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FLUID PUMPING OR FEEDING DEVICE

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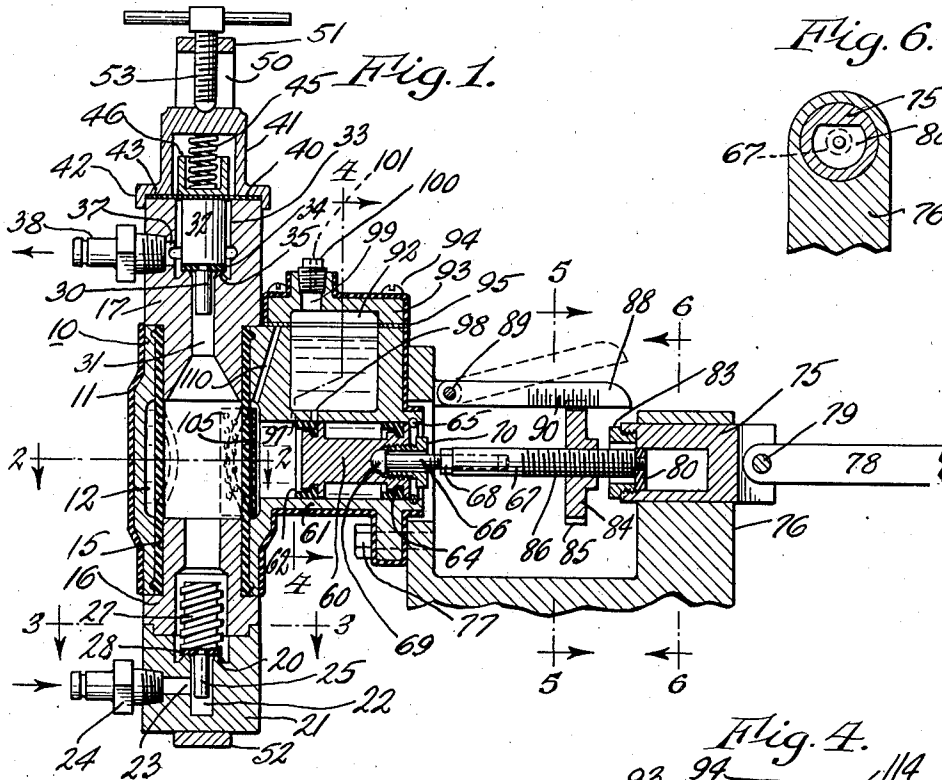


Fig. 6.

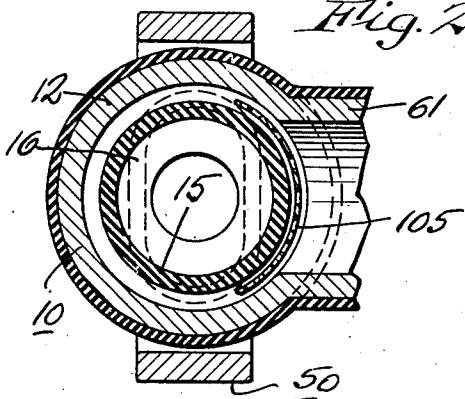
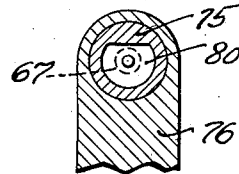


Fig. 2.

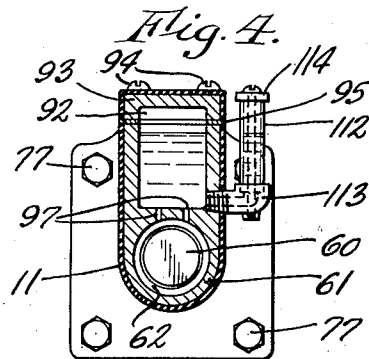


Fig. 4.

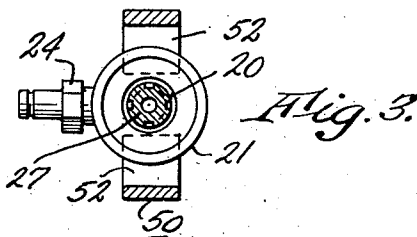


Fig. 3.

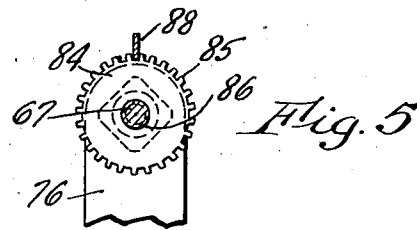


Fig. 5.

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FLUID PUMPING OR FEEDING DEVICE

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9 Claims. (Cl. 103—44)

This invention relates to improvements in pumping or feeding apparatus. The particular embodiment of the invention shown in the drawing is particularly adapted for handling liquids which are corrosive or which attack metals and other materials ordinarily used in the construction of pumping apparatus, but it is not intended to limit this invention to such use.

Heretofore pumps with flexible diaphragms have commonly been used for pumping or feeding corrosive liquids and liquids containing abrasive materials. The diaphragms of such pumps have been troublesome in that they broke at frequent intervals and generally when a diaphragm broke, some of the liquid being pumped would escape and damage metal parts with which it came into contact.

One of the objects of this invention, consequently, is to provide a pumping apparatus in which the fluid which is being pumped is advanced through the apparatus by means of pressure variations acting on a flexible tube arranged in a rigid housing and also acting to separate the pumped fluid from the fluid which is subjected to pressure variations. Another object of this invention is to provide an apparatus of this type of compact and efficient construction, by means of which the quantity of liquid discharged at each cycle of the apparatus may be controlled as desired. A further object is to provide a mechanism of improved construction for producing the pressure variations acting on the flexible tube.

Another object of this invention is to provide a pumping mechanism of this kind in which inlet and discharge valves are arranged within bushings which also serve to clamp the flexible tube in place on the housing. A further object of this invention is to form these bushings of transparent material so that the operation of the valves may be observed while the apparatus is in operation.

Other objects of the invention will appear from the following description and claims.

In the accompanying drawing, which discloses by way of example one embodiment of this invention:

Fig. 1 is a vertical central sectional elevation of a pumping or feeding device embodying this invention.

Figs. 2 and 3 are transverse sections thereof, on lines 2—2 and 3—3 respectively of Fig. 1, Fig. 2 being on an enlarged scale.

Fig. 4 is a sectional elevation thereof, on line 4—4, Fig. 1.

Figs. 5 and 6 are fragmentary sectional elevations thereof, taken respectively on lines 5—5 and 6—6 of Fig. 1.

In the particular embodiment of the invention illustrated in the drawing, 10 is a pump housing which is made of rigid material, such for example as metal. If this housing is made of a material which might be attacked or corroded by the fluid which is being pumped, the exterior of the housing may be covered by a layer 11 of rubber or any other material which serves the purpose of protecting the housing from the action of the fluid which is being pumped. The housing has a passage therethrough extending from end to end thereof, and intermediate of these ends, the housing is provided with an enlarged portion 12, thus forming a cavity or space in the enlarged portion of the housing of greater transverse dimensions than the ends of the housing. These ends of the housing are preferably cylindrical and a tube 15 of flexible or elastic material is preferably positioned within the housing in such a manner that the ends of the tube fit snugly within the cylindrical ends of the housing, the intermediate portion of the tube extending through the enlarged portion 12 of the housing in which it is spaced from the wall of the housing. The flexible tube 15 may be made of any suitable or desired material which is relatively inert with reference to the fluid to be pumped. For example, when pumping certain liquids or solutions, the tube 15 may be made of rubber. With other liquids, such as oil, the use of a neoprene or synthetic rubber tube is preferred. The tube may be made of synthetic materials, such as Vinylite, Koroseal, or the like. Preferably the material selected for this tube is elastic as well as flexible, but if desired, non-elastic flexible tubes may be employed.

In order to secure the ends of the flexible tube 15 in the housing, bushings 16 and 17 are employed which have cylindrical portions of such outside diameter as to extend into the ends of the tube. The bushings are so formed that when in their operative positions as shown in Fig. 1, the bushings press the ends of the tube into fluid-tight engagement with the ends of the cylindrical passage through the housing 10, thus utilizing the flexible material of the tube 15 to form a sealed joint or packing to prevent the escape of fluid at the ends of the housing, and in order to exert the pressure necessary to form this seal, the interior of the tube also forms seals with the bushing to prevent the escape of fluid from the interior of the tube.

An inlet valve is provided for controlling the flow of fluid to one end of the housing and an outlet valve permits the discharge of fluid from the housing. These valves may be of any suitable or desired construction, and as shown, the

inlet valve is adapted to cooperate with a valve seat 20 formed in an extension or part 21 of the bushing 16. This part 21 of the bushing is provided with a cylindrical recess 22 connecting with an inlet passage 23 which is in turn connected with a coupling member 24 to which a tube (not shown) for conducting fluid to the inlet valve may be secured. The recess 22 also forms a guide for a stem 25 of the inlet valve and the main bushing part 16 has a corresponding recess in which an extension or guide part 27 of the inlet valve is guided. A valve disk 28 is preferably arranged on the valve for cooperation with the valve seat 20 and this disk may be made of soft rubber or other suitable packing material. The upper portion 27 of the valve is preferably provided on the outer cylindrical surface thereof with spiral grooves, which when the liquid is flowing upwardly in the central passage of the bushing 16 tends to impart a slight rotary movement to the valve when the same is lifted from its seat. This slight rotary motion has a tendency to remove any particles of solid matter which may be contained in or carried by the fluid which is being pumped, from the valve seat and thus insure a fluid-tight seating of the valve disk 28 on its seat 20. An inlet valve of any other suitable or desired form may be employed, if desired.

The outlet or discharge valve is located in a longitudinal recess or passage in the bushing 17. This valve also has a stem 30, which is guided for vertical movement in a part 31 of the central passage of the bushing member 17. This valve also has an enlarged upper portion 32 which is guided for vertical movement in a part 33 of larger diameter of the bushing 17 and between these two parts 30 and 32 of the valve, a valve disk 34 is secured on the valve member, which is adapted to seat on an annular valve seat 35 formed in the bushing 17 at the junction of the part 31 of smaller diameter of the passage in the bushing with the part 33 of larger diameter. The enlarged portion 32 of the passage in the bushing 17 connects with a lateral passage 37 to which a coupling member 38 may be attached, and this coupling member may be in turn connected with a suitable tube (not shown) for conducting the pumped liquid from the pumping or feeding device.

When the pumping device is arranged in approximately the position shown in Fig. 1, the inlet and discharge valves will ordinarily seat by gravity. If, however, the pumping device should be arranged in a different position, springs of any suitable type for seating one or both valves can be provided. If the discharge of pumped fluid from the pumping device should be at a lower pressure than the pressure in the inlet duct, then it is desirable to provide some resilient means for closing one of the valves. In the construction shown for this purpose, the upper end of the part 32 of the valve is preferably arranged substantially flush with the upper end of the bushing 17 and the passage 33 in the bushing is closed by means of a resilient washer or diaphragm 40 which extends across the upper end of the bushing 17 and is held in place by means of a cap 41 having flange portions 42 engaging the outer walls of the bushing for holding the cap in correct relation to the bushing, and terminating in an annular radial shoulder 43 which engages the edge or peripheral portion of the upper face of the disk or diaphragm 40. When the cap is pressed toward the bushing, a

fluid-tight joint or seal is formed at the upper end of the bushing 17.

If the diaphragm 40 is made of rubber or other elastic material, then the rubber of the bushing tends to urge the discharge valve into its seating position, as shown in Fig. 1. If greater force is desired to urge the discharge valve to its seat, a spring 45 may be arranged in a recess in the cap member 41 so as to exert force downwardly against the diaphragm or packing disk 40, and if desired, the lower end of this spring may seat in a cup 46, which rests against the diaphragm or disk 40. When this arrangement is employed, the discharge valve will be yieldingly held in its closing position by the spring 45.

The bushings 16 and 17 may be held in correct relation to the housing 10 in any suitable or desired manner. For example, removable clamping means may be provided so that the bushings, valves and the cap 41 can be readily removed from and replaced in their operative positions. For example, an elongated U-shaped clamping member 50 may be employed for this purpose having legs extending lengthwise on the exterior of the housing and having an integrally formed cross member 51 at the upper portion thereof. The lower ends of the legs of the clamping member 50 are provided with inwardly extending projections 52 which engage the lower face of the extension 21 of the bushing 16. The cross member or web 51 of the clamping member is provided with a threaded hole adapted to receive a clamping screw 53, the lower end of which may rotatably engage the upper end of the closing cap 41. Consequently, when the clamping member 50 is in place and the screw 53 tightened, the two bushings 16 and 17 will be drawn by pressure against the lower and upper ends respectively of the housing member 10 and the cap 41 will be securely pressed against the upper bushing 17, to form a liquid-tight seal by means of the diaphragm or disk 40.

The bushings 16 and 17 and the inlet and discharge valves may, of course, be made of any suitable or desired material, but if the pumped fluid is of a corrosive nature, these parts must, of course, be made of a material which is inert with reference to the pumped fluid. Preferably, I make the bushings 16 and 17 and the extension 21 of the bushing 16 of a transparent material, such as glass, Vinylite, or other material, and if the valves are made of the same material, they are preferably of a different color from the bushings. By making these bushings of transparent material and the valves of a material of contrasting color, it will be possible at a mere glance to determine whether or not the apparatus is functioning properly, since the opening and closing of the two valves can be observed through the transparent bushings.

It will be noted in the construction thus far described that a fluid may be pumped or fed through the flexible tube 15 by alternately subjecting the portion of the housing spaced from and surrounding the tube to varying pressures. When the fluid in the housing 10 about the tube 15 is under greater pressure than that existing in the interior of the tube, the tube will be deformed by this pressure in such a manner as to decrease the volume of the space in the tube. Consequently, when pressure is applied to the exterior of the tube 15, the pressure of the fluid in the inside of the tube will be increased, thus forcing fluid through the discharge valve. When the pressure in the housing and about the tube is

decreased, the tube 15 will again assume its normal shape and thus draw fluid into the bushing 16 about the inlet valve which will be opened by the reduced pressure within the tube. The tube 15 may be deformed or changed in shape by the pressure of the surrounding fluid in any suitable or desired manner and may, for example, assume the shape indicated in broken lines in Fig. 2, or the portion of the tube within the enlargement 12 of the housing may simply become decreased in diameter, if the tube is made of rubber or other elastic material.

Any suitable or desired means may be provided for alternately supplying greater and less pressures within the enlarged portion 12 of the housing 10 about the tube 15, and in the construction illustrated, these varying pressures may be provided by means of a piston 60 which is reciprocable in a cylinder 61 which may, for example, be formed integral with the housing 10, that shown extending laterally from the housing and terminating at its inner end in the interior of the housing 10. The piston 60 may be of any suitable or desired form, that shown having a cup 62 arranged thereon to form a substantially fluid-tight seal or packing with the cylinder 61. Consequently, if the piston is moved to the left in Fig. 1, the pressure within the enlargement of the housing 10 will be increased. When the piston is in the position shown in Fig. 1, the interior of the housing 10 will be subjected to a reduced or minimum pressure.

The piston 60, in the particular construction shown, is provided with a second cup 64 spaced from the cup 62 for the purpose of eliminating the necessity of providing a stuffing box for a piston rod for reciprocating the piston. 65 represents a spring ring held by its own resilience in a groove in the cylinder 61 for the purpose of limiting the outward movement of the piston to the right in Fig. 1. A piston or pressure varying device of any other suitable or desired construction may be employed in place of the one described.

Reciprocatory motion may be imparted to the piston in any suitable or desired manner, for example, through the medium of a piston rod. In the construction shown in the drawing, an adjustable or two-piece piston rod is provided which includes two relatively adjustable piston rod parts 66 and 67. The part 66 is in the form of a rod or bar having an exteriorly threaded part adapted to engage in a correspondingly threaded hole in the other rod part 67. This threaded engagement of the two parts of the piston rod enables the two parts to be adjusted relatively to each other to vary the length of the rod and a lock nut 68 serves to hold the two parts in their adjusted positions.

The piston rod may be connected with the piston in any suitable manner, for example, as in the construction shown in Fig. 1, by providing an enlargement or head 69 on the piston rod part 66, which enters a recess or hole in the outer end of the piston. A threaded sleeve or bushing 70 engages an interior thread on the piston about the recess therein and serves to confine the enlarged part 69 of the piston rod within the hole or recess in the piston.

Means are preferably provided for varying the stroke of the piston in such a manner that its displacement may be varied as desired, so that the quantity of fluid passing through the tube 15 at each stroke of the piston may be varied as desired. This adjustable mechanism

may be constructed in any suitable or desired manner, that shown by way of example in the drawing including a cross head 75 reciprocable in a frame member 76 to which the extension of the housing 10 may be suitably secured, for example, by means of bolts or screws 77. The cross head 75 may be reciprocated by means of a reciprocable link or connecting rod 78 connected to the cross head by means of a pin 79. Any suitable or desired means for reciprocating the link or connecting rod 78 may be employed, such for example as an eccentric or crank (not shown), or any other usual or suitable mechanism for producing the desired back and forth movement of the connecting rod 78.

The cross head 75 is preferably hollow and the end of the piston rod has secured thereto a slide member 80 which is movable back and forth in the hollow connecting rod 75. Preferably this slide member is held against rotation within the cross head, this being accomplished by forming the hollow or bore of the cross head of non-circular cross section and constructing the slide member of similar cross section, as shown in Fig. 6. The end of the cross head nearest to the piston 60 is partly closed by means of a cap or bushing 83 through which the outer end of the piston rod part 67 extends, and which confines the slide member 80 to the interior of the cross head 75. The sleeve or bushing 83 is adapted to engage an adjustable member 84 mounted on the piston rod part 67. This adjustable member, in the construction shown, is in the form of a wheel having a toothed or notched periphery 85, the wheel or sleeve being internally threaded and engaging with a threaded portion 86 of the piston rod part 67. Consequently, the sleeve 84 may be adjusted lengthwise of the piston rod 70. When this sleeve is adjusted along the threaded portion 86 so that it engages the outer face of the sleeve 83 of the cross head, while the slidable member 80 engages the inner face of this sleeve, then it will be obvious that the cross head and piston rod will be substantially rigidly connected to each other. Consequently, the stroke of the piston 60 will be equal to the stroke of the cross head 75. When the adjustable wheel 84 is in the position shown in Fig. 1, the movement of the cross head 75 to the left from the position shown in Fig. 1 will impart no motion to the piston 60 until the sleeve 83 has moved into engagement with the wheel 84, thus producing a shorter stroke of the piston 60 than the stroke of the cross head 75. The lost motion between the cross head and piston rod may be varied by adjusting the wheel 84 along the piston rod, so that the stroke of the piston 60 may vary from a small fraction of the stroke of the cross head, to a stroke equal to the stroke of the cross head.

Any suitable means may be provided for holding the adjustable collar or wheel 84 in its adjusted position relatively to the piston rod 70, and in the particular construction illustrated, a blade 88 pivoted at 89 is provided for this purpose. The blade when occupying its normal position, as shown in full lines in Fig. 1, enters into a notch or between two teeth of the wheel 84, as shown in Figs. 1 and 5, thus keeping the wheel from turning on the piston rod 70. When the blade is moved upwardly out of engagement with the teeth of the wheel, for example, as shown in broken lines in Fig. 1, the wheel 84 may be turned about the piston rod part 67. If desired, the blade 88 may be provided with graduations 90, by means of which the movement of the pis-

ton 60 can be determined for each adjustment of the collar or wheel 84.

The piston 60 preferably acts on a liquid, so that the displacement of fluid in the flexible tube 15 may be accurately controlled by the stroke of the piston 60. Since liquids are substantially non-compressible, it follows that the amount of liquid displaced by the piston 60 will be equal to the amount of liquid displaced by the flexible tube 15, and when the tube 15 is used to pump or feed a gas, the amount of gas displaced or pumped by the tube 15 will also be proportional to the amount of liquid displaced by the piston, providing the pressures at the inlet and discharge valves are kept constant. It is, of course, also possible to have the piston 60 act on a gas, but a liquid is preferred for this purpose, because liquids are non-compressible and constant the effect on the tube 15 at each stroke of the piston will be the same, and furthermore, liquids may be selected which have the desired lubricating properties on the piston 60.

The apparatus illustrated in the accompanying drawing is intended particularly for use with an actuating liquid on which the piston 60 may act. Any desired liquid or mixtures of liquids may be used, such for example as water, alcohol, glycerine or glycols, oils, or the like. When a liquid is used, it is, of course, desirable to exclude air or other gas from the liquid, since the compressibility of gases would interfere with the accurate operation of the pumping or feeding apparatus. For this purpose, a reservoir or container for a quantity of liquid is provided which is arranged above the cylinder 61 and connected therewith by a passage, so that the piston will at all times be completely submerged in the liquid. In the construction illustrated, a reservoir 92 is formed integral with the extension of the housing in which the piston 60 is located. The reservoir 92 is provided with a removable cover 93 secured to the top of the reservoir by means of screws 94 or the like. A gasket 95 is interposed between the upper edge of the reservoir 92 and the cover 93 thereof.

The cylinder 61 in which the piston 60 reciprocates is connected with the reservoir 92 by means of a pair of holes or passages 97, see Figs. 1 and 4, which are so located that they are uncovered by the inner end of the piston 60 when the piston is at the outer limit of its stroke. Another aperture or passage 98 is also provided for connecting the reservoir 92 with the interior of cylinder 61, this passage supplying liquid into the space between the two cups 62 and 64 of the piston. The aperture 98 serves the purpose of maintaining the liquid between these two cups at the pressure existing within the reservoir 92. Consequently, if some liquid under pressure should leak past the cup 62, such liquid will not build up a pressure in the space between the two cups, since this space will be in communication with the reservoir through the passage 98 throughout the greater part of the stroke of the piston. Hence there will be very little tendency for liquid to leak past the cup 64, and hence no stuffing box is necessary for the piston rod part 65.

In the particular construction shown, the reservoir 92 is provided with means for readily replenishing any liquid that may have been lost from the reservoir 92, and for this purpose, the cover 93 of the reservoir is provided with a threaded hole or opening 99 which is normally closed by means of a plug 100. Preferably the plug is provided with a vent passage or hole 101 extend-

ing therethrough, which may open to the atmosphere or which may be connected in any suitable or usual manner with a source of fluid under pressure greater or less than that of the atmosphere. No such connection is shown in Fig. 1, so that the liquid in the reservoir 92 will be at atmospheric pressure.

As a result of the provision of a liquid reservoir above the piston as described, a constant supply of liquid will be maintained in the space between the inner face of the piston and the cavity within the enlargement 12 of the housing 10. As a result of this construction, the piston 60 in moving to the left in Fig. 1 will displace an amount of liquid depending upon the length of its stroke. The amount of liquid thus displaced will produce a deformation of the tube 15 such that a corresponding decrease in volume within this tube results. This acts upon the fluid contained within the tube in such a manner as to force some of this fluid upwardly toward and past the discharge valve. When the piston 60 returns to its initial position, as shown in Fig. 1, the tube 15 will be restored to its initial shape or form, so that the volume of the interior of the tube will be increased, thus causing liquid to be drawn into the housing 10 past the inlet valve. When the actuating fluid is a liquid, a very accurate control of the quantity of pumped fluid passing the discharge valve can be effected by controlling the length of the stroke of the piston, by adjusting the wheel 84, since the amount of pumped fluid displaced or fed at each stroke of the piston 60 is proportional to the displacement of the piston. If the pumped fluid is also a liquid, the amount of this liquid pumped at each stroke of the piston is substantially equal to the displacement of the piston.

Means may be provided for preventing damage to the tube 15, in the event that the same should be drawn inwardly into the cylinder 61. Any suitable means may be provided for this purpose, and in the construction shown, a guard 105 is provided which is interposed within the enlarged part 12 of the housing between the tube 15 and the cylinder 61. The guard 105 is preferably perforated so as not to interfere with the free passage of liquid between the cylinder and the enlargement of the housing. This guard rests on the bottom of the space 12 between the housing and the flexible tube.

In order to eliminate any air or gas from the space within the enlarged portion 12 of the housing about the tube 15, a vent passage 110 is provided in the housing 10, the inner end of which terminates in the upper portion of the cavity formed by the enlargement 12 of the housing, and the upper end of which terminates in the upper edge of the reservoir 92 in a portion thereof which is normally covered by the gasket 95. Consequently, when the apparatus is put into use, the cover 93 and gasket 95 are removed from the upper surface of the reservoir and liquid is poured into the reservoir to fill the same completely. This liquid displaces any air or gas within the enlargement 12 upwardly through the vent passage 110. By filling the reservoir to the upper edge thereof, so that the passage 110 will also be completely filled, and then applying the cover 93 and gasket 95, the upper end of the completely filled passage 110 will be sealed by the gasket and will be free from gas. Any other means for removing gas from the portion of the apparatus to be occupied by the actuating liquid may be employed, if desired.

If the liquid in the reservoir is to be acted upon by a pressure other than the atmospheric pressure, the apparatus will function similarly as described, except that if the pressure in the reservoir is below atmospheric, the tube 15 will become expanded or stretched when the piston is in the position shown in Fig. 1, and will be reduced in size when the piston moves to the left in Fig. 1.

In order to readily determine the level of liquid in the reservoir 92, a sight glass 112 may be provided at a side of the reservoir. This may be effected by mounting this glass on a nipple 113 arranged in a threaded hole in the lower part of the reservoir. If the liquid in the reservoir is at atmospheric pressure, the top 114 of the sight glass 112 should be open to the atmosphere.

When the apparatus is used for pumping corrosive liquid, the extension of the housing member 10 including the cylinder and the reservoir are preferably also covered with rubber or other protecting material. The apparatus, however, has the advantage that the actuating liquid may be such as to be non-corrosive of the metal of the housing 10, in which case, the interior of the enlargement 12 of the housing 10, as well as the cylinder and other parts of the pumping and feeding device, require no protection against the actuating liquid, and consequently, the exterior of the housing itself need only be protected by the covering material 11 against any leaks or spilling of the pumped material.

The apparatus described has the advantage that the action of the actuating liquid on the tube 15 is such as to result in a much longer life of the tube than the life of diaphragm such as have heretofore been commonly used for pumping or feeding corrosive fluids. The pumping apparatus is also efficient and of simplified construction, since the flexible tube serves not only the purpose of imparting motion to the liquid to be pumped, but also keeps this liquid out of contact with the interior of the housing 10 and forms seals with the valve bushings 16 and 17. The apparatus is more accurate for feeding fluids than diaphragm pumps heretofore employed for this purpose, since the displacement of the actuating liquid by the piston is very accurate and positive and results in an equally accurate displacement of the pumped fluid, while with diaphragm pumps or feeders, deformation of the diaphragm introduces inaccuracy of the feed.

The apparatus described has the advantages that by the use of varying fluid pressure about the tube 15, the tube after having been deformed by increased pressure of the surrounding fluid, is positively returned to its initial position by the decrease in pressure resulting from the return stroke of the piston. It has also been found that less power is required to pump a liquid by means of the apparatus described than is required in connection with diaphragm operated pumps.

Since the actuating liquid may be selected so as to act as a lubricant for the piston, it will be obvious that no additional lubrication of the piston is necessary.

When the apparatus is operating as indicated in the drawing so that the reservoir 92 contains liquid at atmospheric pressure, the flexible tube is not subjected to tension during any portion of the stroke of the piston. It has been found that when this tube is employed for conducting corrosive liquids, such for example as solutions of chlorine compounds for chlorinating water, such solutions have practically no deteriorating

effect upon tubes made of rubber or other elastic materials, this is probably due to the fact that by not stretching the material of the tube, the surface thereof in contact with the solution is not alternately opened and closed to permit chlorine compounds to enter the pores of the material.

We claim as our invention:

1. A pumping device including a housing provided with valve controlled inlet and outlet openings, a flexible tube in said housing connecting said inlet and outlet openings and having the intermediate portion thereof spaced from the walls of said housing, means for conducting fluid to be pumped to said inlet opening and for conducting pumped fluid from said discharge opening, a cylinder formed in said housing and having one end thereof opening into the space arranged about the intermediate portion of said flexible tube, a reciprocable piston arranged in said cylinder for alternately producing varying pressures in said space for alternately changing the volume of the interior of said tube to force fluid to flow from said inlet valve to said outlet valve, a cross-head having a fixed stroke, and an adjustable lost motion connection between said crosshead and said piston, whereby the stroke of the piston may be varied by adjusting said lost motion connection.

2. A pumping device including a housing provided with valve controlled inlet and outlet openings, a flexible tube in said housing connecting said inlet and outlet openings and having the intermediate portion thereof spaced from the walls of said housing, means for conducting fluid to be pumped to said inlet opening and for conducting pumped fluid from said discharge opening, a cylinder formed in said housing and having one end thereof opening into the space arranged about the intermediate portion of said flexible tube, a reciprocable piston arranged in said cylinder and adapted to act on a body of liquid for alternately forcing liquid from said cylinder into and out of the space in said housing about a tube, to vary the shape of said tube to vary the volume of fluid within said tube in accordance with the liquid displaced by said piston, for advancing fluid through said tube, a cross-head having a fixed stroke, a rod connecting said piston and said crosshead and having a limited slidable connection with said crosshead, and means adjustably mounted on said rod for varying the extent to which said rod is slidable relatively to said crosshead to vary the stroke of said piston.

3. A pumping device including a flexible tube, an inlet valve controlling the flow of fluid into one end of said tube, an outlet valve controlling the discharge of fluid from the other end of said tube, reciprocal means adapted to exert pressures on said tube to deform the same to varying degrees to produce variations in the volume of said tube to advance fluid past said valves, a reciprocal member of fixed stroke, and an adjustable lost motion connection between said reciprocal means and said reciprocal member for varying the stroke of said reciprocal means to vary the fluid pumped by said tube.

4. A pumping device including a flexible tube, an inlet valve controlling the flow of fluid into one end of said tube, an outlet valve controlling the discharge of fluid from the other end of said tube, reciprocal means adapted to exert pressures on said tube to deform the same to varying degrees to produce variations in the volume of said tube to

advance fluid past said valves, a cross head having a substantially fixed stroke, and an adjustable connection between said cross head and said reciprocal means whereby varying portions of the stroke of said cross head may be transmitted to said reciprocal means.

5. A pumping device including a flexible tube, an inlet valve controlling the flow of fluid into one end of said tube, an outlet valve controlling the discharge of fluid from the other end of said tube, reciprocal means adapted to exert pressures on said tube to deform the same to varying degrees to produce variations in the volume of said tube to advance fluid past said valves, said reciprocal means including a rod having a pair of projecting parts arranged thereon, one of said parts being adjustable lengthwise of said rod toward and from the other part, and a cross head having a substantially fixed stroke and having a part arranged between said parts of said rod in position to be engaged thereby, whereby the portion of the stroke of said cross head which is transmitted to said rod may be varied by varying the position of said adjustable part.

6. A pumping device including a flexible tube, an inlet valve controlling the flow of fluid into one end of said tube, an outlet valve controlling the discharge of fluid from the other end of said tube, reciprocal means adapted to exert pressures on said tube to deform the same to varying degrees to produce variations in the volume of said tube to advance fluid past said valves, said reciprocal means including a rod having a pair of projecting parts arranged thereon, one of said parts being threaded and having a threaded engagement with said rod for adjustment lengthwise thereof, a reciprocating member having a fixed stroke and having a part extending between said parts of said rod in position to be engaged thereby, whereby the motion transmitted to said rod by said reciprocating member may be varied by adjusting said threaded part, said threaded part having a toothed periphery, and a blade pivoted on a fixed part of said pumping device and movable between a pair of teeth of said threaded part to hold said threaded part against turning out of its adjusted position.

7. A pumping device including a housing provided with valve controlled inlet and outlet openings, a flexible tube in said housing connecting said inlet and outlet openings and having the intermediate portion thereof spaced from the walls of said housing, means for conducting fluid to be pumped to said inlet opening and for conducting pumped fluid from said discharge opening, a cylinder connected with the space arranged about the intermediate portion of said flexible tube, a recip-

rocable piston in said cylinder, a liquid reservoir associated with said cylinder and connected therewith by means of a passage through which liquid is supplied to said cylinder and said space in said housing when said piston is adjacent to one end of its stroke, and a passage leading upwardly from the highest portion of said space and terminating at its upper end at a point which is not above the liquid level in said reservoir, and means for closing the upper end of said passage, whereby, when said reservoir is filled, all air is expelled by the liquid from said space.

8. A pumping device including an upright tubular housing provided with valve controlled inlet and outlet openings, a flexible tube in said housing connecting said inlet and outlet openings and having the intermediate portion thereof positioned from the walls of said housing to form an upright annular space between said flexible tube and said housing, a cylinder connected with said space, a reciprocable piston in said cylinder, a liquid reservoir connected with said cylinder by means of a passage through which liquid is supplied to said cylinder and to said space in said housing, when the piston is adjacent to one end of its stroke, and a passage extending outwardly from the highest portion of said space and terminating at its upper end at a point which is no higher than the liquid level in said reservoir, and means for closing the upper end of said passage, whereby when said reservoir is filled, air in said space and said passage is displaced by said liquid.

9. A pumping device including an upright tubular housing provided with valve controlled inlet and outlet openings, a flexible tube in said housing connecting said inlet and outlet openings and having the intermediate portion thereof positioned from the walls of said housing to form an upright annular space between said flexible tube and said housing, a cylinder connected with said space, a reciprocable piston in said cylinder, a liquid reservoir formed integral with said housing and said cylinder and connected with said cylinder by a passage through which liquid from said reservoir is supplied to said cylinder and said space when said piston is adjacent to one end of its stroke, a cover for said reservoir, a gasket arranged between the upper edge of said reservoir and said cover, and a passage connecting the upper end of said space with the upper edge of said reservoir, whereby when said reservoir is completely filled with liquid, air is displaced by liquid from said space and said passage, the upper end of said passage being sealed by said gasket when said cover is secured to said reservoir.

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