July 15, 1958 W. H. MASHINTER 2,843,045

METERING PUMP APPARATUS

Filed May 3, 1956 3 Sheets-Sheet 1

Fig. 1.

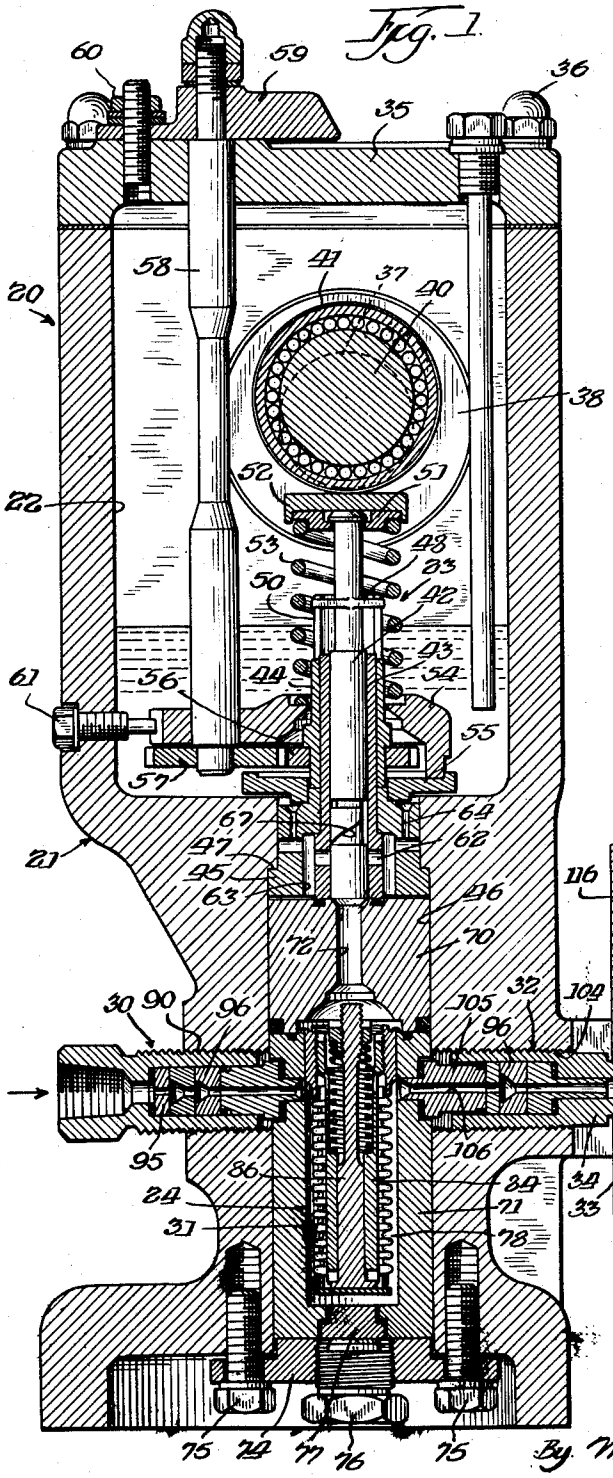


Fig. 7.

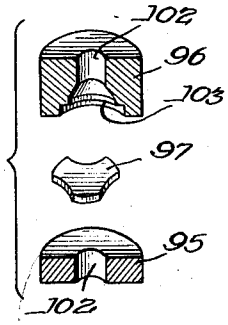
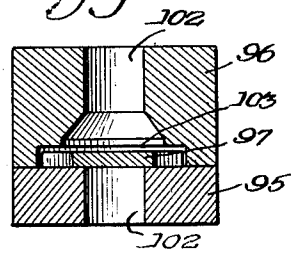
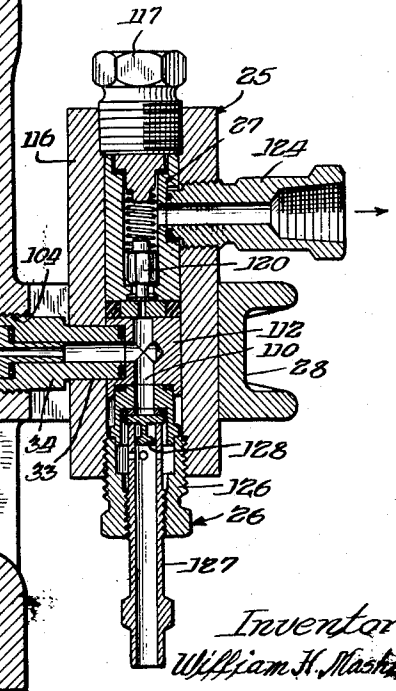


Fig. 8.





Inventor:
William H. Mashinter.

By Wilkinson Huxley Byron & Hume
Attys.

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Fig. 2.

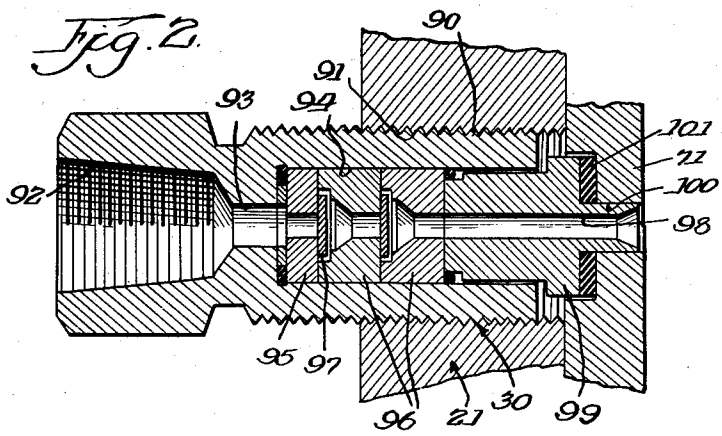


Fig. 3.

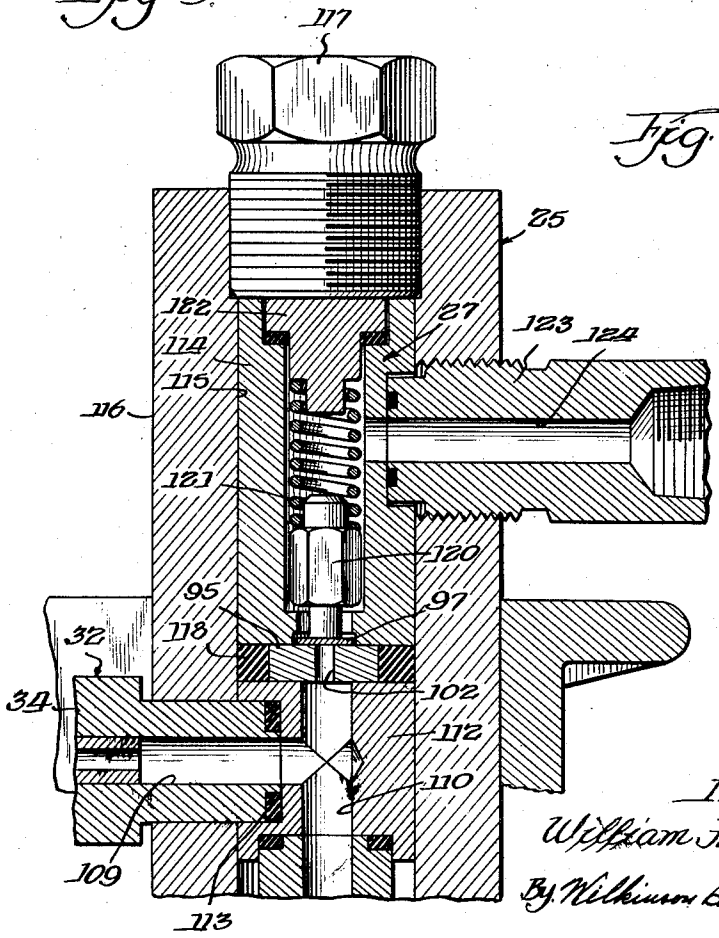
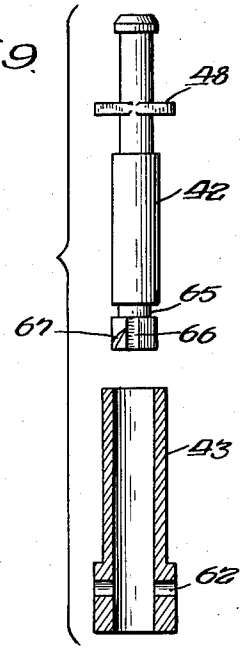


Fig. 9.



Inventor.
William H. Mashinter.
By Wilkinson Huxley Byron & Hume
Attys.

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Fig. 4

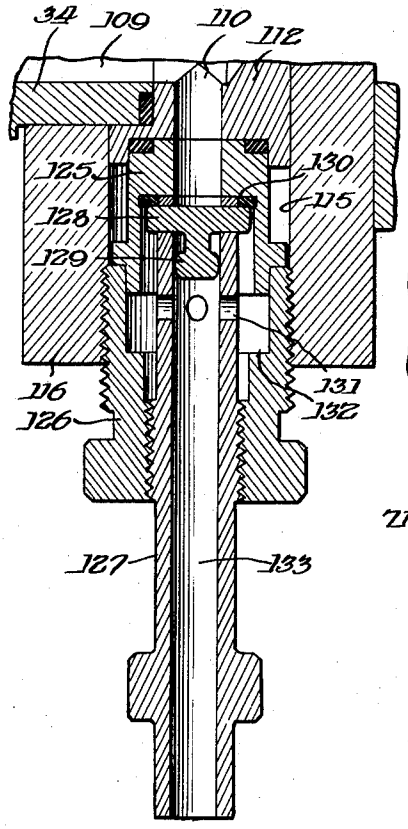
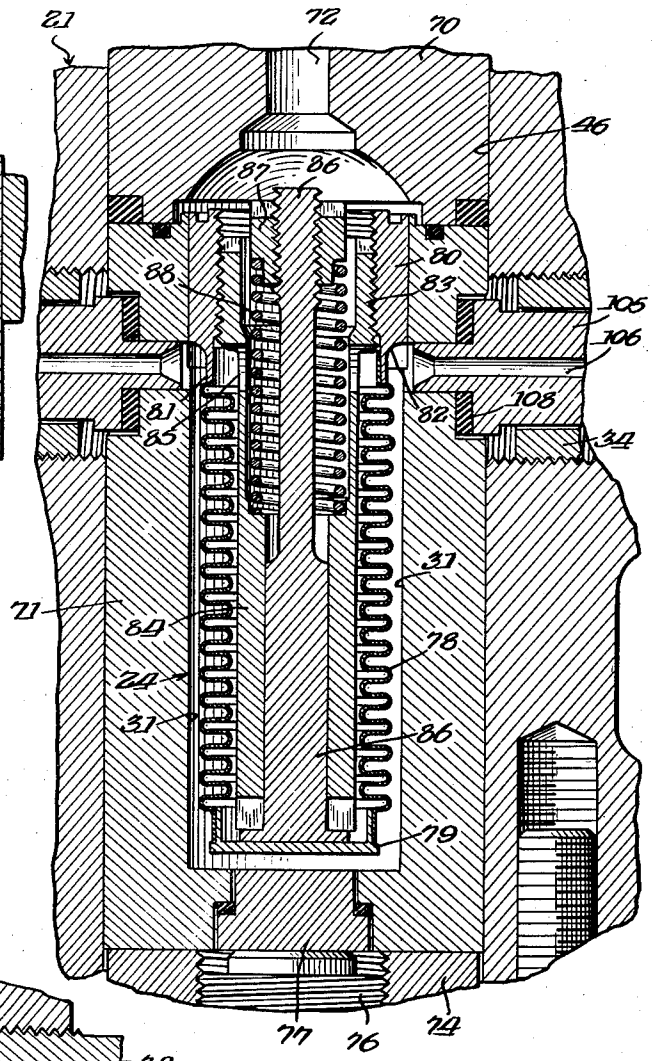


Fig. 5.



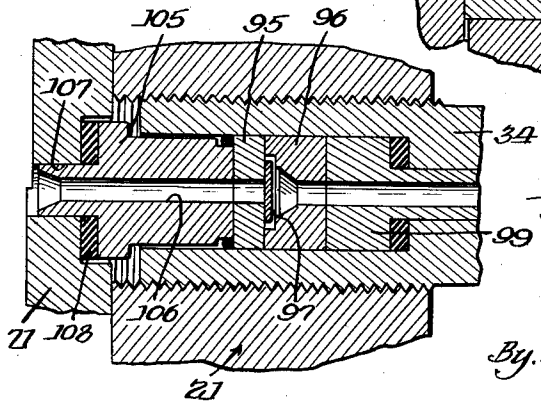


Fig. 6.

Inventor:
William H. Mashinter.
By. Wilkinson Huxley Byron & Hume
Attys.

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METERING PUMP APPARATUS

William H. Mashinter, Hinsdale, Ill.

Application May 3, 1956, Serial No. 582,466

10 Claims. (Cl. 103—44)

The invention relates to pumps and has reference in particular to a metering pump of packless construction which will pump measured quantities of fluid at high pressures and in an accurate and precise manner for discharge over a wide output flow range and wherein the said fluids will include those of a chemical or corrosive nature as well as other difficult to handle materials.

The pumping and metering apparatus of the present invention incorporates improvements over the pump disclosed and claimed in my co-pending application Serial No. 443,251, filed July 14, 1954 and accordingly the said apparatus has certain basic characteristics such as the complete absence of frictional moving parts or rubbing surfaces in contact with the liquid being pumped whereby the apparatus is ideally suited for pumping and metering such materials as light liquid hydrocarbons, water, liquified petroleum gases, and liquids having particles in suspension. Also the said pump makes use of an hydraulically actuated bellows member to provide an hermetically sealed, leak-proof pumping element so that stuffing boxes and packing glands have been entirely omitted. These and other structural features have been so combined as to provide a pump having the pressure producing possibilities of a positive displacement type pump, the ability to pump hard to handle liquids such as would ordinarily require a diaphragm type of pump, and a pump that can be operated to discharge a continuous flow in the manner of a centrifugal pump.

The improvements which have been incorporated in the pumping apparatus as basically described includes a novel arrangement of parts for effectively handling the non-condensable gases which are generally entrained in the fluids being pumped and which, if not properly discharged along with the fluids, might otherwise accumulate within the pumping chamber to the extent where the metering accuracy of the pump is either destroyed or the pump becomes entirely inoperative as a pumping instrumentality.

Another object of the invention resides in the provision of a pump having a pumping chamber incorporating certain special and unique design features for effectively handling fluids having non-condensable gases entrained therein and wherein the inlet and outlet valve assemblies are associated with the pumping chamber in a manner to additionally assist the flow of said fluids from the said inlet through the pumping chamber to the outlet thereof.

Another object of the invention is to provide a pump having inlet and outlet valve assemblies so constructed and arranged with respect to the pumping chamber as to provide the shortest path through the chamber for the flow of the liquids being pumped, and wherein said flow path will be confined to the upper end of the pumping chamber so that the entrained gases are caused to travel along with the fluid are thus prevented from accumulating within the said pumping chamber.

Another object of the invention is to provide pumping apparatus such as described which may be further characterized by a vertically positioned pumping chamber

having an expansible type bellows member adapted to pulsate vertically within the chamber, and wherein the inlet assembly and the outlet assembly for the pumping chamber are disposed in a horizontal plane, all for the purpose of flowing the fluids to be pumped through the pumping chamber in a manner to prevent the gases which may be entrained therein from accumulating within said chamber.

Another object of the invention resides in the provision of a pump having a pumping chamber and bellows assembly which will comprise a unitary structure complete in itself so that said assembly as a unit can be quickly and conveniently inserted or removed from the pump housing to facilitate repairs and reduce the time during which the pump may be out of use.

A further object is to provide a pump such as described wherein the inlet valve assembly and the outlet valve assembly will also comprise unitary structures and which will have positions on the respective sides of the pumping chamber that may be reversed, if desired, or changed from a connection with the top end of the pumping chamber to a connection with the bottom end of the chamber. Paralleling such interchange of elements is the additional facility of placing the vent valve assembly on either side of the pumping chamber or in communication with the bottom portion of the pumping chamber since said vent valve assembly is also interchangeable with either the inlet or the outlet valve assembly.

A still further object is to provide a pump such as described wherein the inlet and outlet valve assemblies will incorporate valves of a flat type having a flat valve member of light weight adapted to contact flat seating surfaces whereby said valves are quick-acting, positive in seating, and wherein they incorporate a self-cleaning feature which renders the valves especially suited for high pressure pumping and for handling liquids containing particles in suspension.

Still another object of the invention resides in the provision of a pump wherein the outlet valve assembly which incorporates light weight valves of the flat type as described is combined in tandem relation with an outlet valve unit of the spring-loaded type. The said spring-loaded discharge valve is located exteriorly of the pump housing so as to be readily removable, which is sometimes necessary, as, for example, when pumping heavy slurry which does not properly flush through the valve but has a tendency to build up therein. Also, when pumping corrosive chemicals the coil spring of the discharge valve is subject to rapid deterioration and must be frequently replaced.

A further object of the invention is to provide pump apparatus incorporating a unitary bellows pumping assembly including a cylindrical member providing a pumping chamber having a corrugated metal bellows depending therein and which is hermetically sealed by a bellows closure element. A bellows guide and a bellows guide stem are located within the metal bellows and these parts are associated in a manner to operatively position the bellows return spring which is accordingly located within the bellows and protected from the corrosive fluids such as may be pumped by the device.

With these and various other objects in view, the invention may consist of certain novel features of construction and operation as will be more fully described and particularly pointed out in the specification, drawings and claims appended thereto.

In the drawings, which illustrate an embodiment of the invention, and wherein like reference characters are used to designate like parts—

Figure 1 is a vertical sectional view taken substantially through the center of a metering and proportioning pump

embodying the improved features of the present invention;

Figure 2 is a fragmentary sectional view on an enlarged scale showing the inlet valve assembly for the present pump;

Figure 3 is a fragmentary sectional view showing the spring-loaded discharge valve on an enlarged scale;

Figure 4 is a fragmentary sectional view showing the gas and vapor venting unit on an enlarged scale;

Figure 5 is a fragmentary sectional view showing structural details of the pumping chamber and bellows assembly also on an enlarged scale;

Figure 6 is a fragmentary sectional view showing details of the outlet valve assembly on an enlarged scale;

Figure 7 is an exploded view illustrating the flat-type of valve structure employed in the inlet and outlet valve assemblies, with the seating member and cage thereof being shown in section;

Figure 8 is a vertical sectional view taken through one of the flat-type valve units illustrating the association of the several parts when assembled; and

Figure 9 is an exploded view of the metering plunger and its barrel, with the plunger being shown in elevation, whereas the barrel is shown in vertical section.

Referring first of all to Figure 1, the invention is embodied in a pump indicated in its entirety by numeral **20** and which includes a housing **21** generally rectangular in shape, having an oil reservoir chamber and a plunger pumping assembly **23** located within the upper portion of the housing and having a pumping chamber and bellows assembly **24** incorporated in the lower portion of the housing. A third assembly **25** provides a housing for the vapor and gas venting unit **26** and a housing for the spring-loaded discharge valve assembly **27**, the combined structural unit being releasably secured to the lower portion of the pump housing by the retaining member **28** which thereby permits removal of the unit for speedy servicing of the pump. The lower portion of the housing **21**, approximately opposite the assembly **25**, has an inlet valve assembly **30** threaded in the wall thereof and which functions to admit fluids to be pumped to the pumping chamber **31** within the bellows assembly **24**. The inlet valve assembly is disposed on a horizontal plane and the same has connection with the pumping chamber **31** at the extreme upper end thereof for purposes which will be best understood as the description proceeds. Diametrically opposite the inlet valve assembly the housing **21** is bored and threaded for receiving the outlet valve assembly indicated in its entirety by numeral **32** and which is likewise horizontally disposed on the same plane as the inlet valve assembly. The exterior end of the casing **34** of the discharge valve assembly is bored for receiving a slip joint for the unit assembly **25**, which is clamped thereto to hold the entire assembly properly positioned and clamped by member **28** to the main housing of the pump. The oil reservoir chamber **22** may contain a quantity of oil to the level as indicated in Figure 1 and said chamber is closed by a top plate **35** suitably secured to the housing by cap screws such as **36**.

The drive shaft for the pump indicated by numeral **37** extends through opposed side walls of the reservoir chamber, being suitably journalled in said walls by the ball bearing assemblies **38** and between the said assemblies the shaft is provided with an eccentric lobe **40** on which is mounted a roller bearing assembly having the outer race **41**. The plunger pumping assembly **23** is disposed vertically within the oil reservoir chamber **22** and the same essentially consists of the metering plunger **42**, the plunger sleeve **43**, the outer sleeve **44** and the sleeve retainer **45**. The retainer is inserted within the central bore **46** formed in the base end of the housing and said retainer is positioned by contact thereof with shoulder **47**. The sleeve **43** extends upward through the retainer, being in turn positioned and held thereby in vertical relation within the oil reservoir chamber. The metering plunger **42** is adapted to reciprocate within sleeve **43** and it will be observed that the plunger is provided with ears **48** disposed adjacent to the upper end thereof and which are adapted to ride in slots **50** formed in the upper end of outer sleeve **44**. As a result thereof any rotation imparted to sleeve **44** is directly transmitted to the plunger. The top terminal end of the plunger is provided with an upper spring seat **51** and with the tappet **52**, said tappet being held in contact with race **41** on the eccentric lobe by the coil spring **53**, which is confined between the upper spring seat **51** and the lower spring seat **54**. The action of the coil spring is to maintain the plunger in elevated position with the tappet up against said eccentric lobe **40**. The lower spring seat **54** is supported and positioned by the support **55** and within the space formed by these coacting elements there is located the pinion **56** which is fixed to the outer sleeve **44**. The gear **57** has meshing relation with pinion **56** and said gear is rotated by the quantity control shaft **58** journalled at its lower end by the lower spring seat **54** and at its upper end by top plate **35** having the indicator **59** suitably fixed thereto. The lock nut **60** can be employed to lock the indicator and associated parts in adjusted metering positions, whereas the lock screw **61** is associated with the lower spring seat **54** to prevent rotation of said spring seat.

The reciprocating movements of plunger **42** function to apply hydraulic pulsations to the bellows pumping assembly, for which purpose the sleeve **43** is provided with one or more ports such as **62**, leading to a peripheral chamber such as **63** provided by the retainer **45**, and which chamber surrounds said sleeve **43**. The vertical passages **64** lead upwardly from chamber **63** and connect with the oil reservoir chamber **22**. Accordingly, the oil from the reservoir will flow downwardly through passages **64** into chamber **63** and through the port or ports **62** to within sleeve **43** so that the end of the plunger **42** will have pumping action thereon. As best shown in Figure 9, the plunger is provided with an annular groove **65**, with the vertical slot **66**, and with the inclined helical ramp **67**, the latter making it possible to vary the quantity of oil acted on by the plunger by adjusting its rotative position with respect to the port or ports **62**. The ramp of the plunger need not necessarily have a helical inclination, as other configurations may be resorted to, depending on the pumping characteristics desired of the plunger. Also the ramp may be referred to as the scroll surface of the helix and by rotation of the quantity control shaft **58** the sleeve **44** and thus the plunger **42** may be rotated to secure any desired rotative position of the plunger, all in a manner which will permit free reciprocating movements of said plunger for producing the hydraulic pulsations as herein described.

A spacing member **70** is located within the central bore **46**, the same having location between the retainer member **45** and the pumping chamber element **71** forming part of the bellows pumping assembly. The spacing element has a bore **72** therein and which is in alignment with the sleeve **43** so that the hydraulic pulsations produced by the plunger are transmitted directly to the bellows assembly, the structural details of which will now be described.

In Figure 5 the said assembly is shown in an enlarged fragmentary view and accordingly it will be observed that the bellows and associated parts are entirely housed within the pumping chamber element **71**, being located within the pumping chamber **31** provided thereby so as to comprise a unit therewith and which can be inserted into the central bore **46** from the bottom end of the housing, the unitary structure being locked within the bore by the bottom plate **74** held in place by bolts **75**.

The plate **74** is adapted to receive the threaded nut **76** for holding the plug **77** in place within an opening provided therefor in the bottom wall of the pumping

chamber element 71. The plug and threaded nut are provided for a number of purposes. In the first place, with the inlet valve assembly 30 and the outlet valve assembly 32 positioned as shown in Figure 1, it may be necessary at periodic times to remove the plug 77 from the bottom of the pumping chamber 31 in order to flush and clean the chamber of accumulated particles. Also as a feature of the invention either the inlet valve assembly or the discharge valve assembly can be located in this lower end of the pumping chamber and for this reason the diameter of the outer casings of the valve assemblies are made equal to the threaded end of nut 76 and, further, the size of the plug 77 is such as to equal the size of the inserted ends of said valve assemblies. Thus the valve assemblies have universal positioning with respect to the housing of the pump and this concept is further carried out with respect to the vapor and gas venting unit 26 wherein the threaded outer casing thereof is so formed that the same may be threaded into either of the openings occupied by the valve assemblies in Figure 1.

The flexible bellows 78, having the bottom closure member 79 suitably fixed thereto is suspended within the pumping chamber 31 of the element 71 by means of the upper closure element 80. Said element has a tight fit within the upper end of the pumping chamber 31 and the element is suitably fixed to the part 71 by means of brazing, welding or the like. The bellows closure element 80 is tubular and the lower end of the same has a special formation which renders the present pump especially efficient in the pumping of fluids having non-condensable gases entrained therein. The lower end of said element 80 is designated by numeral 81 and this depending portion extends circumferentially of chamber 31, being spaced inwardly from the walls of said chamber and having the upper end of the bellows 78 hermetically sealed to the inside surface thereof. The outer surfaces, as provided by depending portion 81 and by element 80, are smooth-surfaced throughout and the same have an arcuate contour as indicated by numeral 82, for the special purpose of providing a flow path at this upper end of the pumping chamber for the fluids as they flow from the inlet valve assembly to the outlet valve assembly. As a result of the smooth surfaces of arcuate contour the non-condensable gases are prevented from accumulating and, in fact, the gases are caused to move along at the same rate with the fluids and are thus eventually discharged through the outlet valve assembly.

The interior surface of element 80, above the depending portion 81 thereof, is threaded for receiving the threaded upper end 83 of the tubular bellows guide 84, which accordingly extends for the length of the bellows and provides a stop member therefor in that the guide limits the contracting movement of the bellows. Also openings such as 85 are formed in the guide in order that the hydraulic medium such as the oil from the reservoir chamber can freely flow to within the bellows whereby the hydraulic pulsations produced by the reciprocating plunger are transmitted to the bellows. The bellows guide stem 86 extends within the tubular bellows guide 84 and said stem is fixed at its base end to the bottom closure member 79 of the bellows. The nut 87 is threaded to the upper end of the stem for the purpose of confining the coil spring 88 within the space provided therefor by the tubular bellows guide 84. Accordingly the stem has seating contact at its base on the bellows guide and at its upper end the coil spring has seating contact on nut 87 so that through the stem the bellows 78 is yieldingly urged and maintained in contracted position to the extent as permitted by the guide.

All of the space within the bellows 78 and including passages 72 and also the chambers and ports provided by the retainer 45 and sleeve 43 will be filled with oil supplied by the reservoir chamber 22 and upon a downward stroke of the plunger a quantity of oil will be trapped below the ports 62 and said quantity will be compressed by the plunger to expand the bellows 78, thus producing a pumping stroke of the bellows. On upward movement of the plunger the pressure on the oil will be released and the bellows will return under the tension of spring 88 to effect a suction stroke. Thus the hydraulic pulsations produced by plunger 42 operating on the oil within the bellows will cause alternating pumping and suction strokes of the bellows within the pumping chamber 31 and accordingly a liquid can be pumped by this action of the bellows. On one side of the housing the pumping chamber has communicating relation with the inlet valve assembly 30 and on the side diametrically opposite thereto the pumping chamber communicates with the discharge valve assembly 32.

As best shown in Figure 2, the inlet valve assembly essentially consists of an outer threaded casing or housing 90 which is threaded into the opening 91 provided therefor in the wall of the housing 21. The exterior end of casing 90 is interiorly threaded as at 92, whereby the casing can be threadedly secured to an inlet supply pipe or the like for supplying the fluid to be acted on by the pump. The passage 93 leads from the interiorly threaded end to the central bore 94 formed in the casing for the remainder of its length and within said bore there is located valve members such as the base 95, the cage 96 and the flat valve member 97. The inlet valve assembly is completed by member 99 having the passage 98 therein and which is adapted to enter opening 100 provided for the purpose in the cylindrical wall of the pumping chamber element 71. The washer 101 of any suitable plastic is located between the parts for effectively sealing the same against the escape of liquid. The valve base, cage and flat valve member are best shown in Figures 7 and 8. The valve member 97, which is of the fast-acting type, is light in weight and has a shape formed by the scalloped edges, as shown. Said flat valve member is supported on the flat surface of the base 95 and said valve member is enclosed within the space formed by the stepped surfaces 103, the shoulder thus provided by said stepped surfaces limiting the upward movement of valve member 97. For the inlet valve assembly one base and two cages are employed. Additional cages could be provided and each will have a valve member since as the cages are repeated the bottom one forms a base member for the cage supported thereby.

The discharge valve assembly 32 is similar in all basic details to the inlet assembly. Referring to Figure 6, it will be seen that the casing or housing 34 is externally threaded for threaded connection in opening 104 provided in the wall of housing 21. The member 105, having the discharge passage 106 therein, is adapted to enter opening 107 provided therefor in the pumping chamber element 71, and there is interposed between the parts the washer 108 of any suitable plastic to maintain a sealing contact. The valve structure within this assembly is the same as previously described for the inlet valve structure, namely, a base 95 is positioned in contact with member 105 and a cage 96 is located next to the base, with a flat valve member 97 being positioned therebetween and having movement with respect to the flat seating surface provided by the base to an extent as permitted by the stepped surfaces 103 of the cage. The fluid discharged by the valve structure is delivered to passage 109 which communicates with the T-shaped passage 110 provided by member 111, having location within the unitary assembly indicated by numeral 25. The assembly 25 is secured by a slip joint to the end 33 of the casing 34 and here there is likewise provided a plastic washer such as 113 to assure a sealing contact between the parts.

In accordance with the invention the present pump incorporates a spring-loaded discharge valve generally indicated by numeral 27 which has tandem relation with the discharge valve assembly 32. As shown in detail in Figure 3 the member 114 has location within the bore 115 provided by the housing 116 of the unitary assembly 25,

and said member is maintained within the bore by the threaded nut 117. The bottom end of member 114 has contact with a valve base 95 and with a washer 118 of suitable plastic material for sealing purposes. The flat valve member 97 is supported on the flat surface provided by the base member and the same has movement within a space provided by member 114. The valve element 120 provides the lower spring seat for the coil spring 121 and said valve element has contact at its lower end with the flat valve member 97. Actually member 97 is maintained in valve closing position by the resilient pressure of the coil spring 121 communicated through element 120. The plug 122 provides the upper seat for coil spring 121 and said plug is maintained in position by the nut 117. Outlet connection 123 having the discharge passage 124 is suitably threaded in housing 116 so that the said passage has communicating relation with the valve elements of the spring-loaded discharge valve.

On the down stroke of the plunger 42 the pumping action thereof does not become effective until the scroll surface of the helix 67 has passed the port or ports 62. From there on the plunger will act on the oil below the same to produce an expansion of the bellows 78. The extent to which the bellows may be caused to expand will therefore depend on the rotative position of the plunger. The quantity of liquid acted on per stroke can be varied from zero to maximum and a further control of the delivery rate of the pump can be effected by adjusting the speed of rotation of the drive shaft. When two parts such as 62 are provided the zero position for the plunger is effected when slot 66 is aligned with either port and accordingly the present pump has a zero position at both ends of the quadrant. On a suction stroke of the bellows the valve member of the discharge valve assembly will close and the valve members of the inlet valve assembly will open. A quantity of liquid is accordingly delivered to the pumping chamber 31 of the pump.

Assuming that the pump has been properly primed and is in condition for operation, the pumping chamber 31 will be full of liquid and upon an expansion stroke of the bellows the inlet valve members will close and the outlet valve member will open, effecting a discharge of a quantity of liquid to the discharge passage 109. The flat type of valve members 97 are extremely fast acting and it is necessary that this be the case since the bellows may expand and contract many times a minute, the said rate being controlled by the speed of operation of the drive shaft 40. Also the valve members require very little effort to effect a fully opened position, and the horizontal wash action, or vertical wash action, depending on how the valves are disposed within the housing, which takes place across both faces, is a self-cleaning feature, accounting in a large measure for the high efficiency of the pump when operating on liquids having particles in suspension.

The pressure on the liquid within the discharge passages 109 and 110 will eventually attain a value sufficiently high to lift valve element 120 against the pressure exerted by the coil spring 121 and thus the spring-loaded discharge valve will open to permit flow of the discharging liquid to the outlet connection 123.

When the pump is initially started or started after a long period of inactivity, the high pressure chamber 31 and connecting passageways leading to the inlet and outlet valves must be completely vented of all air, gas and vapor. To efficiently and effectively accomplish this function the invention provides the venting device 26 which is shown in enlarged section in Figure 4. The tubular valve seat member 125 is located within the bore 115 in alignment with passage 110. The tubular retaining nut 126 is threaded in said bore 115 at the lower end thereof and said retaining nut holds said member 125 in tight contact with member 112. The bleeder tube 127 is in turn threaded in the retaining nut 126 and by means of a ball connection the bleeder valve member 128 is loosely fixed to the inner end of said tube. More particularly, the valve member 128 has the ball 129 formed integrally therewith and said ball has a loose fit within the adjacent end of the bleeder tube. A resilient washer 130 of any suitable plastic is located between valve member 128 and the seat provided therefor by member 125. The openings 131 in the bleeder tube 127 connect the chamber 132 with the passage 133 extending longitudinally of the bleeder tube. When the tube is retracted by rotating the same a prescribed number of turns in a releasing direction, valve member 128 is accordingly released to thus open the venting passages whereby some of the gas, air or vapors within the pumping chamber 31 will escape on each pumping stroke of the bellows. However, on a suction stroke the valve member 128 will automatically close since it will be drawn shut by the suction effect. In order to permit this mode of operation and to assure proper seating of the valve member 128 some play or looseness is provided therefor by its ball connection with the bleeder tube. Otherwise atmospheric air would be drawn into the pumping chamber instead of the liquid to be pumped. Eventually all gas and vapor will be vented from the pumping chamber and thereafter a quantity of the liquid will be discharged from the bleeder tube. This is an indication for the operator to close the venting valve member 128 against its plastic seat, whereupon the pump will thereafter discharge liquid from the outlet valve assembly 32.

What is claimed is:

1. In a pump, the combination with a housing providing a reservoir chamber in the upper portion thereof and said housing having a central bore extending from the reservoir chamber to the base of the housing, means including a bellows pumping assembly located within the bore adjacent the base thereof, a plunger pumping assembly located in the reservoir chamber in alignment with the said bore, said bellows pumping assembly including a member providing a pumping chamber, a flexible bellows depending within the pumping chamber, and a bellows closure element within the pumping chamber at the upper end thereof and to which the open end of the flexible bellows is secured, said plunger pumping assembly including a reciprocating plunger member, means providing a passage from the reciprocating plunger member to the open end of the flexible bellows, a tubular bellows guide extending longitudinally within the bellows and being fixed at its upper end to the bellows closure element, a bellows guide stem fixed to the closed bottom end of the bellows and extending through the tubular bellows guide for approximately the length of the same, and a bellows return spring in surrounding relation with the guide stem and being located within the bellows guide, said bellows return spring yieldingly biasing the guide stem in an upward direction whereby to maintain the bellows in contracted condition.

2. In a pump, the combination with a housing providing a reservoir chamber in the upper portion thereof and said housing having a central bore extending from the reservoir chamber to the base of the housing, means including a bellows pumping assembly located within the bore adjacent the base thereof, a plunger pumping assembly located in the reservoir chamber in alignment with the said bore, said bellows pumping assembly including a cylindrical member providing a pumping chamber open at its top end and which is aligned with the bore, a flexible bellows depending within the pumping chamber, and a bellows closure element fixed within the open top end of the pumping chamber and to which the open end of the bellows is secured, said plunger pumping assembly including a reciprocating plunger member for producing hydraulic pulsations to cause the bellows to alternately expand and contract, a tubular bellows guide extending longitudinally within the bellows and being fixed at its upper end to the bellows closure element, a bellows guide stem fixed to the closed bottom end of the bellows

and extending through the tubular bellows guide for approximately the length of the same, and a bellows return spring in surrounding relation with the guide stem and being located within the bellows guide, said spring having its base end seated on the bellows guide and having its opposite end fixed to the guide stem, whereby said spring yieldingly biases the guide stem in an upward direction to maintain the bellows in contracted condition.

3. In a pump, the combination with a housing providing a reservoir chamber in the upper portion thereof and said housing having a central bore extending from the reservoir chamber to the base of the housing, means including a bellows pumping assembly located within the bore adjacent the base thereof, a plunger pumping assembly located in the reservoir chamber in alignment with the said bore, said bellows pumping assembly including a cylindrical member providing a pumping chamber open at its top end and which is aligned with the bore, a flexible bellows depending within the pumping chamber, and a bellows closure element fixed within the open top end of the pumping chamber and to which the open end of the bellows is secured, an inlet valve assembly having threaded connection with the housing and communicating with the pumping chamber adjacent the bellows closure element, an outlet valve assembly also having threaded connection with the housing and also communicating with the pumping chamber adjacent the bellows closure element, and said bellows closure element providing a flow path from inlet valve assembly to outlet valve assembly characterized by smooth surfaces of arcuate contour whereby to facilitate flow of fluids having non-condensable gases entrained therein.

4. In a pump, the combination with a housing providing a reservoir chamber at the upper portion thereof and said housing having a central bore extending from the reservoir chamber to the base of the housing, means including a bellows pumping assembly located within the bore adjacent the base thereof, a plunger pumping assembly located in the reservoir chamber in alignment with the said bore, said bellows pumping assembly including a cylindrical member providing a pumping chamber open at its top end and which is aligned with the bore, a flexible bellows depending within the pumping chamber, and a tubular bellows closure element fixed within the open top end of the pumping chamber and to which the open end of the bellows is secured, said plunger pumping assembly including a reciprocating plunger for producing hydraulic pulsations to cause the bellows to alternately expand and contract, a tubular bellows guide extending longitudinally within the bellows and being threaded at its upper end to the bellows closure element, a bellows guide stem fixed to the closed bottom end of the bellows and extending through the tubular bellows guide for approximately the length of the same, a bellows return spring confined between the bellows guide and the bellows stem for yieldingly maintaining the bellows in contracted condition, an inlet valve assembly and an outlet valve assembly having threaded connection respectively with the housing and each communicating with the pumping chamber adjacent the bellows closure element, and said bellows closure element providing a flow path from inlet valve assembly to outlet valve assembly characterized by smooth surfaces of arcuate contour whereby to facilitate flow of fluids having non-condensable gases entrained therein.

5. In a pump, the combination with a housing having a reservoir chamber in the upper portion thereof and having a pumping chamber in the base portion thereof, said housing providing a connecting passage between the chambers, a flexible bellows depending within the pumping chamber and having its open top end hermetically sealed to the chamber walls in surrounding relation with the passage at the upper end of said pumping chamber, a reciprocating metering plunger located within the reservoir chamber for subjecting the liquid in the passage and within the bellows to hydraulic pulsations whereby to alternately expand and contract the bellows and produce pumping strokes thereof, said housing having a pair of threaded openings in the walls thereof in approximate horizontal alignment with the upper end of the pumping chamber, an inlet valve assembly threaded in one opening and communicating with the pumping chamber, a discharge valve assembly threaded in the other of said openings, said discharge valve assembly at its inner end communicating with the pumping chamber and having its opposite end projecting exteriorly of the housing, a unitary assembly having connected relation with the projecting end of said discharge valve assembly, said unitary assembly including a cylindrical housing, a gas and vapor venting unit located in one end of the cylindrical housing, and a spring-loaded discharge unit located in the opposite end of said cylindrical housing.

6. A pump as defined by claim 5, wherein said gas and vapor venting unit has a threaded exterior for connection with a threaded opening in the cylindrical housing at the venting unit end thereof, and wherein said valve assemblies and venting unit each comprise a unitary structure complete in itself and said parts having the same maximum diameter and similar threaded exteriors so that they are interchangeable as regards said openings.

7. In a pump, the combination with a housing providing a reservoir chamber in the upper portion thereof and said housing having a central bore extending from the reservoir chamber to the base of the housing, a member located in the base of the bore and providing a pumping chamber open at its top and at its bottom, a flexible bellows depending within the pumping chamber, a bellows closure element within the pumping chamber at the top end thereof and to which the open top end of the bellows is secured, a plunger pumping assembly located in the reservoir chamber in alignment with said bore and operating for producing hydraulic pulsations to cause the bellows to alternately expand and contract, said housing having threaded openings therein leading to the pumping chamber, an inlet valve assembly and an outlet valve assembly having threaded relation respectively with said openings and having communicating connection with the pumping chamber, a plug located in and closing the opening in the bottom of said member, a plate secured to the base of the housing and locking the member within the bore, a threaded nut located within an opening in the plate and aligned with the plug for locking the plug in place, and said valve assemblies each comprising a unitary structure complete in itself and said assemblies and also the threaded nut having the same external diameter and similar threaded exteriors so that they are interchangeable as regards said openings.

8. In a pump of the character described, the combination with a housing providing a reservoir chamber in the upper portion of the housing and incorporating a member in the base portion thereof providing a pumping chamber, said housing being formed with a passage for connecting the bottom of the reservoir chamber with the upper end of said member, a flexible bellows depending within the pumping chamber and having its open top end hermetically sealed to said member in surrounding relation with the passage at the upper end of said member, a reciprocating metering plunger located within the reservoir chamber for subjecting the liquid in the passage and within the bellows to hydraulic pulsations, means for reciprocating the metering plunger whereby to alternately expand and contract the bellows and produce pumping strokes thereof within said pumping chamber, said housing having a plurality of threaded openings in the walls thereof, at least two of said openings being located in approximate horizontal alignment and having communicating relation with the upper end of the pumping chamber, the third opening having location in the base of the housing and also communicating with the

pumping chamber, an inlet valve assembly threaded in one of said first mentioned horizontally aligned openings and thus in communication with the pumping chamber, a discharge valve assembly threaded in the other of said first mentioned horizontally aligned openings and also in communication with the pumping chamber, a threaded nut located within the threaded opening in the base of the housing to close said opening, said valve assemblies each comprising a unitary structure complete in itself, and said assemblies and also the threaded nut having the same external diameter and similar threaded exteriors so that they are all interchangeable as regards said openings.

9. In a pump of the character described, the combination with a housing providing a reservoir chamber in the upper portion of the housing and incorporating a member in the base portion thereof providing a pumping chamber, said housing being formed with a passage for connecting the bottom of the reservoir chamber with the upper end of said member, a flexible bellows depending within the pumping chamber and having its open top end hermetically sealed to said member in surrounding relation with the passage at the upper end of said member, a reciprocating metering plunger located within the reservoir chamber for subjecting the liquid in the passage and within the bellows to hydraulic pulsations, means for reciprocating the metering plunger whereby to alternately expand and contract the bellows and produce pumping strokes thereof within said pumping chamber, said housing having a plurality of threaded openings in the walls thereof, at least two of said openings being located in approximate horizontal alignment and having communicating relation with the upper end of the pumping chamber, the third opening having location in the base of the housing and also communicating with the pumping chamber, an inlet valve assembly threaded in one of said first mentioned horizontally aligned openings and thus in communication with the pumping chamber, a discharge valve assembly threaded in the other of said first mentioned horizontally aligned openings and also in communication with the pumping chamber, a threaded nut located within the threaded opening in the base of the housing to close said opening, said discharge valve assembly projecting exteriorly of the housing, a unitary assembly having connected relation with the said projecting end of the discharge valve assembly and including a cylindrical housing, a gas and vapor venting unit having threaded connection with the cylindrical housing at one end thereof, and a spring-loaded discharge unit located in the opposite end of the said cylindrical housing and communicating with the discharge valve assembly and with the gas and vapor venting unit, said valve assemblies each comprising a unitary structure complete in itself, and said assemblies and also the gas and vapor venting unit and the threaded nut having the same external diameter and similar threaded exteriors so that they are all interchangeable as regards the threaded openings.

10. In a pump, the combination with a housing providing a reservoir chamber in the upper portion thereof and said housing having a central bore extending from the reservoir chamber to the base of the housing, a member located in the base of the bore and providing a pumping chamber open at its top end, a flexible bellows depending within the pumping chamber, a bellows closure element within the pumping chamber at the top end thereof and to which the open end of the bellows is secured, a plunger pumping assembly located in the reservoir chamber in alignment with said bore, said plunger pumping assembly including a reciprocating plunger member for producing hydraulic pulsations to cause the bellows to alternately expand and contract, said housing having openings therein leading to the pumping chamber, an inlet valve assembly and an outlet valve assembly having location respectively in said openings and communicating with the pumping chamber in the vicinity of the bellows closure element, said inlet and outlet valve assembly each comprising a unitary structure complete in itself, said valve assemblies having the same external diameter so that their location within the openings can be reversed, and said assemblies being disposed on a horizontal plane which is approximately level with the bellows closure element, whereby said inlet and outlet valve assemblies communicate with the pumping chamber adjacent the said bellows closure element, and said bellows closure element providing a flow path from inlet to outlet characterized by smooth surfaces of arcuate contour to facilitate flow of fluids having non-condensable gases entrained therein.

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