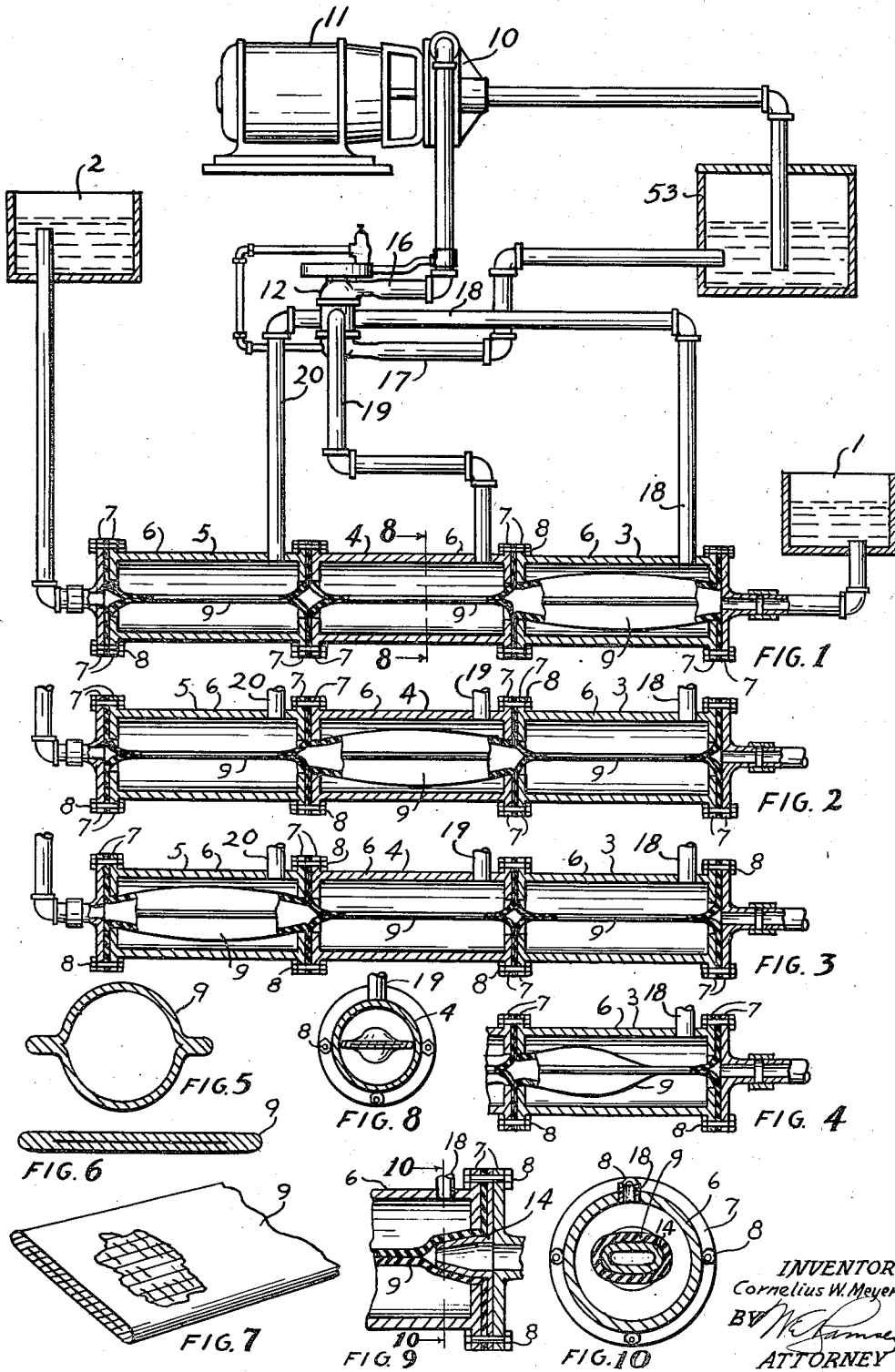


4 Sheets-Sheet 1



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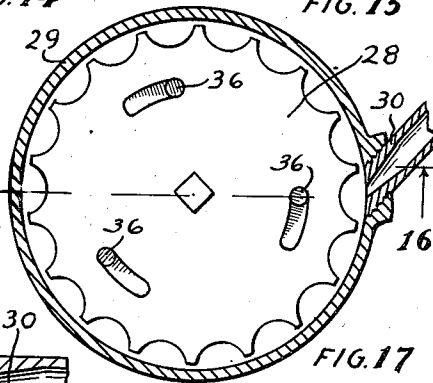
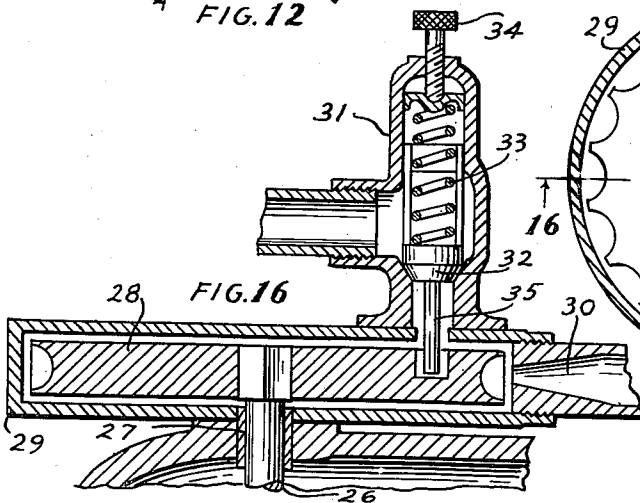
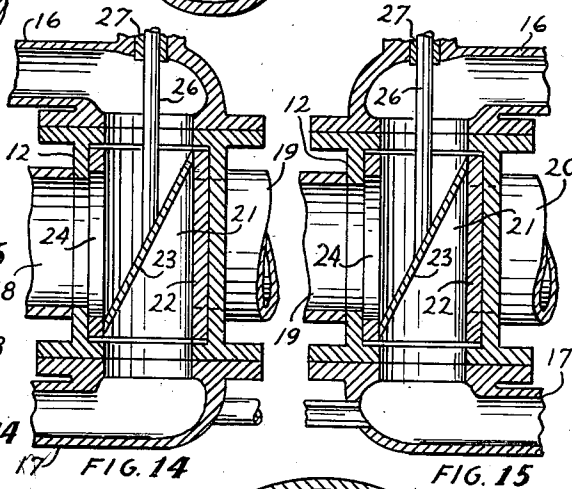
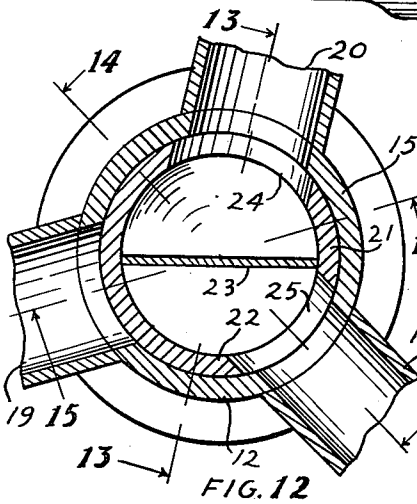
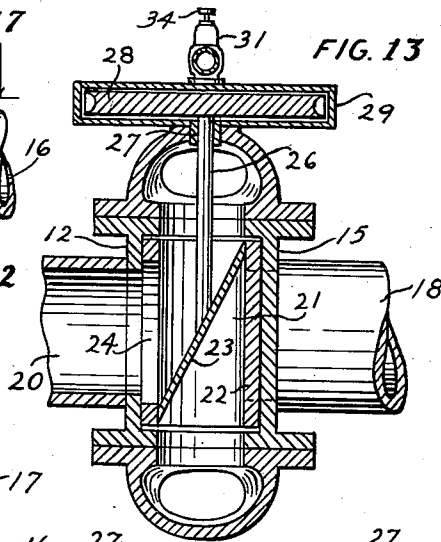
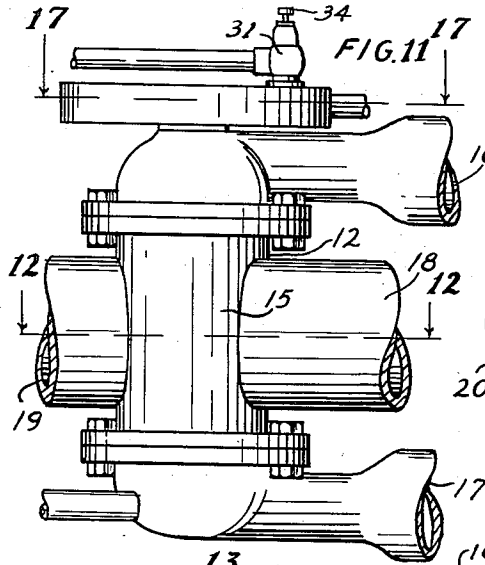
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PUMPING APPARATUS

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4 Sheets-Sheet 2



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PUMPING APPARATUS

Filed April 8, 1940

4 Sheets-Sheet 3

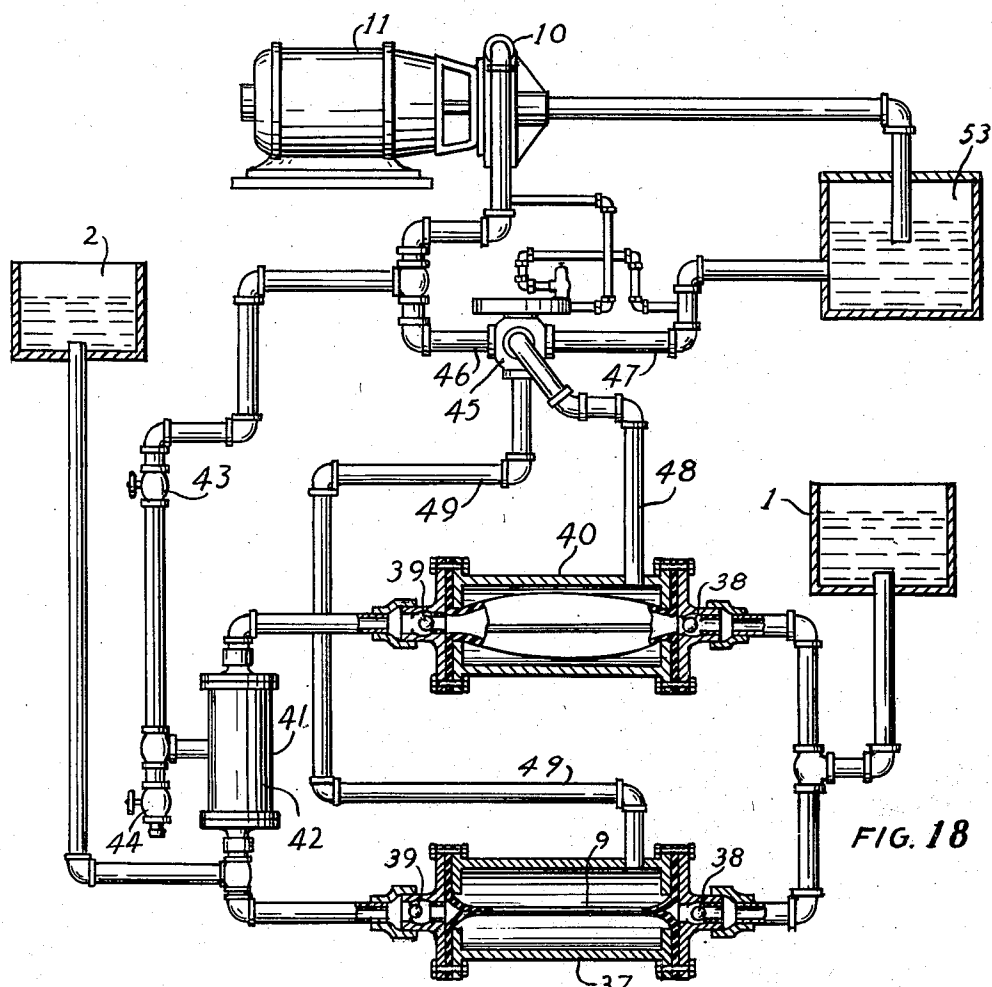
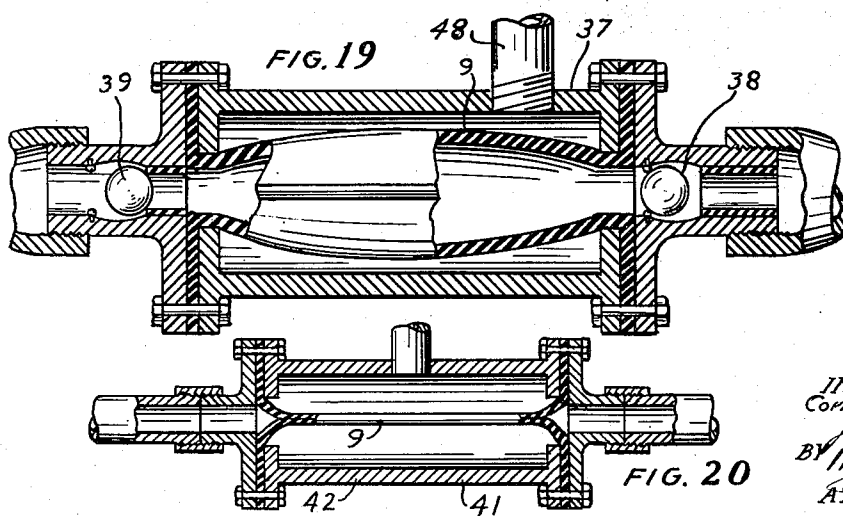


FIG. 18



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4 Sheets-Sheet 4

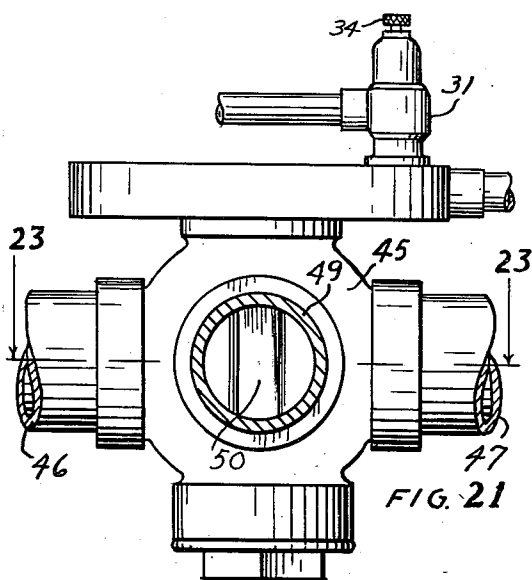


FIG. 21

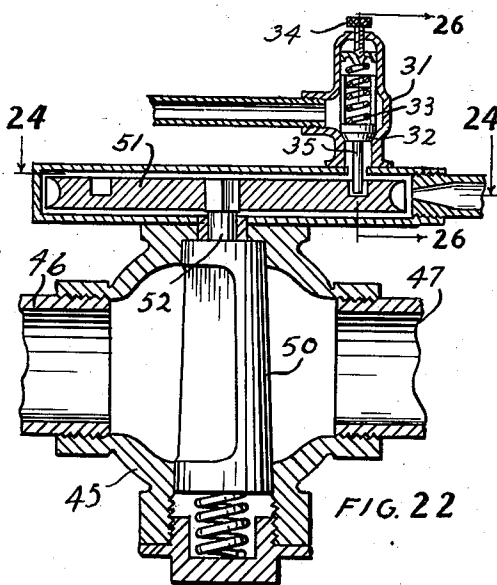


FIG. 22

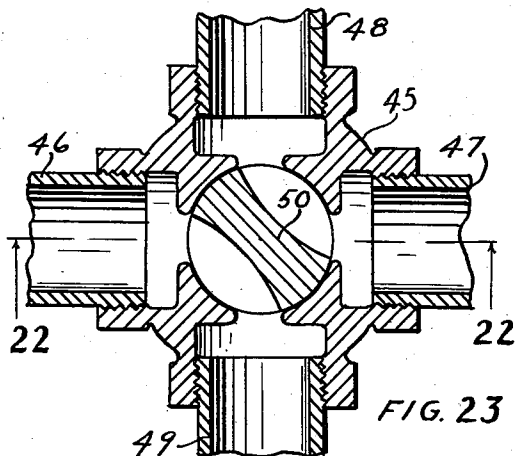


FIG. 23

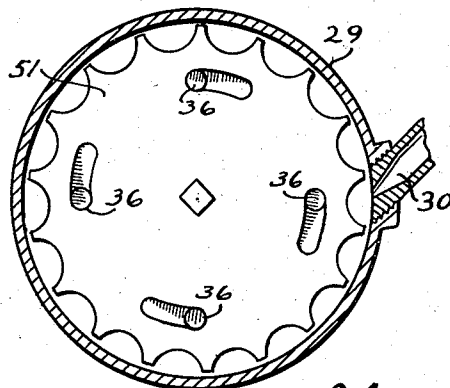


FIG. 24

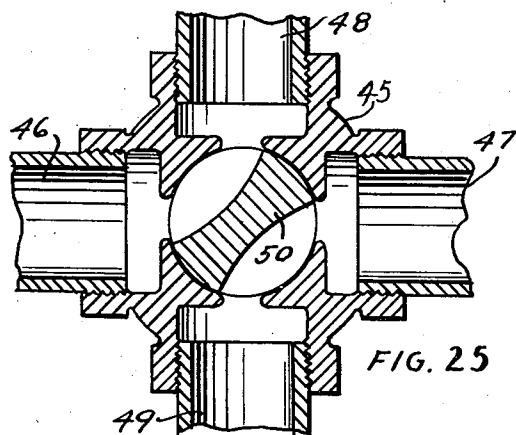


FIG. 25

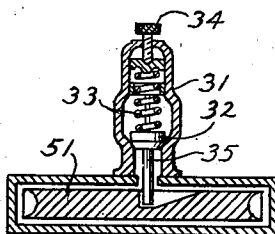


FIG. 26

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UNITED STATES PATENT OFFICE

2,291,912

PUMPING APPARATUS

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Application April 8, 1940, Serial No. 328,417

7 Claims. (Cl. 103—44)

My invention relates to pumping equipment and it relates more particularly to pumping equipment for mines and industrial plants. In this service, it is often necessary to pump corrosive liquids that rapidly damage a pump made of ordinary materials. It has heretofore been necessary to construct such pumps of stainless steel, or some other noncorrodible metal, but this construction is unduly expensive.

In some cases, it is necessary to pump liquids containing grit whose abrasive action effectively grinds away the metal parts with which it comes in contact. In other cases, foamy liquids must be pumped, and they tend to deposit air in the pumping system, interfering with its operation. Liquids to be pumped may contain solid matter, such as gravel or stones, that interfere with the operation of the ordinary pump by preventing the valves closing properly, or the valves may prevent the passing of the solid matter, resulting in clogging of the pump.

The principal object of my invention is to provide a pump that will not be corroded or abraded when it is used for pumping corrosive or gritty liquids. I achieve said object by providing a pump having a flexible walled conduit as an interior lining. Said flexible walled conduit may be made of rubber, or some similar compound, that will resist both abrasion and corrosion.

A further object of my invention is to provide a pump, and a method of operating the same, wherein liquid is forced longitudinally along a flexible walled conduit by hydraulic pressure progressively applied thereto. Check valves are thus rendered unnecessary, and solid matter up to the size of the conduit may readily be pumped.

A further object of my invention is to provide a shutoff valve for pumping units of the type herein described. Said shutoff valve will be subject to the same abrasive and corrosive action as said pumps, and it must be adapted to seat properly notwithstanding the presence of solid matter in the liquid being pumped. I achieve said object by providing a flexible walled conduit adapted to be closed and held by hydraulic pressure.

A further object of my invention is to provide a flexible walled conduit for a pumping cylinder, or for a shutoff valve, that will not crack under repeated applications of pressure sufficient to wholly close the lumen of said conduit. I achieve said result by forming said conduit of two sheets of flexible material laid one upon the other and fastened together along their edges.

There will thus be no bending of the flexible material when said conduit is completely flattened by compression, and the bending will not be acute when the conduit is filled.

A further object of my invention is to provide a flexible walled conduit for a pumping cylinder, or for a shutoff valve, that will not stretch materially lengthwise under substantial pressures of the liquid being pumped. The flexible walled conduits herein described will not be distorted appreciably by the pressure normal to their surfaces, since said pressure will be opposed by an equal and opposite pressure on the opposite surface. They will tend to be stretched, however, longitudinally, and I prefer to prevent said stretching, or at least minimize it, by embedding reinforcing material in the flexible walls.

Other objects of my invention will be disclosed with reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic view, partly in section, of a pumping system embodying my invention;

Fig. 2 is a fragmentary sectional view of a portion of the structure illustrated in Fig. 1, said structure being shown in a different operating position;

Fig. 3 is a view similar to Fig. 2, the structure being shown in a still different, operating position;

Fig. 4 is a fragmentary sectional view of a portion of the structure shown in Fig. 2, said structure being shown in an operating position intermediate those shown in Figs. 1 and 2;

Fig. 5 is an enlarged transverse sectional view of the flexible elements shown in Fig. 1;

Fig. 6 is a view similar to Fig. 5, said flexible element being shown in a different operating position;

Fig. 7 is a fragmentary perspective view of the structure shown in Fig. 6, a portion thereof being shown broken away;

Fig. 8 is a section taken on the line 8—8 in Fig. 1;

Fig. 9 is a fragmentary sectional view of a modification of my invention;

Fig. 10 is a sectional view taken on the line 10—10 in Fig. 9;

Fig. 11 is an enlarged elevational detail view of the control valve mechanism shown in Fig. 1;

Fig. 12 is a section taken on the line 12—12 in Fig. 11;

Fig. 13 is a section taken on the line 13—13 in Fig. 12;

Fig. 14 is a fragmentary section taken on the

line 14—14 in Fig. 12, the rotor thereof being shown in a different operating position;

Fig. 15 is a fragmentary section taken on the line 15—15 in Fig. 12, the rotor thereof being shown in a still different operating position;

Fig. 16 is a section taken on the line 16—16 in Fig. 17;

Fig. 17 is a section taken on the line 17—17 in Fig. 11;

Fig. 18 is a diagrammatic view, partly in section, of a pumping system embodying a modification of my invention;

Fig. 19 is an enlarged sectional detail view of one of the cylinder members shown in Fig. 18;

Fig. 20 is an enlarged sectional detail view of the shutoff valve shown in Fig. 18;

Fig. 21 is an enlarged elevational detail view of the control valve mechanism shown in Fig. 18;

Fig. 22 is a section taken on the line 22—22 in Fig. 23;

Fig. 23 is a section taken on the line 23—23 in Fig. 21;

Fig. 24 is a section taken on the line 24—24 in Fig. 22;

Fig. 25 is a view similar to Fig. 23, the rotor thereof being shown in a different operating position; and

Fig. 26 is a sectional view taken on line 26—26 in Fig. 22.

For the purpose of explaining my invention, assume that liquid is to be pumped from tank 1 to tank 2, shown in Figs. 1 and 18. Three similar cylinders 3, 4, and 5, or any greater number, are connected in tandem. Each of said cylinders comprises a metal body 6 having flanged ends 7 for holding said cylinders together by bolts 8. Said cylinders may be made of some suitable material, such as cast or formed metal. Within each of said cylinders, and secured therein by being clamped between flanged ends 7, is a flexible tube 9 which will be referred to herein as a rubber tube, although it may be made of some other suitable material. For example, when oil is to be pumped, I prefer to use the compound known under the trade name of Neoprene instead of rubber.

Said flexible tubes 9 are preferably formed of two flat sheets of rubber laid one upon the other and vulcanized along their edges, as is shown in Fig. 6. The flexible tube thus formed has seams along its opposite sides, and said seams serve to prevent the sharp bending of the rubber that would otherwise occur when the tube changes from its full condition, shown in Fig. 5, to its flattened condition shown in Fig. 6.

Referring to Fig. 1 it will be seen that the three flexible tubular elements in cylinders 3, 4, and 5 form a continuous passageway which is a part of a conduit connecting tanks 1 and 2. Briefly stated, the function of said flexible tubes is to force liquid from tank 1 to tank 2 by an action closely akin to the peristaltic movement so familiar to physiologists.

To bring about the necessary alternate contractions and relaxations of said flexible tubes, water is alternately forced into and released from metal cylinders 6. Said water will thus surround said flexible tubes and its pressure will cause them to flatten, squeezing the contents of said flexible tubes forward. Centrifugal pump 10 driven by motor 11 is adapted to supply said water under pressure, or to create suction. Considering my invention in its broader aspects, any other devices for forcing a satisfactory fluid pres-

sure into and out of said cylinders might be utilized. Certain phases of my invention are concerned directly with the operating characteristics of the pump and its source of power, however, and these phases are hereinafter described. The structure of the pump and motor is not described in detail, however, because I contemplate the use of only well known forms of pumps and motors.

Water from pump 10, or suction produced thereby, is distributed alternately to cylinders 3, 4 and 5, by means of a control valve 12, hereinafter described. Referring to Fig. 1, said control valve is in such position that pressure has been applied to cylinder 5 to flatten the tube therein, and said pressure is being held by said control valve to maintain said tube in a flattened condition thereby preventing a return flow of liquid from tank 2. Said control valve is also in such position that water is just started to be withdrawn from cylinder 4, the suction of pump 10 being applied thereto. Pressure on cylinder 4 will then be relieved and the tube therein will be ready to receive liquid from the tube in cylinder 3. At the same time, water has just started to be forced into cylinder 3 to compress the flexible tube therein, forcing the liquid content thereof into the tube in cylinder 4. The completion of this operation is illustrated in Fig. 2.

The position of control valve 12 is then changed, by means hereinafter described, and the following conditions exist, as is illustrated in Fig. 3: The pressure on cylinder 5 is released, thereby relaxing the flexible tube therein. Pressure is applied to cylinder 4 to force the liquid therein forward into cylinder 5. Pressure is held on cylinder 3 to flatten the flexible tube therein thereby preventing a reverse flow of liquid.

Control valve 12 is then actuated to apply pressure to cylinder 5 to force the liquid in the flexible tube therein forward toward tank 2. At the same time, pressure is held on cylinder 4 to prevent a reverse flow of liquid, and the pressure on cylinder 3 is released to permit the flexible tube therein to fill from tank 1, this being illustrated in Fig. 1. This completes the cycle of three operations.

As illustrated, tank 1 is above cylinder 3 so that liquid will flow from said tank into said cylinder by gravity. It is not necessary, however, that tank 1 be higher than cylinder 3. When the pressure on cylinder 3 is released, the suction of pump 10 is applied thereto, thus tending to evacuate the space within cylinder 3 surrounding the flexible tube therein. It will be apparent that fluid from tank 1 will be drawn into said flexible tube not only by the force of gravity but also by the pressure of the atmosphere in the well known manner. In other words, water will be sucked into cylinder 3 according to the suction produced by pump 10.

As mentioned, when pressure is applied to cylinder 3, the liquid in the flexible tube therein is forced forward into cylinder 4. No check valve is required to prevent a reverse flow of said liquid. The reason for this phenomenon will be explained with reference to Fig. 4. When water under pressure is first supplied to cylinder 3 through pipe 13, the tube within said cylinder is full and the water pressure is applied uniformly to its surface. Then, when a small amount of liquid is forced back toward tank 1, said tube will assume the shape shown in Fig. 4, the end thereof nearest tank 1 being flattened

first due to the escape of liquid therefrom. Thereafter, the remainder of said tube will be flattened, and its contents forced forward into cylinder 4.

It will be seen that, when the aforesaid pumping system is used to pump liquids under high pressure, that is, when tank 2 is at a high elevation, considerable longitudinal force will be exerted upon the flexible tubes, particularly the one in cylinder 5. I prefer to reinforce said tube by embedding cords or fabric therein, as is shown in Fig. 7, thereby minimizing the tendency of said tube to lengthen under operating forces. To preclude the possibility of said tube puckering and being forced into the pipe at the end of cylinder 3, as it would tend to do in the condition shown in Fig. 4, said cylinder may be provided with a shield 14. (Figs. 9 and 10.) Said shield is somewhat flattened so that the flexible tube will not be forced into the rather narrow opening therein.

I will now describe the control valve which I prefer to use alternately to apply pressure and suction to cylinders 3, 4, and 5. (See Fig. 13.) Said valve comprises a cylinder 15 to which is connected at its upper end a water supply pipe 16, and to which is connected at its lower end a discharge pipe 17. Spaced 120° apart around the periphery of said cylinder, and opening therein, are three pipes 18, 19, and 20 leading to cylinders 3, 4 and 5, respectively.

Within cylinder 15 is a rotor 21 comprising a cylinder 22 having a diagonal partition 23. As is shown in Fig. 13, said partition divides said rotor into two compartments, one connected to water supply pipe 16 and the other to discharge pipe 17. Two ports 24 and 25 extend through the walls of cylinder 22 at each side of partition 23. Said two ports are spaced substantially 120° apart, and are somewhat larger than the openings by which pipes 18, 19, and 20 enter cylinder 15. At the other 120° interval the rotor is imperforate. It will thus be seen that, with rotor 21 turned to a certain position, one of pipes 18, 19, or 20 will be connected to supply pipe 16 thereby to supply water under pressure to the corresponding cylinder 3, 4, or 5. At the same time, another of said pipes will be connected to discharge pipe 17 to remove water from another of said cylinders. At the same time, the third of pipes 18, 19, or 20 will be closed by a blank face of rotor 21 thereby maintaining pressure in one of cylinders 3, 4, or 5.

To achieve the desired result of alternately applying pressure and suction to cylinders 3, 4, and 5, and to maintain pressure on said cylinders during the interval between the application of pressure and the application of vacuum, it is only necessary to rotate rotor 21 one-third of a revolution at the proper times. The timing of the rotation of said rotor, however, is a matter of importance. It is unsatisfactory to cause it to rotate at fixed time intervals because variations in the head to which or from which liquid is pumped, or other variations, may cause the time required to force the liquid out of one of the flexible tubes in cylinders 3, 4, or 5 to vary. It is desirable that rotor 21 be rotated whenever the operation of flattening one of said tubes is completed. I achieve this result by the following means:

A stem 26, which may be welded to partition 23 if desired, extends upwardly from rotor 21 through a packing gland 27 and carries at its upper end impulse wheel 28. Said impulse wheel

is surrounded by a water-tight housing 29, and it is adapted to be actuated by a jet of water from nozzle 30. Operation of said impulse wheel is not controlled by means of a valve in the supply pipe to said nozzle, however; water under pressure is continually supplied to nozzle 30. A relief valve 31 in housing 29 is adapted to serve two purposes. First, it releases water from housing 29 thereby permitting more water to flow through nozzle 30 thus causing impulse wheel 28 to rotate, and, second, it serves as a stop to position rotor 21 properly so that ports 24 and 25 therein register with two of pipes 18, 19, or 20.

Relief valve 31 may be of a well known type, having a valve member 32 held against its seat by spring 33 whose compression is adjustable by means of thumb screw 34. The well known type of relief valve is modified however in that it is provided with a downwardly projecting pin 35 adapted to engage recesses 36 in impulse wheel 28 to stop and hold said wheel.

Water for nozzle 30 is supplied from pump 10. When one of cylinders 3, 4, or 5 is being filled with water to flatten the flexible tube therein, a certain pressure will be produced by said pump. When said flexible tube becomes flattened, the pressure produced by said pump will increase because no water can flow into the cylinder around said tube. I so adjust spring 33 that valve 32 will lift when the pressure from pump 10 increases slightly above that required to flatten the aforesaid flexible tube, that is, valve 32 lifts immediately after said flexible tube is completely flattened. When said valve 32 lifts, water is released from housing 29 and impulse wheel 28 starts to turn due to the inflow of water through nozzle 30, pin 35 being disengaged from impulse wheel 28 when the water pressure within housing 29 increases and lifts valve 32. Valve 32 immediately tends to return to its closed position, however, due to the reduction of water pressure in housing 29. But valve 32 cannot close until impulse wheel 28 has rotated far enough to permit pin 35 to drop into another of recesses 36, that is, until rotor 21 has turned far enough to connect another of cylinders 3, 4, or 5 to pump 10. Thus, when one of cylinders 3, 4, or 5 is filled, control valve 12 automatically connects pump 10 to another cylinder, and the sequence of operations hereinbefore described is continued.

As is shown in Fig. 26, an incline leads to each of recesses 36, so that pin 35 is lowered gradually, thus preventing any tendency to produce water hammer.

The pumping equipment thus far described has the advantage, among others, of presenting a large passageway to solid objects such as stones. Indeed, any stone that will pass through the pipe system will readily pass through the pump, and neither mud nor gravel nor grit will interfere with its operation. This result is due directly to the elimination of check valves, which are rendered unnecessary by the flexible tubes, hereinbefore described, which have the property of unilateral conductivity of liquids. Said flexible tubes have the inherent property of forcing water in the direction of the highest pressure, the end thereof toward the lower pressure quickly flattening.

However, where the pumping of stones or mud or other suspended solids is not required, the following variation of my invention may be utilized: Fig. 18 illustrates structure similar to that shown

in Fig. 1 except that the arrangement of the cylinders is slightly different, and a different type of control valve is illustrated. Cylinder 37 is provided with an inner flexible tube 9 exactly like those used in cylinders 3, 4, and 5. Liquid from tank 1 may flow into said flexible tube by gravity and suction, or by suction alone when suction is applied to cylinder 37. A ball type check valve 38 prevents a reverse flow of said liquid when water under pressure is forced into cylinder 37 to flatten tube 9, thus forcing said liquid forward toward tank 2. When said water is released from cylinder 37, check valve 39 prevents reverse flow of said liquid while flexible tube 9 fills again. Thus, to pump liquid from tank 1 to tank 2, it is only necessary to alternately apply water under pressure to cylinder 37 and to release said water therefrom. The intermediate operation of holding pressure on said cylinder, as described in connection with the apparatus shown in Fig. 1, is thus unnecessary.

To utilize the power supply during the time water is being released from cylinder 37, I prefer to provide another cylinder 40, exactly like cylinder 37 and connected in parallel therewith.

It is frequently desirable to vary the rate at which a pumping system pumps liquid. I find it feasible to do this temporarily by simply shutting off the discharge of one of the cylinders 37 or 40. When most forms of centrifugal pumps are utilized as sources of water pressure, said pumps will merely churn the water, when their discharge is shut off, without using an undue amount of power. It is therefore feasible to temporarily control the output of the pumping system by shutting off the discharge of one cylinder, which in some cases is more convenient than shutting off the intake to said cylinder although the latter method is preferable where the arrangement permits its use. I, therefore, provide a shutoff valve 41 in the discharge pipe of cylinder 40.

Where corrosive liquids are to be pumped, it is a difficult problem to provide a satisfactory shut-off valve, and it is particularly difficult in large installations to provide a shutoff valve that will operate easily. Most power operated valves are too expensive, although they have the advantage of being operable by remote control. I find that I can provide a cheap power operated shutoff valve, and one that may readily be made to resist the corrosive action of acids by utilizing the principle hereinbefore described in connection with pumping cylinders.

Valve 41 comprises a cylinder 42 adapted to receive water under pressure from some suitable source such as pump 10. Said water under pressure may be admitted to cylinder 42 by opening valve 43, and closing valve 44, and it may be released therefrom by closing valve 43 and opening valve 44. Inside cylinder 42, and forming a part of the discharge conduit from cylinder 40, is a flexible tube 9 like those used in the pumping cylinders hereinbefore described. When water under pressure is admitted to cylinder 42, said tube is flattened, stopping the flow of liquid from cylinder 40. Of course, said tube may be only partially flattened to impede, rather than stop, said flow of liquid.

I will now describe the control valve that I prefer to use alternately to apply pressure and suction to cylinders 37 and 40. Control valve 45 (Fig. 21) comprises essentially a two-way valve having pipes 46, 47, 48, and 49 leading thereto. Pipe 46 is the discharge pipe from pump 10. It

may be connected to either pipe 48, to supply water under pressure to cylinder 40, or to pipe 49, to supply water under pressure to cylinder 37, by rotating rotor 50 to either of the positions shown in Figs. 23 and 25. Pipe 47, which is the return pipe to pump 10, will thereby be connected to the cylinder to which water is not supplied under pressure, and from which water is to be released.

I desire to rotate rotor 50 immediately after one of cylinders 37 or 40 becomes full and the pressure therein builds up above that required to flatten the flexible tube therein. I achieve this result by providing an impulse wheel 51 carried by stem 52 of rotor 50. Impulse wheel 51 is like impulse wheel 28 except that it is provided with four recesses 36 instead of three, it being necessary to rotate rotor 50 only one-quarter turn at a time. Impulse wheel 51 is otherwise arranged and connected exactly like impulse wheel 28.

I prefer to provide a tank 53 in the circulating system of pump 10, to provide a reserve or make-up supply of circulating water for operating the pumping cylinders. If liquid is to be lifted by suction by said pumping cylinders, said tank 53 should be closed air tight except for a make-up supply line in order that suction from pump 10 may be applied to said cylinders.

Although I have described my invention in connection with a pumping system for liquids, it will be apparent that it may also be used for pumping gases. It will then be particularly useful where a rather high vacuum is to be produced in which case a large cylinder displacement is required for fast evacuation, or when high pressures are to be attained, it being easier to attain high pressures by a water pump than by an ordinary air pump. Said high water pressure may be applied directly to a rather fragile flexible tube thereby to produce high gas pressure within said tube, since the varying pressures inside and outside said tube will be equalized, that is, the effect of the difference in pressures will merely be alternately to compress and expand the walls of said tube.

An important advantage of the pumping cylinders and shut-off valve hereinbefore described is that no packing gland or stuffing box is required. There is no rod or valve stem leading from the liquid being pumped to some external source of power as in the ordinary pump or valve. This is advantageous in that liquids carrying a large amount of abrasive will quickly cause a packing gland to leak.

Another advantage of my invention arises from the fact that the source of power may be located at a considerable distance from the liquid being pumped. This is particularly advantageous where oil is being pumped. It is not desirable to locate the electric motor or other source of power in a pit because of the danger of fire or explosions. Neither is it desirable to bring the oil pipe to the surface. With the equipment hereinbefore described, the motor or engine may be located on the surface, at a safe distance from the oil, and the pumping cylinders may be placed in a pit where the oil pipe is located.

Although I have shown, in Fig. 1, a single assembly of three pumping cylinders in tandem, it will be understood that a plurality of said assemblies might be connected in parallel for the same purpose that a plurality of cylinders are connected in parallel in the structure shown in Fig. 18, hereinbefore described.

I claim:

1. In a fluid pumping mechanism an elongated casing, a flexible conduit section arranged in said casing and having both of its ends communicating with the exterior of the latter, means for securing the ends of said flexible conduit section with the ends of the casing in which it is arranged, a conduit leading into said casing adapted to admit and withdraw circulating operating fluid from about the exterior of the flexible conduit section and within said casing to collapse and expand, respectively, said flexible conduit section within said casing, and means for causing and regulating the flow of circulating fluid into and out of said casings to produce the alternate collapse and distension of said flexible conduit section thereby to pump fluid through said casing, said flexible conduit section comprising two sheets of normally flat sections of rubbery material joined at their marginal edges to form a laterally extending external seam at each edge.
2. A pumping mechanism comprising three pumping cylinders joined end to end and discharging successively one into another, each pumping cylinder comprising an elongated casing, a flexible conduit section arranged in said casing and having its end joined to the end of said casing, both of the ends of said conduit section opening to the exterior of said casing, each cylinder having an opening leading through said casing and into a space between said casing and the enclosed flexible conduit section to admit and discharge operating fluid for collapsing and distending said flexible conduit section to pump fluid longitudinally of said flexible conduit section, a closed circuit for operating fluid, a pump in said circuit, branch conduits leading to said three pumping cylinders, respectively, and a distributing valve in said circuit for controlling flow to and from each of said branch conduits.
3. A pumping mechanism comprising three pumping cylinders joined end to end and discharging successively one into another, each pumping cylinder comprising an elongated casing, a flexible conduit section arranged in said casing and having its end joined to the end of said casing, both of the ends of said conduit section opening to the exterior of said casing, each cylinder having an opening leading through said casing and into a space between said casing and the enclosed flexible conduit section to admit and discharge operating fluid for collapsing and distending said flexible conduit section to pump fluid longitudinally of said flexible conduit section, a closed circuit for operating fluid, a pump in said circuit, branch conduits leading to said three pumping cylinders, respectively, a distributing valve in said circuit for controlling flow to and from each of said branch conduits, said valve being common to all of said branches and having a discharge port, an intake port and a holding surface for closing off a branch conduit when it registers therewith, and means for actuating said valve to bring said three portions into registry and communicating with each of said branches, successively.
4. A pumping mechanism comprising three pumping cylinders joined end to end and discharging successively one into another, each pumping cylinder comprising an elongated casing, a flexible conduit section arranged in said casing and having its end joined to the end of said casing, both of the ends of said conduit section opening to the exterior of said casing, each cylinder having an opening leading through said casing and into a space between said casing and the enclosed flexible conduit section to admit and discharge operating fluid for collapsing and distending said flexible conduit section to pump fluid longitudinally of said flexible conduit section, a closed circuit for operating fluid, a pump in said circuit, branch conduits leading to said three pumping cylinders, respectively, a distributing valve in said circuit for controlling flow to and from each of said branch conduits, said valve being common to all of said branches and having a discharge port, an intake port and a holding surface for closing off a branch conduit when it registers therewith, and means for actuating said valve to bring said three portions into registry and communicating with each of said branches, successively, said latter means being pressure responsive and adapted to be actuated step by step in the presence of predetermined pressures in said closed circuit.
5. In a fluid pumping mechanism, a plurality of elongated casings joined end to end, a flexible conduit section arranged in each of said casings and having each of its ends communicating with the exterior of the casing and with the flexible conduit section in the adjacent casing, means for securing the ends of each of said flexible conduit sections with the ends of the casing in which it is arranged, a conduit leading into each of said casings adapted to admit and withdraw circulating operating fluid from about the exterior of the flexible conduit section and within said casing, to collapse and expand, respectively, said flexible conduit section within said casing, and means for causing and regulating the flow of circulating fluid into and out of said casings to produce the alternate collapse and distension of said flexible conduit sections thereby to pump fluid serially thru said casings.
6. In a fluid pumping mechanism an elongated casing, a flexible conduit section arranged in said casing and having both of its ends communicating with the exterior of the latter, means for securing the ends of said flexible conduit section to the ends of the casing in which it is arranged, a passageway leading into said casing adapted to admit and withdraw circulating operating fluid from about the exterior of the flexible conduit section and within said casing to collapse and expand, respectively, said flexible conduit section within said casing, and a constantly operated, uni-directional pump and closed circulatory system with which said passageway communicates, a control valve at the point of joinder of said passageway with said circulatory system for regulating the flow of circulating fluid into and out of said casing thru said passageway to produce the alternate collapse and distension of said flexible conduit section thereby to pump fluid thru said casing.
7. Mechanism for pumping fluids including a flexible walled conduit having an encompassing casing for said conduit composed of a plurality of longitudinally spaced chambers and means for filling and exhausting said chambers with an operating liquid, in progressive sequence to produce a moving hydraulic pressure upon the exterior of said conduit, thereby to express the contents of said conduit progressively longitudinally thereof.

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