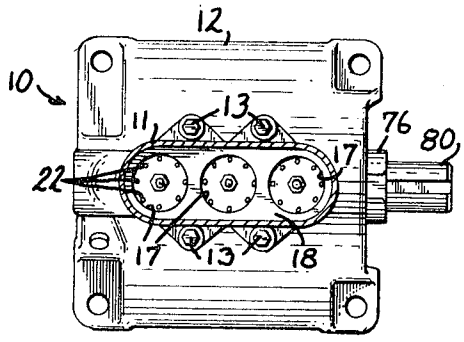
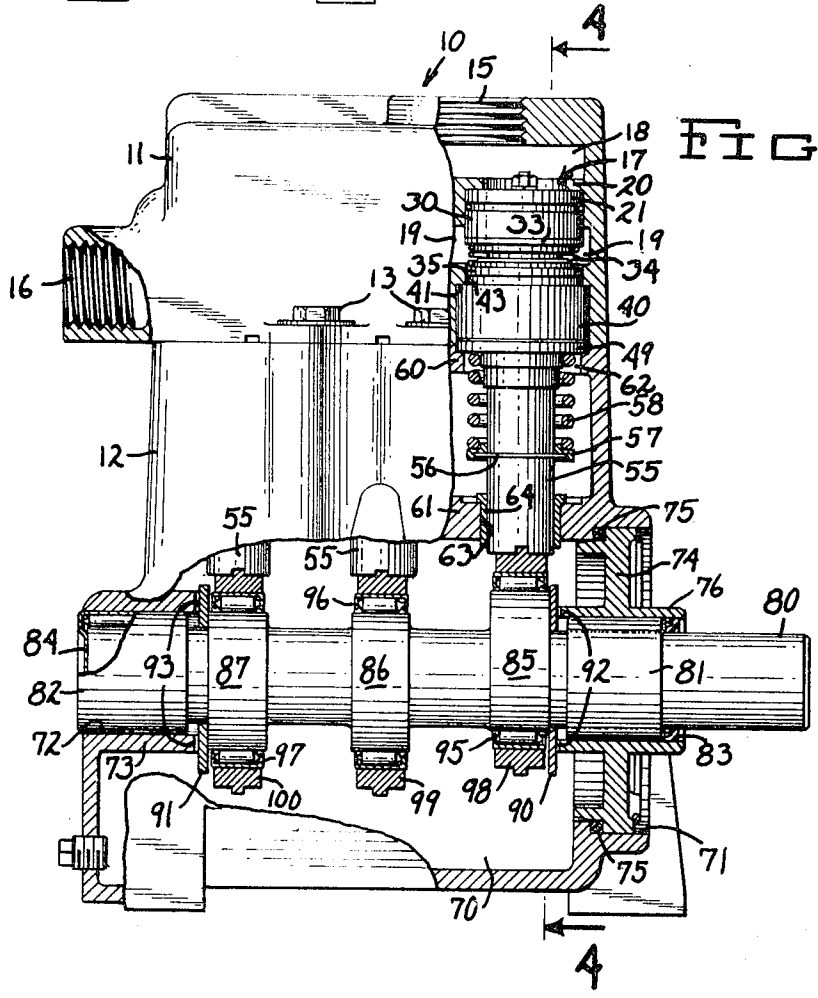


FIG. 3



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FIG. 4

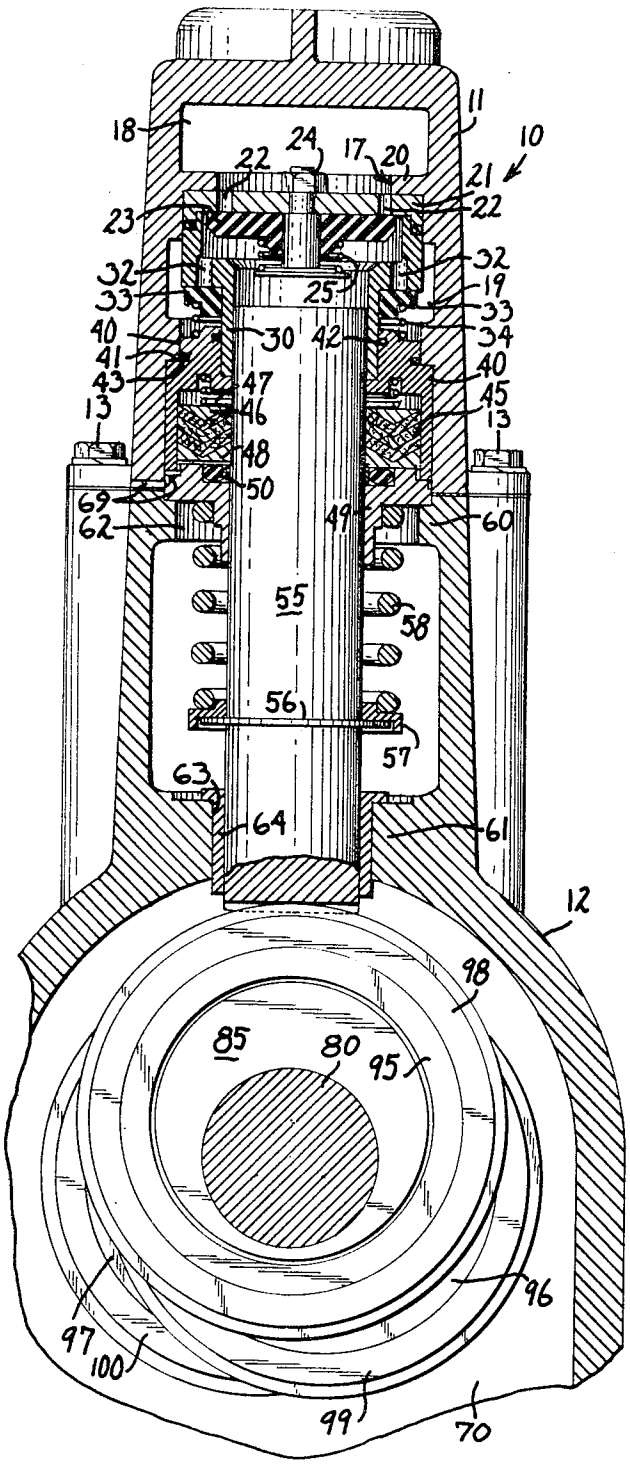


FIG. 5

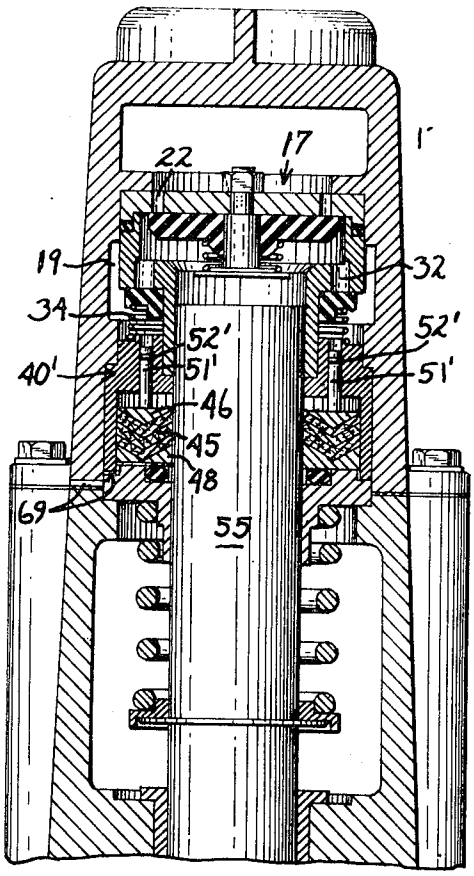
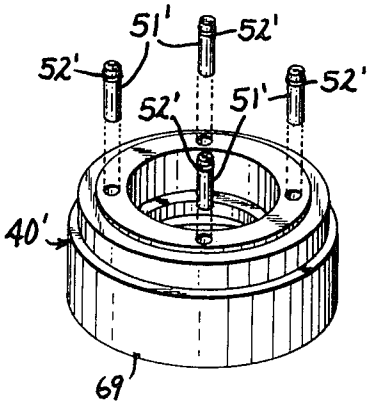


FIG. 6



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Fig. 9

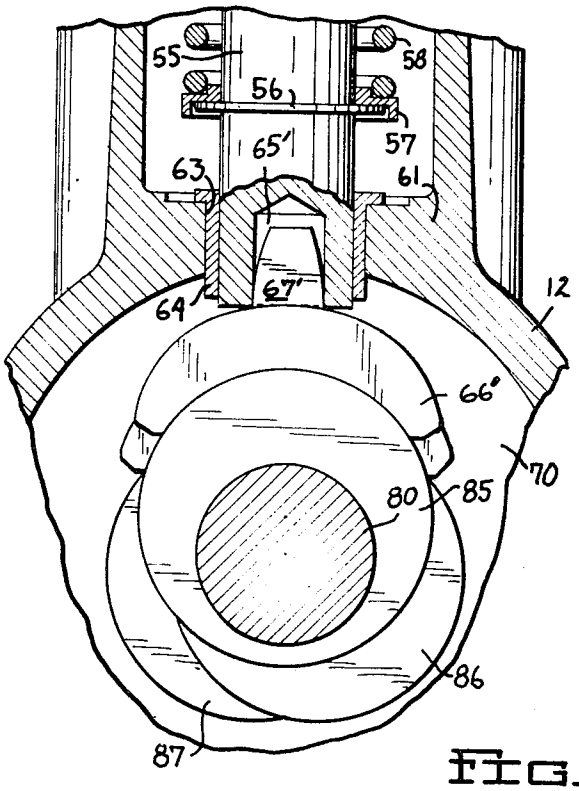


Fig. 10

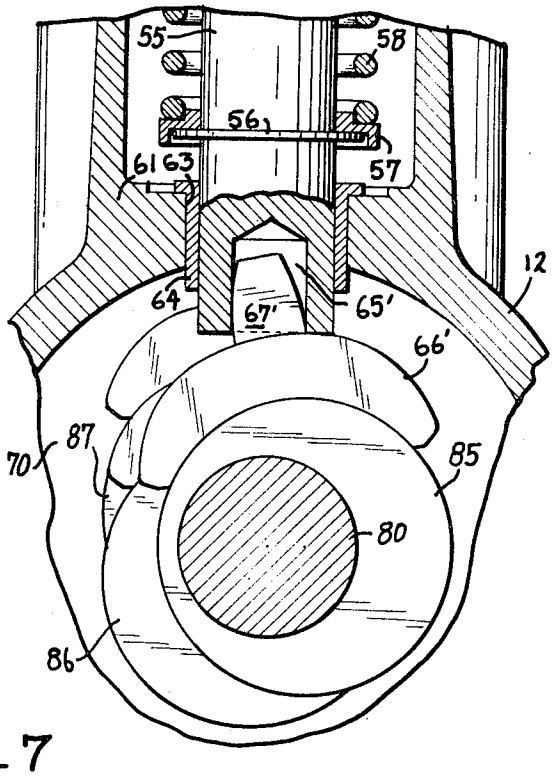


Fig. 7

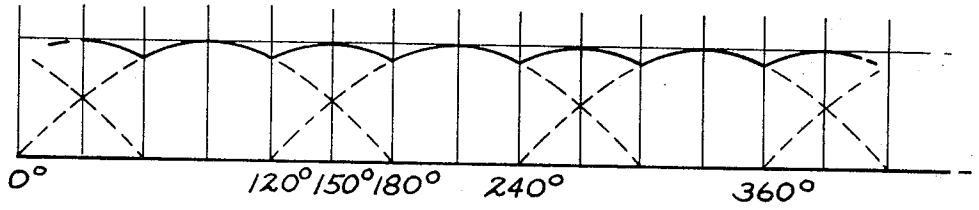
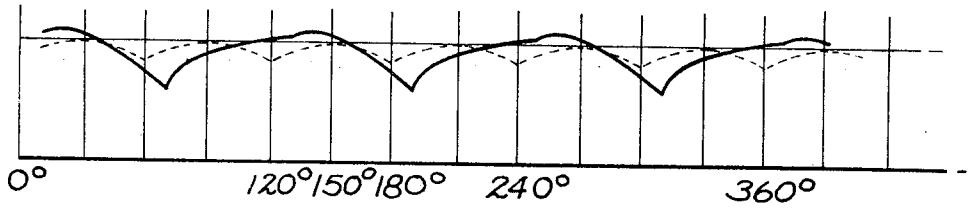


Fig. 8



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United States Patent Office 3,666,382
Patented May 30, 1972

3,666,382

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Continuation-in-part of application Ser. No. 810,681, Mar. 26, 1969. This application Mar. 24, 1970, Ser. No. 22,176
Int. Cl. F16j *15/00;* F04b *21/02, 39/10*
U.S. Cl. 417—533 12 Claims

ABSTRACT OF THE DISCLOSURE

A housing having three in-line cylindrical openings formed therein with an outlet and inlet in communication with each of said openings, an insert positioned in each of said openings for forming outlet valve means, a second insert positioned in each of said openings for forming inlet valve means, packing positioned in each of said openings and cooperating with the inserts to define a cylinder, and a plunger mounted in each of said cylinders for reciprocating movements. The further improvement including means subject to fluid outlet pressure operating on the packing to maintain a compression force on said packing. Said three plungers being reciprocated sinusoidally by means of eccentric members attached to a drive shaft.

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of U.S. application Ser. No. 810,681, filed Mar. 26, 1969, now abandoned.

Field of the invention

The present invention pertains to pumps utilized for pumping fluids and generally to the type of pump containing a reciprocating plunger which creates a vacuum in a cylinder to draw fluid into the cylinder during movement in one direction and creates a pressure on the fluid to force it out of the cylinder during movement in the opposite direction.

Description of the prior art

In general, prior art pumps of the type described are complicated and expensive to produce since many operations are required on the housing to form inlet and outlet valves and cylinders therein. In addition, these prior art pumps generally must be constructed entirely of a material compatible with the fluid being pumped so that no chemical interaction takes place therein. Because inlet and outlet ports and valves are formed in the housing, these prior art pumps are complicated and time consuming to assemble. Further, some multi-cylinder pumps, wherein the plungers move sinusoidally, have been constructed but they are complicated and unaccommodating to nonlubricating fluids. One example of such a pump is disclosed in U.S. Patent 3,169,488 issued to Galliger.

SUMMARY OF THE INVENTION

The present invention pertains to an improved pump having a housing which defines an elongated opening in communication with inlet and outlet ports and insert means positioned in the opening for defining inlet and outlet valve means in communication with the inlet and outlet ports and further defining a cylinder with a plunger positioned therein for reciprocating movements.

It is an object of the present invention to provide an improved pump produced by forming a cylindrical opening in a housing and positioning valve means in the cylindrical opening to define inlet and outlet valves and a cylinder for receiving a plunger therein.

It is a further object of the present invention to provide a pump in which the housing is produced with a head formed of material chemically compatible with a fluid being pumped and the base is formed of a relatively inexpensive material.

It is a further object of the present invention to provide an improved pump wherein packing means encircle the plunger to prevent leakage of fluid into the base of the housing and the packing is maintained in a compressed position by use of compression springs or means subject to the fluid pressure in the outlet port of the pump.

It is a further object of the present invention to provide an improved pump having at least three in-line cylinders with plungers that reciprocate sinusoidally, to provide a net output pressure that is relatively constant.

It is a further object of the present invention to provide an improved pump which is relatively inexpensive and simple to produce and assemble.

These and other objects of this invention will become apparent to those skilled in the art upon consideration of the accompanying specification, claims and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to the drawings, wherein like characters indicate like parts throughout the figures:

FIG. 1 is a view in side elevation of an embodiment of the improved pump;

FIG. 2 is a sectional view as seen from the line **2—2** in FIG. 1;

FIG. 3 is an enlarged view in side elevation, portions thereof broken away and shown in section;

FIG. 4 is an enlarged sectional view as seen generally from the line **4—4** in FIG. 3, portions thereof broken away;

FIG. 5 is an enlarged sectional view similar to FIG. 4 illustrating another embodiment, portions thereof broken away;

FIG. 6 is an enlarged exploded view in perspective of a portion of the apparatus illustrated in FIG. 5;

FIG. 7 is a graphic representation of the output flow rate of the three cylinders, the dotted lines indicating individual cylinder flow rates and the full line indicating the total flow rate of the improved pump;

FIG. 8 is a graphic representation of the total flow rate of the improved pump, in dotted line, compared to the total flow rate of a pump utilizing short connecting rods to drive the plungers;

FIG. 9 is an enlarged sectional view similar to FIG. 4 of another embodiment of the improved pump, portions thereof removed; and

FIG. 10 is a view similar to FIG. 7 illustrating a different position of the mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIGS. 1–4 the numeral **10** generally designates a housing having a head **11** and a base **12**. In the present embodiment the housing **10** contains three cylinders and

their associated parts, but it should be understood that any desired number of cylinders might be utilized in the present pump. The head **11** and base **12** are fixedly attached together by means of a plurality of bolts **13** inserted through openings in projecting portions of the head **11** and threadedly engaged into the base **12**. In the following description of the figures, the terms "upper" and "lower" are utilized to describe the various parts illustrated, although it should be understood that in some instances these are not limiting and the pump might be used in orientations other than that shown.

The head **11** has formed in the upper wall thereof an inlet port **15** which is adapted to have conduit threadedly engaged therein for conveying fluid to be pumped. An outlet port **16** is formed at one end of the head **11** and adapted to have conduit threadedly engaged therein for conveying the fluid away from the pump. Three cylindrical openings generally designated **17** are formed in the head **11** in parallel, longitudinally spaced apart relationship so as to extend generally transverse to the longitudinal dimension of the head **11** and open axially outwardly (or downwardly in the figures) at the junction of the head **11** and the base **12**. This particular orientation of the cylindrical openings is referred to as an in-line configuration hereinafter. A first elongated cavity **18** formed adjacent the upper wall of the head **11** communicates with the inner end of each of the cylindrical openings **17** and with the inlet port **15**. A second elongated cavity **19** extending generally parallel with the cavity **18** and spaced axially outwardly (or downwardly in the figures) therefrom communicates with each of the cylindrical openings **17** and with the outlet port **16**. While the head **11** might be formed in a variety of ways the presently disclosed embodiment is formed by casting and by machining the cylindrical openings **17** to fit the various components to be described presently.

Each of the cylindrical openings **17** has a radially inwardly extending flange **20** adjacent the axially inner extremity (or upper end) thereof and defined by the lower wall of the cavity **18**. A generally cup-shaded insert **21** is provided with a plurality of openings **22** therethrough and a flexible valve member **23** affixed to the insert **21** by a centrally located bolt **24**. The valve member **23** has a diameter such that it overlies the openings **22** and a spring **25**, fixed in position by the bolt **24**, biases the valve member **23** against the insert **21** to maintain the openings **22** normally closed. The assembly including the insert **21** is fitted into the axially inner end of the cylindrical opening **17** in abutting engagement with the flange **20**. In this position the openings **22** are in communication with the cavity **18**.

A second generally tubular insert **30** is formed with a first portion having an outer diameter approximately equal to the outer diameter of the insert **21** and adapted to mate therewith. An O-ring **31** is positioned between the mating portions of the insert **21** and the insert **30** to prevent leakage therebetween. Adjacent the axially outer end of the portion of insert **30** just described is a radially inwardly directed portion having a plurality of openings **32** extending therethrough in a direction approximately parallel with the direction of the cylindrical opening **17**. A third portion of the insert **30** extends generally coaxial with the cylindrical opening **17** from the inner edges of the radially inwardly direction portion of the insert **30**. The openings **32** in the insert **30** communicate with the cavity **19** and with the cavity formed within the inserts **30** and **21**. A flexible ring or valve member **33**, having an inner diameter slightly larger than the outer diameter of the lower portion of insert **30** for easy axially sliding movements thereon and an outer diameter sufficiently large to overlie the openings **32**, is slidably engaged over the insert **30** to operate as a valve in conjunction with the openings **32**.

A generally tubular insert or packing cartridge **40** is positioned in the cylindrical opening **17** in parallel juxtaposition with the inner walls thereof and with an axially inner edge butting against a radially inwardly directed shoulder **41** in the inner wall of the cylindrical opening **17**. The shoulder **41** positions the packing cartridge **40** within the cylindrical opening **17** so that the various springs and valves can operate properly. The insert **40** has a radially inwardly directed flange thereon which engages the axially outer end of the insert **30** to maintain the insert **30** in the correct position. O-rings **42** and **43** are positioned between the insert **30** and the packing cartridge **40** and between the packing cartridge **40** and the head **11** to prevent leakage axially along the sides thereof. A spring **34**, positioned between the axially inner end of the insert **40** and the valve member **33**, biases the valve member **33** against the insert **30** to normally maintain the openings **32** closed.

Sealing means, which in this embodiment is pump packing **45**, is positioned coaxially within the packing cartridge **40** axially outwardly from the insert **30**. A metal ring-shaped packing follower **46** engages the upper surface of the packing **45** and a spring **47** positioned between the packing follower **46** and the flange of the packing cartridge **40** biases the packing follower **46** against the packing **45** to maintain compression thereon. A ring-shaped packing seat **48** engages the lower surface of the packing **45** and is held fixedly in position by means of an insert **49**.

Insert **49** has a generally tubular configuration with the inner diameter thereof approximately equal to the inner diameter of the packing **45** and the insert **30**. An O-ring **50** is positioned between the upper edge of the insert **49** and the lower edge of the packing seat **48** to prevent leakage therebetween. The insert **49** forms an upper bearing for a plunger **55**, which is positioned in the cylinder formed by packing **45** and insert **30**.

It will be appreciated that the components numbered **21–25**, **30–34** and **40–50** together define a unitary, removable assembly (best seen in FIG. 3) which, by simple insertion into the receptacle defined in head **11** provides an inlet check valve communicating with the inlet chamber or cavity **18** through its associated opening **17**, an outlet check valve communicating with the outlet chamber **19**, and a cylindrical pumping chamber in which plunger **55** may reciprocate. It will also be appreciated that, by reason of the several shoulder abutment surfaces between the insert assembly and its receptacle, the head **11** and base **12** cooperate to rigidly retain the insert assembly in operating position; and that removal of the assembly is quickly and easily effected by removal of the bolts **13** and lifting head **11** from base **12**. Since the fluid pumped is always isolated from the base **12** and plunger reciprocating mechanism by the improved structure, it is possible to adapt a given pump to a given fluid simply by changing the insert assemblies and/or head **11**.

The plunger **55** has a snap-ring **56** positioned in a groove spaced axially from the lower edge of the insert **49** and a ring-shaped spring seat **57** is coaxially positioned over the plunger **55** in abutting engagement with the snap-ring **56**. A compression spring **58** is positioned between a radially outwardly directed flange of the insert **49** and the spring seat **57** to bias the plunger **55** axially outwardly in the cylindrical opening **17**.

The base **12** of the housing **10** is generally hollow except for a wall **60** adjacent the upper extremity thereof and extending generally transverse to the cylindrical openings **17** in the head **11** (with the head **11** and base **12** fixedly attached), and a second wall **61** parallel with the first wall **60** and spaced therefrom into the base **12**. Pairs of openings **62** and **63** are formed in the walls **60** and **61** generally coaxial with each of the cylindrical openings **17** in the head **11**. The lower opening **63** has an insert **64** therein with an inner wall that slidably engages the outer wall of the plunger **55** and serves as a lower bearing therefor. The upper wall **60** engages the axially outer or lower edge of the upper bearing **49** and

holds it fixedly in place in abutting engagement with the packing seat **48** and the packing cartridge **40**. Thus, all of the various components in the cylindrical openings **17** of the head **11** are maintained in their correct orientation.

In the event the packing **45** and/or some of the other components in the head **11** become worn after extended use, some leakage of the fluid being pumped may occur before the wear is noticed by an operator. To prevent this leaking fluid from entering the base **12** vents **69** are provided adjacent the juncture of the head **11** and base **12**. The vents **69** consist of at least one external opening for each cylindrical opening **17**, adjacent the juncture and at least one radially inwardly extending groove formed between the axially outer edges of the packing cartridge **40** and the packing follower **48** and the mating edge of the insert **49**. The O-ring **50** prevents leaking fluid from continuing axially along the plunger **55** and directs externally through the vents **69**.

A cavity **70** is formed in the base **12** between the wall **61** and the lower wall thereof. The base **12** has a large opening **71** at one end thereof in communication with the cavity **70** for the assembly of the pump and a smaller opening **72** at the other end thereof, generally coaxial with the opening **71**. Opening **72** has an axially inwardly directed flange **73** therearound formed integral with the base **12**. A generally disc-shaped cover **74** is provided to sealingly fit within the opening **71** and, in conjunction with an O-ring **75**, prevent leakage of oil therethrough. The cover **74** has a coaxial opening therethrough with axially inwardly and outwardly directed flanges **76** therearound forming a generally tubular element coaxial with the opening through the flange **73** at the opposite side of the base **12**.

A shaft **80** is mounted in the openings formed by the flanges **73** and **76** by means of bearings **81** and **82**. Bearings **81**, which are press fit into the flange **76**, have an oil seal **83** fixedly positioned at the outer edge thereof between the shaft **80** and the flange **76** to prevent leakage of oil therethrough. Bearings **82** are the closed type incorporating a cover **84** which is press fit into the opening **72** in the flange **73** to prevent leakage of oil therethrough. In the present embodiment the shaft **80** has three eccentrics **85**, **86** and **87** spaced axially apart therealong and formed as an integral part thereof. The eccentric **85** is positioned adjacent the inner edges of the flange **76** and the eccentric **87** is positioned adjacent the inner edges of the flange **73**. Hardened steel disc-shaped wear plates **90** and **91** are positioned coaxial with the shaft **80** between the eccentric **85** and flange **76** and between the eccentric **87** and flange **73**, respectively. The wear plates **90** and **91** prevent axial movement of the shaft **80** and further prevent wearing of the base **12**, which may be constructed of a relatively soft material such as aluminum and the like. The innermost ends of the flanges **73** and **76** have vertically oriented grooves **92** and **93**, respectively, extending diametrically thereacross to provide for a flow of lubricating oil into and out of the bearings **81** and **82**.

Each of the eccentrics **85**, **86** and **87** have bearings **95**, **96** and **97** engaged coaxially thereover with rollers **98**, **99** and **100** engaged coaxially over the bearings **95**, **96** and **97**, respectively. Each of the rollers **98**, **99** and **100** have a radially outwardly extending flange aproximately axially centered thereon, which flange engages a groove in the lower end of the plunger **55** associated with the rollers **98**, **99** or **100**. The three eccentrics **85**, **86** and **87** are positioned on the shaft **80** so that the maximum eccentricity thereof is located at approximately 120° intervals.

In the operation of the pump a driving force is attached to the shaft **80** to produce rotation thereof. As the shaft **80** rotates, the eccentrics **85**, **86** and **87** cause the three plungers **55** to move radially outwardly and, as the maximum eccentricity passes the lower portion of the plunger **55** assocaited therewith, the plunger **55** is forced radially inwardly in the cylindrical opening **17** by the biasing spring **58**. Thus, reciprocating movement is produced in each of the plungers **55** when the shaft **80** is rotated. This reciprocating movement is sinusoidal in nature with the output pressure portion or flow rate of each stroke being illustrated in FIG. 7. Referring specifically to the plunger **55** illustrated in FIG. 4, as the plunger **55** moves radially inwardly in the cylindrical opening **17** fluid is drawn through the openings **22** from the cavity **18**, to fill the portion of the cylindrical opening **17** above the plunger **55**. During this inward movement of the plunger **55** the flexible ring **33** is held tightly over the openings **32** by a combination of the suction in the cylindrical opening **17** and the springs **34**. When the plunger **55** begins to move radially outwardly the fluid in the cylindrical opening **17** is under pressure and the valve member **23** closes the openings **22** to prevent the fluid from flowing back into the cavity **18**. The pressurized fluid is thus forced through the openings **32** and moves the flexible ring **53** radially inwardly so that fluid is free to flow into the cavity **19** and through the outlet port **16**.

Since each of the three plungers **55** is moving sinusoidally within the cylindrical openings **17** under the impetus of the shaft **80** and attached eccentrics **85**, **86** and **87** and since the pressure output, or flow rate, varies sinusoidally for each cylindrical opening **17** and associated plunger **55** (as illustrated in FIG. 7), the total pressure, or flow rate, at the outlet port **16** follows a curve substantially as illustrated in the solid line of FIG. 7. Also, the reciprocations of the plungers are equiangularly displaced (wtih 3 cylinders the angular spacing is 120°). It should be noted from FIG. 7 that the point at which adjacent pressure waves cross, for example 150°, is 30° from the end of the first pressure wave and 30° beyond the start of the second pressure wave. Because the sine of 30° is one-half, the sum of the pressure (the total pressure at the outlet port **16**) at these crossover points is equal to one, or the peak pressure of any of the pressure waves. Thus, the total pressure at the outlet port **16** is a nearly constant pressure having a slight ripple or variation with a frequency twice that of the three combined pressure waves illustrated in FIG. 7. In a similar fashion the suction at the inlet port **15** is nearly constant.

Referring to FIG. 9, a graphic comparison of the output flow rate of the improved pump (dotted line) to the output flow rate of a pump having plungers driven by short connecting rods (full lines) is illustrated. The short, or low L/R ratios (where L equals the length of the connecting rod and R equals the crank radius), connecting rods have a tendency to produce flow rates in individual cylinders which more closely approximate sawtooth waves, rather than sine waves. The combination of these waves produce a total flow rate having the distorted wave illustrated in FIG. 9 and the relatively widely varying output pressure. As the length of the connecting rod increases (L/R ratio increases) the variations of the total flow rate decrease until the length approaches infinity, the individual flow rates become sinusoidal, and the flow rate curve of the improved pump is reached. The total flow rate curve illustrated by the full line in FIG. 9 is produced by a three cylinder pump having connecting rods with an $L/R=2\frac{1}{2}$.

It should be noted that the fluid being pumped comes in contact only with the head **11** and portions therein and, thus, only the head **11** and portions therein contacting the fluid need to be chemically compatible therewith. Also, because of the in-line configuration the coring and casting is all done in one plane and, therefore, greatly simplified. Thus, the overall construction of the pump facilitates the manufacture of a line of pumps wherein the heads are altered for various end results, such as for pumping different types of fluids, various pressures and amounts of flow, etc., while the base 12 remains substantially uniform.

In FIGS. 5 and 6 a different embodiment of the pump is illustrated wherein the spring **47**, which provides a compression on the packing **45**, is eliminated for reasons which will be apparent presently. In this embodiment modified or new components are indicated with a similar or new

number and a prime added to indicate a different embodiment. A packing cartridge **40'**, similar in shape to packing cartridge **40**, has a plurality (in this embodiment, four) of openings therethrough extending generally parallel with the axis of the cylindrical opening **17** and substantially centered over the packing follower **46**. A plurality of small pistons **51'** are slidably engaged in the openings for axial sliding reciprocating movements. Flexible rings or seals **52'** encircle each of the pistons **51'** to prevent fluid from passing axially therealong. The lower ends of the pistons **51'** rest against the packing follower **48** while the upper ends are in communication with the cavity **19** and have outlet fluid pressure thereon.

The packing **45** is most susceptible to movement relative to the plunger **55** when the plunger **55** is moving axially into the cylindrical opening **17**. At this time fluid in the cylindrical opening **17** is under pressure and is being forced out of the cylindrical opening **17** through the openings **32** and into the cavity **19**. In the embodiment illustrated in FIG. 5 the fluid under pressure in the cavity **19** is in communication with the axially inner ends of the pistons **51'** and produces an axially outward force thereon, which is transmitted through the pistons **51'** to the packing follower **48**. The packing follower **48** in turn maintains the packing **45** under compression so that leaking does not occur between the packing **45** and the plunger **55**. It should be understood that the pistons **51'** are simply one embodiment for utilizing the output fluid pressure to maintain a compressive force on the packing **45** and many other embodiments might be devised by those skilled in the art. One example of such an embodiment is to provide direct communication between the cavity **19** and the packing follower **48** so that fluid passing through the cavity **19** and under outlet pressure will provide a pressure directly on the packing follower **48**.

In FIGS. 9 and 10 another different embodiment of the pump is illustrated wherein modified or new components are indicated with a similar or new number and a double prime to indicate a different embodiment. Each of the plungers **55'** is formed with a downwardly opening cavity **65'** in the lower end thereof, rather than the groove described in the first embodiment. The shaft **80** has three eccentrics **85**, **86** and **87** spaced axially apart therealong and formed as an integral part thereof. Each of the eccentrics **85**, **86** and **87** has an arcuately shaped bearing shoe **66'** slidably engaged thereon with a radially outwardly extending tooth **67'** formed as an integral part thereof. The shoe **66'** is constructed so that an inner arcuate surface having a diameter equal to the diameter of the associated eccentrics **85**, **86** and **87** is concentric with an outer arcuate surface thereof. The rotation of the eccentrics **85**, **86** and **87** produces a relatively rolling movement between each of the shoes **66'** and the associated plungers **55**, as illustrated in FIG. 10, thereby, greatly reducing friction and wear. Further, the motion produced by the combined rotary movement of each of the eccentrics **85**, **86** or **87** and the associated shoes **66'** urge the plungers **55** in sinusoidally reciprocating movements.

Thus, an improved pump is disclosed which is relatively simple and inexpensive to manufacture since the entire housing can be cast and the cylindrical openings **17** can then be formed with a single tool operation. The present pump is relatively simple and quick to assemble since the various parts are all fitted within the cylindrical opening **17** and the shaft **80** is simply placed in the base **12** so as to contact the lower ends of the plungers **55**. Because the cylinders are all in-line the overall construction of the pump is greatly simplified and the reliability and life is greatly increased. In addition, the means for mounting the shaft **80** in the base **12** provides for wear-resistant mounting of the shaft **80** while allowing the base **12** to be constructed of a relatively inexpensive and soft material. Further, the use of three cylinders and sinusoidally moving plungers therein produces a relatively constant outlet pressure, or flow rate, and inlet suction. It should be understood that more than three cylinders might be utilized and additional reductions of outlet pressure variations can be realized, for example while four cylinders produce larger variations five or more will produce a smoother outlet pressure if properly timed. Many other advantages and modifications may become apparent to those skilled in the art upon further consideration thereof.

What is claimed is:

1. An improved pump, comprising:

(a) a housing having joinable base and head portions;

(b) the head portion including a wall member defining elongated first and second chambers, the first and second chambers being disposed in parallel alignment with the first chamber overlying the second chamber;

(c) a fluid inlet communicating with the first chamber and a fluid outlet communicating with the second chamber;

(d) a plurality of openings alignably formed in the wall member to establish fluid communication between the first and second chambers;

(e) removable insert means for each of said openings disposed entirely within said second chamber and in transverse relation to the first and second chambers, each removable insert means comprising:

(1) tubular sealing means defining a pumping chamber;

(2) inlet check valve means abutting the wall member and cooperable with the associated opening and tubular sealing means for admitting fluid from the first chamber to the pumping chamber;

(3) outlet check valve means cooperable with the tubular sealing means for permitting fluid to flow from the pumping chamber to the second chamber;

(4) the tubular sealing means and inlet and outlet check valve means being constructed and arranged for joint assembly;

(f) the head and base portions being constructed and arranged to cooperably retain the respective insert means when joined;

(g) a plunger reciprocally disposed in each pumping chamber;

(h) and means disposed in the base portion for reciprocating the plungers.

2. The pump defined by claim **1**, wherein each tubular sealing means further comprises packing encircling the associated plunger for substantially preventing fluid flow axially therealong.

3. The pump defined by claim **2**, wherein each tubular sealing means further comprises biasing means for maintaining a compression force on the packing during reciprocating of the associated plunger.

4. The pump defined by claim **3**, wherein the biasing means includes means mounted in communication with the second chamber for receiving fluid pressure therefrom during compression strokes of the associated plunger.

5. The pump defined by claim **1**, wherein the plunger reciprocating means comprises a drive shaft rotatably mounted in the base portion and eccentric means rotatably affixed to the shaft and engageable with each plunger.

6. The pump defined by claim **5**, wherein the eccentric means includes a member having a generally circular outer periphery eccentrically attached to the shaft and a bearing mounted, generally annular roller coaxially affixed in overlying relation to the periphery of said member.

7. The pump defined by claim **5**, wherein the eccentric means includes a member having a generally circular outer periphery eccentrically attached to the shaft and a bearing shoe slidably engaged on the outer periphery of said member with a radially outwardly extending tooth engaged in a downwardly opening cavity in the lower end of the plunger.

8. The pump defined by claim **5**, including spring biasing means mounted in the housing and urging the plunger into engagement with the eccentric means.

9. The pump defined by claim 5, wherein that portion of the base portion in which the shaft is mounted is constructed of a relatively soft material and relatively hard annular wear elements are coaxially positioned with respect to the shaft between radially outwardly extending portions of the shaft adjacent both ends thereof and the base portion.

10. The pump defined by claim 9, wherein bearings mounting the shaft in the base portion are positioned coaxial with the shaft axially outwardly from each wear element and grooves are formed in the base portion adjacent each wear element for the circulation of lubricant into said bearings.

11. The pump defined by claim 5, wherein the eccentric means and plunger are mounted in relative rolling engagement and cooperating groove and flange portions are formed therebetween to substantially prevent relative transverse movements.

12. The pump defined by claim 11, having three openings in the wall member, the plunger engaging means constructed and arranged to effect equiangularly displaced reciprocations of the plunger.

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