Jan. 20, 1959 L. H. BROWNE 2,869,468

PUMPS

Original Filed Jan. 10, 1952 3 Sheets-Sheet 1

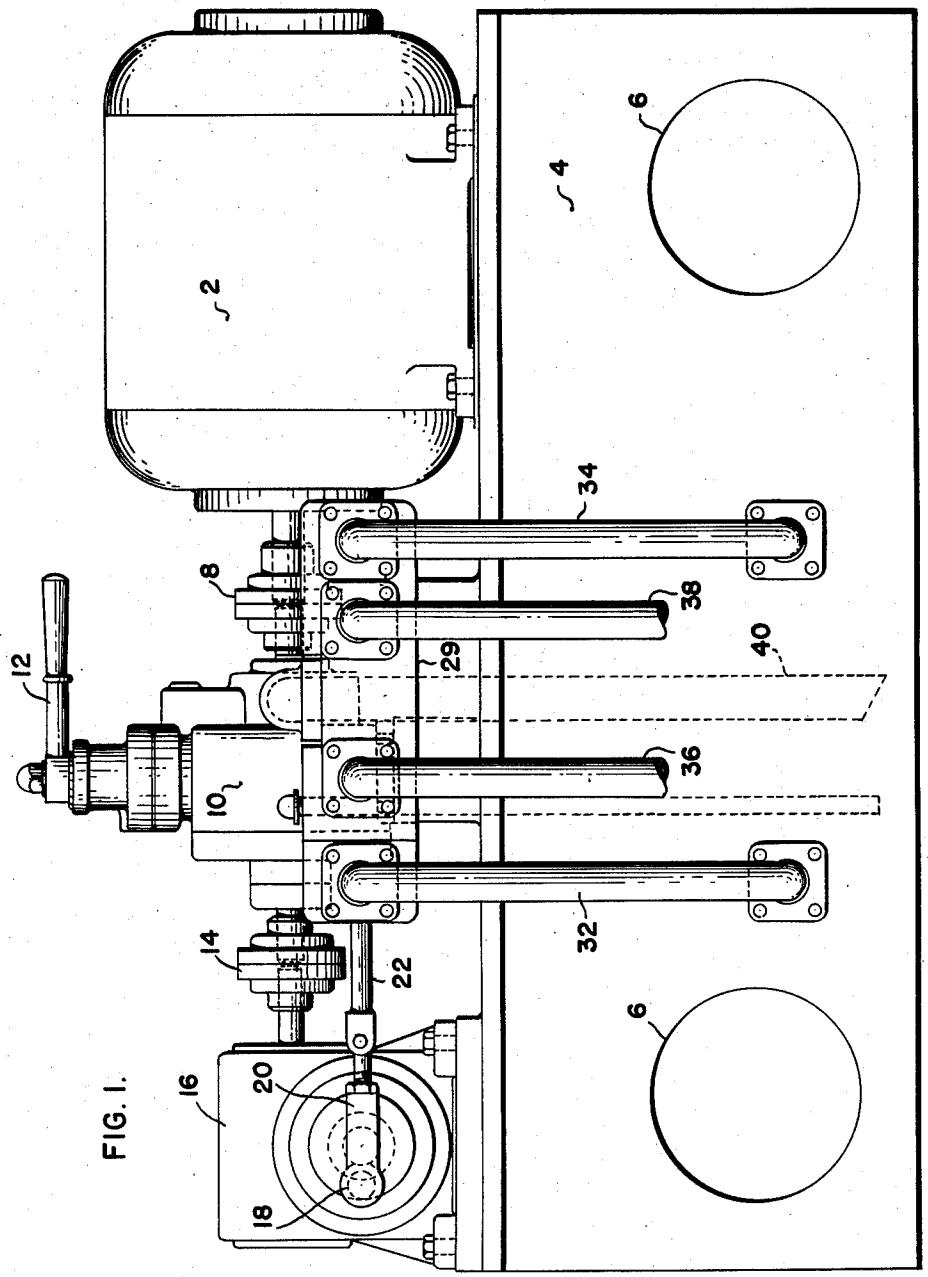


FIG. 1.

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PUMPS

Original Filed Jan. 10, 1952 3 Sheets-Sheet 2

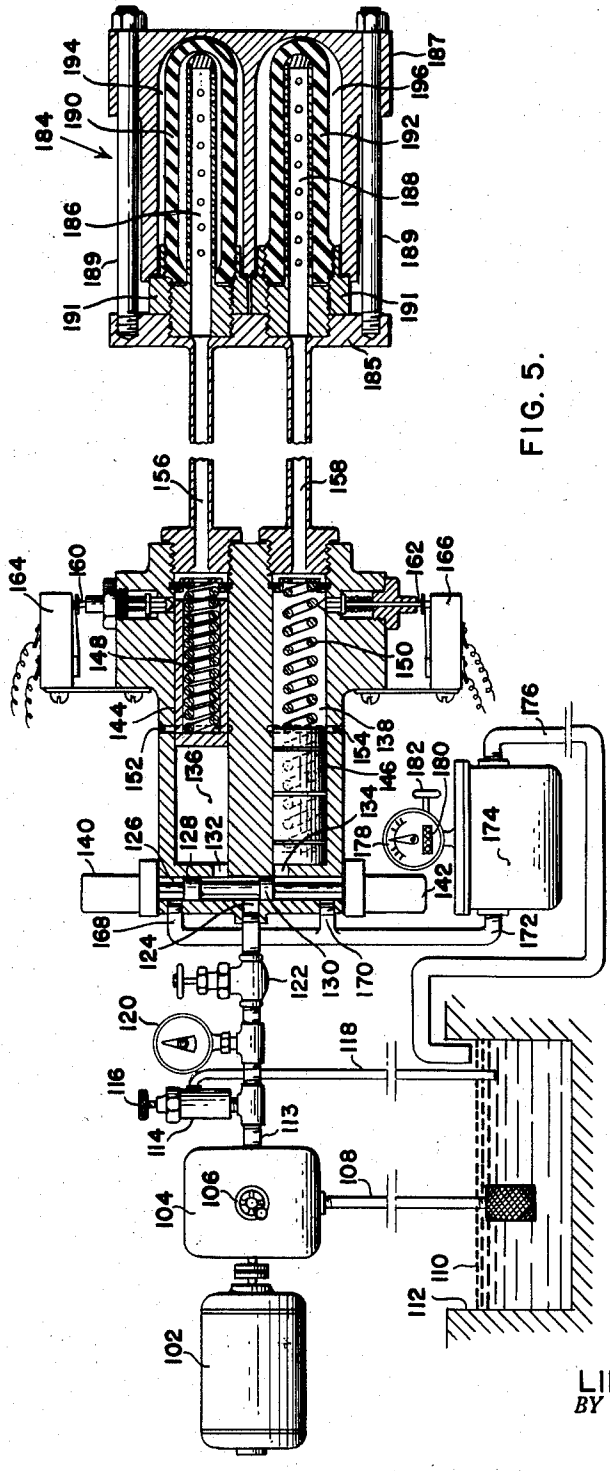


FIG. 5.

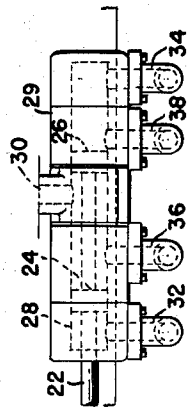


FIG. 2.

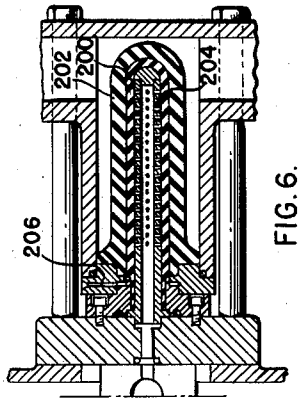


FIG. 6.

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Jan. 20, 1959 L. H. BROWNE 2,869,468

PUMPS

Original Filed Jan. 10, 1952 3 Sheets-Sheet 3

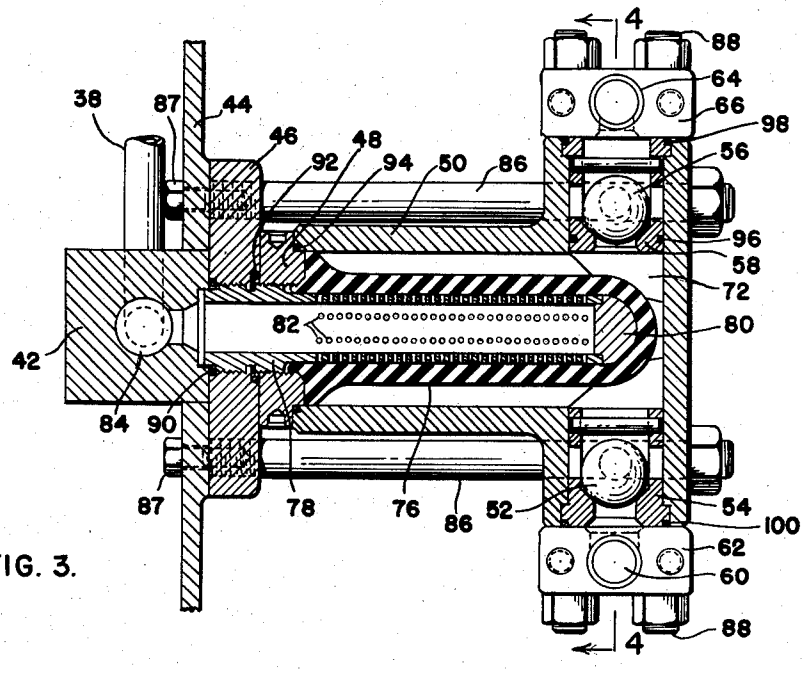


FIG. 3.

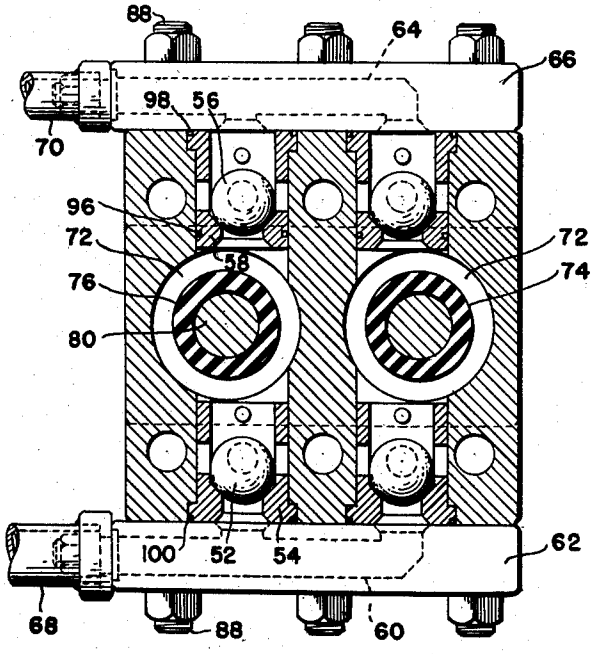


FIG. 4.

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PUMPS

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Continuation of application Serial No. 265,769, January 10, 1952. This application July 14, 1958, Serial No. 748,539

5 Claims. (Cl. 103—44)

This invention relates to pumps and has particular reference to pumps of pulsating type in which an operating liquid is completely isolated from the liquid being pumped.

This application is a continuation of my application, Serial No. 265,769, filed January 10, 1952 now abandoned.

Under many circumstances it is required that a liquid being pumped should be handled under conditions involving no leakage which dictates the avoidance of relatively moving packed parts such as pistons, impeller shafts or the like. In particular such requirements exist when highly corrosive or otherwise dangerous liquids are pumped.

At other times leakage might not be serious, but the requirement is that the pump should handle liquid under sterile conditions so that cleaning may be easily effected, this requirement also generally preventing the use of such packing as would be necessitated by a rotating shaft or a sliding rod in contact with the liquid. In other instances abrasive materials carried by the liquid preclude the use of pumps having movable pistons which must be packed in cylinders.

It is further frequently required that pumps meeting the foregoing conditions must also be positive and capable of delivering liquid at extremely high pressures, for example, for homogenization.

Requirements such as those indicated are met by the type of pump disclosed in my Patent, No. 2,738,731, dated March 20, 1956. In this patent there is disclosed a pump involving the use of elastic thimbles pulsated by control of interior liquid and serving to displace pumped liquid in chambers external to the thimbles.

While the pump described in said patent is usable where small quantities of liquid are to be pumped, the particular structure disclosed does not lend itself to the handling of liquid in large quantities as exemplified by the volumes of liquid which may be required to be handled in oil well drilling or the like. Furthermore, the arrangement disclosed in said application requires the pumped liquid to be brought to the vicinity of the liquid which controls the pumping action by entering and leaving the pulsating thimbles.

The pump of said application delivers the pumped liquid in pulsating condition as contrasted with smooth flow, though the pulsations may be substantially reduced by utilizing a plurality of pulsating members operating out of phase.

The objects of the present invention relate to improvement of the type of pump disclosed in said prior application. One of the objects of the invention is to provide a pump which may handle very large quantities of liquid. In attainment of this object the invention provides for the use of a conventional type of pump for handling the driving liquid. Such a pump may be provided so as to have a substantially continuous delivery of driving liquid, and furthermore, the rate of such delivery may be adjusted either manually or automatically. As will appear

hereafter, the fact that the driving liquid may be supplied at a uniform rate gives rise to a similar uniform flow condition of the pumped liquid despite the fact that a pulsating driving arrangement is provided.

Furthermore, in accordance with the present improvements, the pump is of a type in which the pumped liquid may be remote from the driving pump arrangement to the end that the pumped liquid may be completely isolated under conditions, for example, where safety so dictates.

In common with the pump described in my prior patent, the parts which come in contact with the pumped liquid are readily accessible for cleaning, replacement or repair.

The foregoing and other objects particularly relating to details of construction and operation will become apparent from the following description read in conjunction with the accompanying drawings, in which:

Figure 1 is an elevation showing the driving devices for a preferred type of pump provided in accordance with the invention;

Figure 2 is a fragmentary plan view indicating a control valve arrangement shown only in exterior view in Figure 1;

Figure 3 is a vertical section showing a pulsating member and its associated parts;

Figure 4 is a vertical section taken on the plane the trace of which is indicated at 4—4 in Figure 3, showing in particular two associated pulsating members and their associated parts;

Figure 5 is a diagrammatic view partly in section showing a modified arrangement provided in accordance with the present invention; and

Figure 6 is a fragmentary section showing a double walled pulsator which may be used in accordance with the invention.

Referring first to Figure 1, there is indicated at 2 a driving motor which is shown as mounted upon a driving liquid supply tank 4 provided with cleaning openings 6 which would normally be closed by plugs. The tank 4, however, may be remote from the motor and the other mechanical parts if desired. Usually a suitable oil would be desirably used as the driving liquid and in what follows the assumption will be made that the driving liquid is an oil having good lubricating qualities.

The motor 2 drives through a coupling 8, a pump 10 which may be of any of a large variety of positive types. It has been found, for example, that one highly satisfactory form of pump is of multiple piston, variable delivery type, which is capable of providing an output reasonably continuous and free from pulsation. In such a pump, for example, variation of displacement from zero to some maximum capacity may be controlled by an adjusting device manually operable by a handle such as 12 though in other forms of the same pump the adjustment may be automatically controlled either pneumatically or electrically. Rotary piston or other types of positive variable delivery pumps may also be used. The particular driving pump here used does not in itself constitute a part of the invention, the invention being concerned only with the use of a positive pump desirably having substantially uniform displacement and, under some circumstances, desirably adjustable as to delivery rate.

The shaft of pump 10 is continued to drive through coupling 14, a reduction gear arrangement 16, the output crank 18 of which is connected by a link 20 to the slide rod 22 of a control valve located within a housing 29. Reference to Figure 2 will show the nature of the control valve. The rod 22 passing through suitable packing (not shown) carries a pair of pistons 24 and 26 slidable in a cylinder 28 within the housing 29. The pump 10 delivers its driving liquid through a passage 30

to the cylinder 28. Liquid return connections 32 and 34 connect the ends of the cylinder 28 to the supply tank 4. Connecting pipes 36 and 38 communicate with the cylinder 28 through ports and serve as will presently appear to deliver driving liquid to the pulsating assemblies which may be remotely located. The pump 10 receives its liquid from the supply tank 4 through pipe 40.

Referring now to Figures 3 and 4, there may be provided, remote from the devices illustrated in Figure 1, a block 42 secured to a mounting plate 44 and assembled with the pulsating devices. A plate 46, a pair of plates 48, and a casting 50 are held in assembled relationship as will be described in greater detail hereafter. The casting 50 is provided with a pair of cylinders 72, and associated with each of these cylinders is an intake and an outlet valve arrangement. Each inlet valve comprises the simple arrangement of a ball 52 and a seat 54 while each outlet valve arrangement comprises a ball 56 and a seat 58. Desirably, these valves are as simple as possible and the ball and seat arrangements indicated are highly satisfactory for the valve control. An inlet header passage 60 provided in a block 62 communicates with the undersides of the inlet valves while an outlet header 64 provided in a block 66 provides connection to the outlet sides of the outlet or delivery valves.

Inlet lines 68 and outlet line 70 for the pumped liquid communicate with the manifold passages 60 and 64, respectively.

The chambers 72 contain the pulsators 74 and 76 in the form of thimbles of rubber which may be natural rubber or, more usually desirable, synthetic rubber which will not be affected by either the oil used as the driving fluid or by the pumped fluid. The choice of the particular rubber depends upon considerations of these fluids. Each of the rubber thimbles is secured to a plate or disc 48 and receives a tubular metallic filler 78 to which the plate 48 is threaded. Each tube 78 is threaded into the plate 46.

Each of the tubes 73 is preferably provided at its outer end with a rounded plug 80 and is radially perforated with a large number of holes 82. The use of a filler tube 78 is important to limit the inward movements of the walls of the elastic thimbles. These thimbles furthermore are of such wall thickness and initial construction that of their own resilience they will contract to engage the exterior of the fillers despite a gradient of pressure from inside to outside exceeding atmospheric pressure. The reason for this, as will more fully appear hereafter, is to insure that under conditions of possible sticking of the inlet valves, the thimbles will return to initial condition tightly embracing the filler members during the pressure relief phase of the interior of the thimbles. The filler 78 should slightly distend the thimble for entrance therein.

Passages 84 in block 42 respectively connect the interiors of the thimbles 74 and 76 with the supply pipes 38 and 36.

The casting 50, plates 48 and plates 46 are clamped together by bolts 86 and plate 46 is clamped to plate 44 by bolts 87. The blocks 66 and 62 are secured to casting 50 by bolts indicated at 88. Liquid-tight seals for withstanding high pressure are provided by O rings at 90, 92, 94, 96, 98 and 100, the last three serving to provide packings for the valve seat assemblies.

The operation of the pump may now be described as follows:

The pump 10 delivers an adjustable flow of driving liquid from the tank 4 to the cylinder 28 through connection 30. The pistons 24 and 26 are so arranged that whenever the port at 36 is cut off from the inlet passage 30 the port at 38 is open to the inlet passage and vice versa. Desirably, the combined port areas at 36 and 38 are approximately constant at all times to avoid throttling of the driving liquid. The result is that flow through the passage 30 is continuous, at any rate to the same extent as the flow from the pump is continuous. The pistons 24 and 26 may be somewhat greater in axial extent than the ports which they control, this meaning only that there is a slight interval between inflation and deflation of the thimbles.

It will be evident that when the port corresponding to one of the thimbles is open to the supply, liquid will enter the thimble causing it to expand and correspondingly displace the liquid being pumped in its chamber. Then when its port is closed, the expansion is momentarily maintained until the port is opened when the liquid within the thimble discharges through its corresponding passage 32 or 34 to the tank and liquid is drawn into the corresponding cylinder by reason of the resilience of the thimble causing it to return to its position tightly embracing the filler 78. It is the condition thus arising which requires that the thimble should have sufficient resilience to collapse under full atmospheric pressure existing between its interior and exterior. The thimble, however, will never be subjected to excessive external pressure after collapse so long as the discharge valve 56 does not leak. In the event, however, that this does occur and high pressure is exerted from the discharge connections on the exterior of a thimble, the passages 82 in the filler 78 are so small that the material of the thimbles will not be extruded into these passages. Nevertheless, sufficient passages are provided so that liquid may freely enter the interior of the thimble to expand it. It may be here noted that during a thimble-expanding phase of a cycle, the pressure gradient across the thimble is never greater than that due to the resilience of the thimble material itself, and consequently there is no tendency for the thimble to rupture. It may also be noted that, while rubber, both synthetic and natural, is distortable, it is quite incompressible, so that volume changes in a thick thimble do not affect the relative displacements of the interior and exterior spaces.

While due to the valve action, the thimbles pulsate, approximately alternately, except for the intervals during which a thimble may be cut off by the valve from both inlet and outlet of the driving liquid, the total displacement of liquid appearing in the discharge connection 64 is constantly almost precisely equal to the displacement of liquid through the inlet passage 30. The only deviation from equality is due to slight leakage which may occur in the valve past the pistons 24 and 26. Reference to the total flow is made since it is also possible that for short instants both thimbles could be receiving liquid due to the fact that one of them might be opened to the inlet slightly before the other was closed. In any event, it will be evident that if the inlet flow through 30 is at a constant rate, the outlet flow of pumped liquid through 70 will also be at a constant rate and, except for leakage, equal to the inlet flow through 30.

Thus it follows that though pulsations of the thimbles exist, the pump delivers essentially smooth flow.

So far as variation in flow rate is concerned, it may be noted that, assuming the motor speed constant, the number of pulsations in a given time is constant but variation of volume is secured corresponding to that of pump 10 by less volumetric displacement of each thimble during a single pulsation cycle. The arrangement must, of course, be so designed that for maximum pumping rate at the pulsation frequency used the volumetric displacement of a thimble will not be greater than a permissible maximum limited by engagement of the expanded thimble with any wall portions of its chamber.

It is frequently impossible to measure pressure of a pumped liquid due to the fact that the liquid, owing to its corrosive nature, sediment content or the like, must not be permitted to enter a pressure gauge. In the case of the present pump, it will be evident that a pressure gauge may be connected to the passage 30 and will effectively indicate the pressure of the pumped liquid

except for the pressure representative of the tendency of the thimbles to contract. This pressure while exceeding atmospheric pressure as above noted will generally be a negligible percentage of the discharge pressure in a pump of this type, the discharge pressure being normally upwards of 100 pounds per square inch. Even if lower pressures are delivered, however, the pressure differential due to resilience of the thimbles may be taken into account in making a pressure reading.

The possibility of remoteness of the assembly of Figures 3 and 4 from the assembly of Figure 1 will be evident since the connecting lines 36 and 38 may be of any desired length. Thus where required, a dangerous liquid may be kept far away form the position where the mechanical operating parts are located or the operator is located. On the other hand, the connections 36 and 38 may be reduced to the extent that the assembly of Figures 3 and 4 may be mounted directly on the valve housing 29.

The assembly details of Figures 3 and 4 will reveal that under conditions where cleaning is required the thimble assemblies may be readily taken apart. Furthermore, they contain a minimum number of elements which may be easily cleaned. This is particularly important in the handling of food materials or of other materials contamination of which is to be prevented.

It will be clear that the pump may handle abrasive materials. The thimbles themselves are highly resistant to abrasion. The inlet and outlet valves and their seats may be made of abrasion-resistant materials such as nylon or other synthetic plastics or compositions. The same remarks apply to the handling or corrosive liquids. The metallic parts exposed to the liquid may be formed of stainless steel or other corrosion-resistant materials.

Reference may now be made to Figure 5 which shows an alternative embodiment of the invention. A motor 102 drives a pump 104 which may be of the same type as pump 10 referred to above, its displacement being adjustable by means of a crank or lever 106. This pump receives driving liquid through connection 108 from the supply sump 112. The pump 104 delivers its discharge through connection 113 to a pressure limiting valve 114 adjustable by means of a knob 116 and bypassing liquid to the sump through connection 118 if the pressure exceeds a predetermined set amount. A similar safety arrangement may, of course, be provided in the arrangement of Figure 1.

A pressure gauge 120 is connected to the discharge line and, as will be evident, will give a reading which is essentially equal to the pressure of the ultimately pumped liquid. A shutoff valve 122 may be provided the object of which is to permit preadjustment of the setting at which relief valve 114 will bypass liquid, the valve 122 being closed while such preadjustment is made. This preadjustment limits the maximum pressure of delivery of the pumped liquid. The driving liquid is delivered through port 124 to the cylinder 126 of a control valve provided with pistons 128 and 130 serving to control flow through ports 132 and 134. These ports communicate with cylinders 136 and 138 in which are located pistons 144 and 146 urged outwardly by springs 148 and 150. At the outer ends of their strokes these pistons uncover ports 152 and 154 which are desirably submerged in a second driving liquid which, as will appear, is forced by pistons 144 and 146 through tubes 156 and 158. Follower members 160 and 162 in the form of plungers which may be moved outwardly by the pistons 144 and 146 in their extreme inner positions control switches 164 and 166 which in turn control the supply of current to solenoids 140 and 142 controlling movements of the liquid distributing valve. This arrangement provides for rapid movements of the valve between its extreme positions. Discharge from the ends of the valve cylinder takes place through connections 168, 170 and 172 to a meter 174 which measures volume of liquid,

giving indications on a dial 180 to measure either total volume of liquid or rate of flow of liquid, the meter being resettable through a knob 182. Liquid from the meter is discharged through connection 176 to the supply sump. Connections 156 and 158 lead to a pulsator assembly 184 which may be similar to or identical with that shown in Figures 3 and 4. In this case the plate 185 has clamped thereto the plates or discs 191 and the casting 187 under the action of bolts 189. The chambers 194 and 196 enclose thimbles 190 and 192 of the type previously described secured to the plates 191. Fillers 186 and 188 provided with perforations correspond to filler 78.

In this modification it will be noted that there are primary and secondary driving liquids which may be of the same type but which are essentially separate from the standpoint of operation. The primary liquid acts upon the pistons 144 and 146 to drive the secondary liquid for expansion of the thimbles. Upon each outward stroke of a piston such as 144 the corresponding port 15 is uncovered and then as inward movement of the piston takes place a definite volume of liquid is trapped and transmitted to the corresponding thimble. Thus the thimbles receive equal displacements during each cycle as contrasted with the variable displacements of the modification first discussed. The total delivered volume then depends upon the number of cycles per unit time, this number being controlled by the intervals between outward and inward positions of the pistons, it being noted that the valve which controls the primary driving fluid is shifted by the displacements of the pistons to their outer positions where they control the switches 164 and 166. It will be evident that in this modification, as in the first one described, the displacement of the pumped liquid will be essentially constant so long as the supply is constant, and pulsations will not appear in the delivery of pumped liquid even though the thimbles have a pulsating action. As to the matter of remoteness, it will be evident that the connection running from the pump 104 may be elongated at any portion of its length to provide spacing between the central assembly of Figure 5 and the pump 104 and its associated parts, or alternatively, the lines 156 and 158 may be of any desired length. The arrangement of this figure is particularly desirable where very considerable isolation is desired since it will be noted that while the cylinders communicate with a supply through immersion and the ports 152 and 154, the cylinders 138 and 136 will contain throughout a long period essentially the same liquid. This modification of Figure 5 need not be described in greater detail since so far as advantages are concerned it has essentially those of the modification first detailed.

Under some circumstances it is extremely important to insure that rupture of a thimble should be immediately detected. For this purpose there may be provided the arrangement illustrated in Figure 6 in which the single thimbles previously described are replaced by a pair of nested thimbles 200 and 202 the inner of which embraces a perforated filler 204. The two thimbles normally act as a single one. The space between them communicates with an outlet passage 206 which may be connected to a sight device to indicate any leakage by the presence of liquid flowing therethrough. An automatic detector for the presence of liquid may of course be here provided. If either the inner or outer thimble should become perforated leakage liquid will appear giving a warning of this condition. The double thimble arrangement of course has the advantage that if one of the nested thimbles breaks the other will at least for a time maintain separation between the driving and pumped liquids.

It will be evident that the invention may be involved in various embodiments within the scope of the appended claims.

What is claimed is:

1. Pumping means comprising a pair of expandible

and contractible members, means providing with said members individual chambers of which said members form wall portions, inlet and outlet valves controlling flow to and from said chambers, and means for supplying liquid to said members on their sides opposite their chambers for expanding them and for releasing liquid therefrom for their contraction, the last named means comprising a positive pump supplying a continuous substantially uniform flow of liquid, a movable valve comprising a pair of spaced connected pistons, a chamber mounting said valve and having a pair of ports located to be covered by said pistons, one port communicating with each of said members, the spacings of said pistons and ports being such that during each movement of the valve one port alone is uncovered, then both ports are simultaneously uncovered, and then the other port alone is uncovered, means for cyclically operating the valve, and connections for delivery of liquid from said pump through the valve and ports to said members, said valve and its operating means effecting a cycle of flow wherein said continuous substantially uniform flow of liquid from the pump is delivered successively to said members individually, when said ports are respectively individually uncovered by their pistons, with delivery thereof simultaneously to both members, when both of said ports are uncovered, between said deliveries to the members individually, the foregoing operation being such that the liquid is supplied at a substantially constant uninterrupted total rate to said members to effect a total volumetric displacement of said members due to their expansions which is substantially constant throughout a complete cycle of operation.

2. Pumping means according to claim 1 in which said members are elongated thimbles surrounded by housings providing said chambers.

3. Pumping means according to claim 1 in which each of said members is contractible due to its resiliency to a predetermined initial condition despite a pressure gradient across it in excess of atmospheric pressure.

4. Pumping means according to claim 1 in which said pump is of adjustable delivery type and in which the cycles of valve operation are of a substantially fixed frequency.

5. Pumping means according to claim 1 in which each of said members has a substantially constant displacement in each of its cycles.

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