

Sept. 13, 1960

W. H. CLANCY

2,952,210

FLUID PUMP

Filed May 15, 1958

2 Sheets-Sheet 1

**Fig. 1**

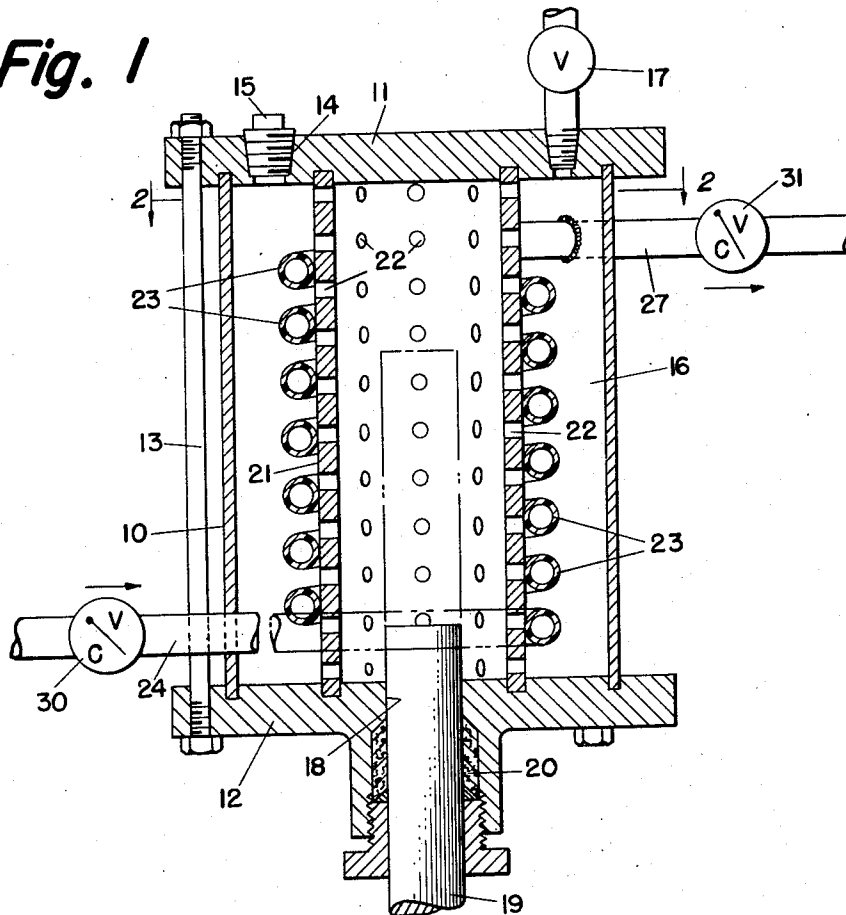
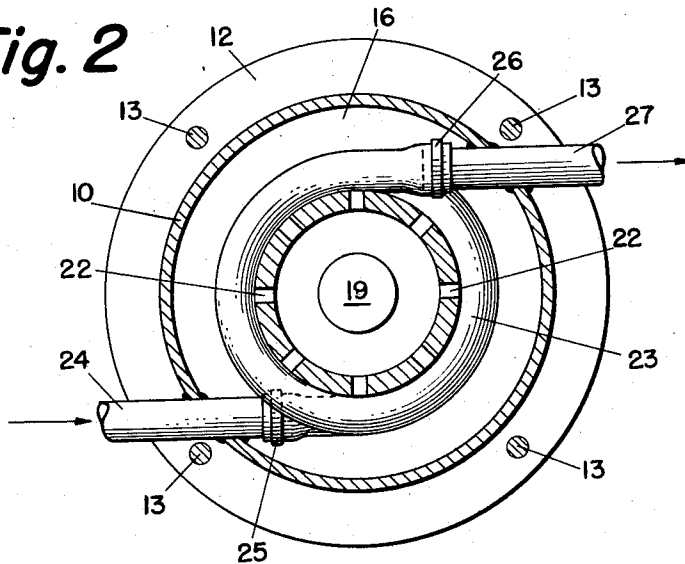


**Fig. 2**



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**Fig. 3**

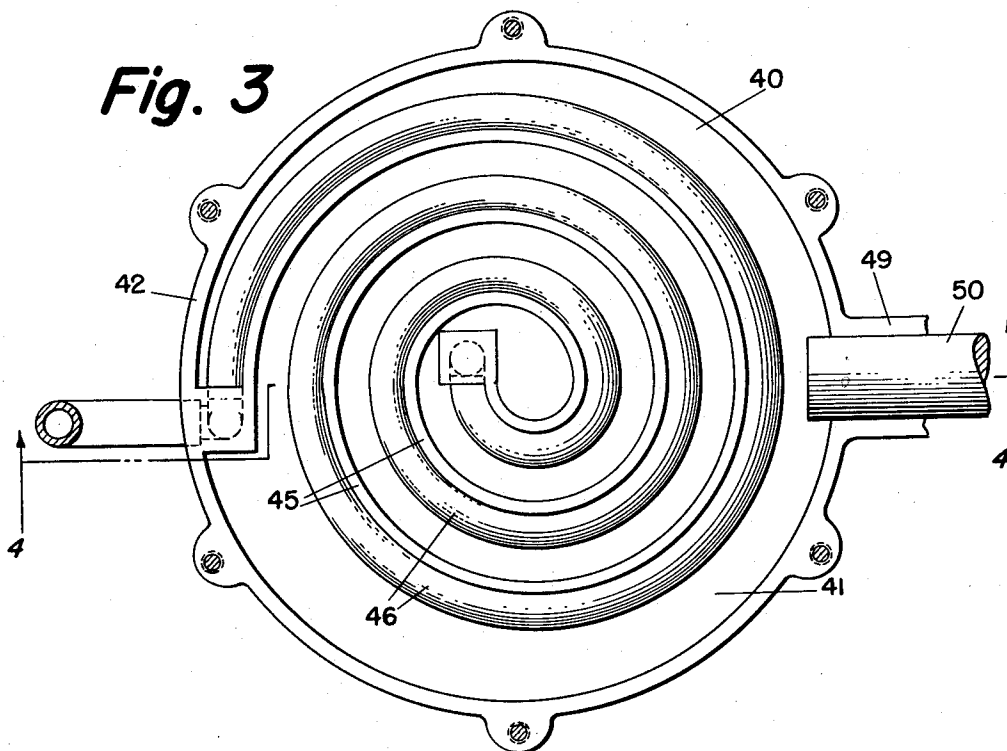
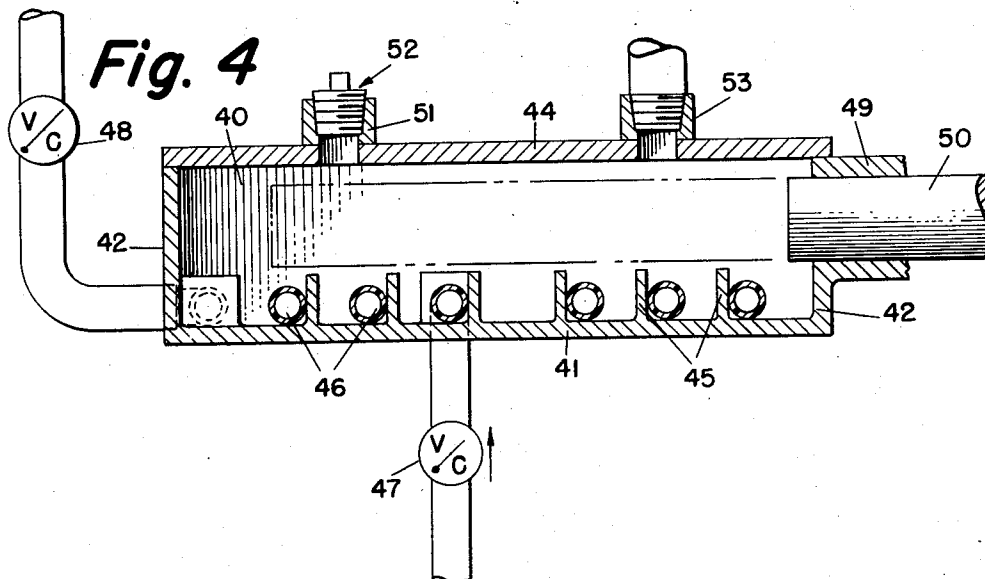


**Fig. 4**



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2,952,210

## FLUID PUMP

William H. Clancy, New Hope, Pa., assignor to Rohm & Haas Company, Philadelphia, Pa., a corporation of Delaware

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5 Claims. (Cl. 103—44)

This invention relates to apparatus particularly adapted to the pumping of fluids, more particularly, to pumps of the type in which the supply fluid is wholly isolated from any part of the pumping mechanism as by the requirements along the flow passage of packing glands, and the like.

It has heretofore been proposed in pumps of the expansion or squeeze type to utilize single lengths of tubing extending through a flow-sealed chamber, the pressure of which is alternately increased and decreased to produce a pumping action. Such pumps have limited output per stroke unless there be a relatively large movement of the walls of the squeeze tube. When there is a large movement, such tubing is subjected to stress and strain of large magnitude tending to decrease its life.

In accordance with the present invention, a flexible-walled tubular member having a plurality of turns is spirally disposed within a closed chamber filled with a fluid medium. By periodically increasing and decreasing the pressure applied to the fluid medium, the volume of the tube is alternately increased and decreased for forced displacement of supply fluid therethrough. In a preferred form of the invention the closed chamber is filled with an incompressible liquid. The tubular member is expansible and contractable. It has a length materially greater than the maximum dimension of the closed chamber and is circuitously disposed therein. Check valves are associated with the inlet and outlet of the tubular member for unidirectional flow of the supply liquid therethrough. A plunger is reciprocated into and out of the incompressible liquid through fluid-tight packing glands. As the plunger moves inwardly it decreases the volume of the closed chamber and, as a result of the rise of pressure on the incompressible liquid, causes the volume of the tubular member to decrease as by change in the cross-sectional area thereof. The extent of change in shape of the tube need not be very great with a plurality of turns thereof in order to displace substantial quantities of supply liquid therein during each reciprocation of the plunger. Since the plunger changes the pressure on the tubing by way of the incompressible liquid, there is a direct relationship between the movement of the plunger and the amount of liquid displaced or pumped per stroke. Thus the device lends itself to metering applications where precision in flow is important.

By making the tubular member thin-walled and of substantial diameter it lends itself to the pumping of slurries and other semi-viscous materials which offer considerable difficulty with controlled volume pumps of conventional design.

Apparatus embodying the invention is quite versatile in that a tubular member may be readily cleaned or a second tubular member substituted when it is desired to change from one fluid to another without the possibility of mixture of any residual part of one with the other.

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Embodiments of my invention are disclosed in the accompanying drawings, wherein:

Fig. 1 is a sectional view of one form of apparatus within the scope thereof;

Fig. 2 is a transverse section taken in the direction of the arrows on line 2—2 of Fig. 1;

Fig. 3 is a plan view of a second embodiment with the top removed; and

Fig. 4 is a transverse section taken in the direction of the arrows on line 4—4 of Fig. 3 with the top in place.

In the embodiment shown in Figs. 1 and 2, 10 is a cylinder provided with end walls 11 and 12 held in fluid-tight engagement with the ends of the cylinder by tie rods 13 to form a chamber 16. The end wall 11 is provided with an outlet 14 and plug 15 therefor, such outlet permitting fluid to be introduced into the chamber 16. End wall 11 is also provided with an inlet which through valve 17 is adapted to be connected to a make-up reservoir (not shown).

End wall 12 contains an aperture 18 located centrally thereof through which passes a piston 19. The piston is held in fluid-tight engagement with the walls of the aperture, a packing gland 20 being provided for this purpose.

A second cylinder 21 provided with a plurality of apertures 22 is located within chamber 16, the ends thereof fitting, respectively, into grooves in end walls 11 and 12. Around this second cylinder there is placed a spirally wrapped tubing 23.

The inlet end of the tubing 23 is connected to a metal pipe 24 which extends through the wall of the outer cylinder 10, being welded to the wall thereof. The inlet end of the tube 23 is secured to the metal tube 24 by any suitable means providing a fluid-tight connection as, for example, by a hose clamp 25. The outlet end of the tube 23 is similarly fastened by a hose clamp 26 to a metal tube 27 extending through and welded to the wall of the outer cylinder 10.

Since the closed chamber is formed by a removable end wall 11, access may be had to the hose clamps 25 and 26 for tightening and loosening them so that the coil 23 may be replaced when desired. It is to be further noted that the assembly as shown in Figs. 1 and 2 may, as a whole, be replaced by another assembly to function with the plunger or piston 19 driven by suitable reciprocation means, preferably with adjustable stroke provisions. One form of such a mechanism is shown in United States Patent No. 2,587,395 to Sheen.

The metal tube ends 24 and 27, to which the ends of tubing 23 are clamped, are provided, respectively, with check valves 30 and 31, so that fluid flow through the tubing is permitted in the direction shown by the arrows in Figs. 1 and 2 but is prevented from flowing in the reverse direction.

Tubing 23 is of flexible material. For example, it may be of natural or synthetic rubber, of thin-walled stainless metal, or of any of the synthetic materials from which flexible-walled tubing can be formed. Depending upon the character of fluid with which the tubing will come into contact in normal operation, the kind of flexible material of which it is formed will be so chosen to be inert to the fluid being pumped and be such as will withstand undue deterioration in operation.

In the modification shown in Figs. 3 and 4, 40 designates a chamber having bottom wall 41, circular end wall 42, and top wall 44. The bottom wall 41 has a spiral flange 45 extending into chamber 40 and in contact with one side of said flange there is placed a spirally disposed tube 46. The ends of tube 46 extend through apertures in the bottom wall 41 and end wall 42, respectively, in

fluid-tight relation with said apertures. Each end of tube 46 is provided with a check valve, respectively designated 47 and 48, to permit flow of fluid in the direction indicated by the arrows.

End wall 42 is apertured to provide a passage 49 for piston 50. The piston is reciprocated by any suitable source of power, as is well understood in the art.

The top wall 44 is provided with outlet 51 having removable plug 52 to permit fluid to be introduced into the system and with outlet 53 adapted to be connected with a make-up reservoir (not shown).

In each of the embodiments described above, as is evident, there is a closed system in which the tubing is surrounded by fluid, either gaseous or liquid.

For controlled volume pumping, i.e., for a known or linear relationship between extent of movement of the plunger 19 of Fig. 1 and the flow of fluid being pumped through the outlet passage, the rigid-walled chamber 16 will be fully filled with an incompressible liquid such, for example, as water or oil. If the latter, then, for example, of the type used in hydraulic brake systems. When the pumping coil 23 is of the expansible and contractable type, then as the piston is withdrawn from the chamber the partial vacuum resulting distends the cross section of the tubing, drawing fluid within the tubing through the inlet check valve in the direction indicated by the arrows, while at the same time holding the outlet check valve closed, thus filling the distended tubing with fluid to be pumped. When the piston is moved in the reverse direction the resulting pressure applied to the tubing reduces its internal cubical volume, thus forcing fluid within the tubing through the outlet check valve while at the same time maintaining the inlet check valve in closed position.

In a preferred form of the invention, when liquid is being pumped, it preferably has a liquid pressure-head adequate to assure the complete filling of the tube and without the need for the development of partial vacuum each time the plunger 19 is moved outwardly of the chamber 16. Accordingly, since the pumping coil 23 is at all times fully filled with liquid the volume of liquid displaced therefrom is always a known and predetermined function of change in volume of the chamber 16 as produced by movement of the plunger 19. The pump lends itself to high pressure and low pressure forced flow of liquids and is likewise applicable to high volume, low pressure displacement of liquids, fluids, slurries and semi-viscous mixtures.

As will be understood by those skilled in the art, instead of a single coil a plurality of spirally wound tubes may be employed, each having an inlet and outlet check valve. In this adaptation several different fluids, each through a separate tubing, may be pumped by means of the single composite fluid-activating assembly. Alternatively, a plurality of spirally wound tubings may be connected in parallel to common headers, one, for instance, at the inlet ends of the tubings and the other at the outlet ends thereof, the inlet and outlet check valves being provided in the respective headers. Several spirally wound tubings connected in series may also be used with check valves at the ends thereof as well as at intermediate points therebetween. When the expression tubing or tubular member is used herein, it is to be understood that it may be of any plane geometric cross section. Such variations and modifications, as come within the scope of the appended claims, are considered a part of this invention.

What I claim is:

1. Pumping means comprising a closed chamber filled with a fluid medium, an expansible and contractable tubular member having a plurality of turns spirally dis-

posed within said chamber and having extremities extending through the walls of said chamber in fluid-tight engagement therewith, inlet and outlet valves operatively engaged with said extremities, respectively, means whereby periodically increased and decreased pressure may be applied to the fluid medium within said closed chamber to alternately contract and expand said spirally disposed tubular member throughout the entire length thereof within said chamber, and stationary means within said chamber and in contact with said tubing for holding the latter in its spirally disposed condition.

2. A pump of the controlled volume type comprising a rigid-walled chamber wholly filled with an incompressible liquid, flexible-walled tubing having a length materially greater than the maximum dimension of the chamber and circuitously disposed therein, means including an inlet valve connected to one end of said tubing for flow of supply liquid into one end of said tubing through an inlet passage isolated from said incompressible liquid, means including an outlet valve connected to the other end of said tubing for flow of said supply liquid from the other end of said tubing through an outlet passage isolated from said incompressible liquid, and displaceable means movable into said chamber for decreasing the volume of said chamber for applying uniformly throughout the length and circumference of said tubing immersed within said incompressible liquid the increased pressure due to said movement of said displaceable means to decrease the net volume occupied by said flexible-walled tubing and to force liquid therein outwardly thereof through said outlet passage.

3. A pump of the controlled volume type comprising rigid walls forming a closed chamber filled with an incompressible liquid, a multiple-turn coil of flexible-walled tubing disposed within said closed chamber with the respective ends thereof in flow communication with inlet and outlet passages extending outwardly of said chamber, a plunger, said closed chamber having an opening for entry of said plunger into said chamber, packing means surrounding said plunger and forming a fluid-tight seal therewith, inlet and outlet check valves in said inlet and outlet passages for unidirectional flow of supply liquid through said coil, and means for reciprocating said plunger alternately to increase and to decrease the volume of said chamber to increase and to decrease the pressure applied uniformly throughout the length and circumference of said flexible-walled tubing by said incompressible liquid first to decrease the volume thereof for forced flow of the supply liquid from said inlet passage outwardly through said outlet passage and then to increase said volume to permit flow of additional supply liquid to said coil.

4. The pump of claim 3 in which said coil extends upwardly from the inlet end thereof thereby to avoid gas entrapment in any turn thereof.

5. The pump of claim 3 in which additional coils of flexible-walled tubing are disposed within said closed chamber for forced flow of a plurality of streams upon each reciprocation of said plunger.

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