

July 13, 1943.

J. B. WADE
PROPORTIONAL FEEDER
Filed May 14, 1940

2,323,950

2 Sheets-Sheet 1

Fig. 1.

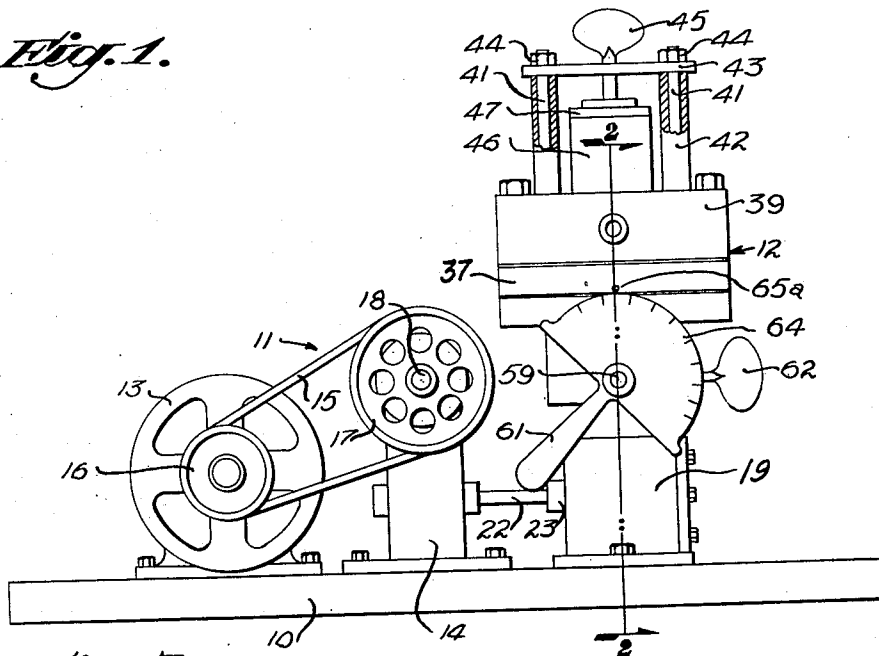


Fig. 3.

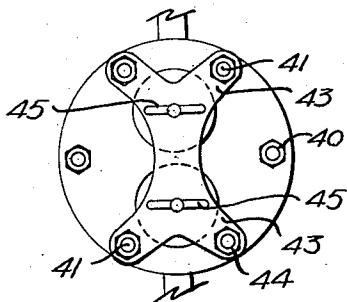


Fig. 5.

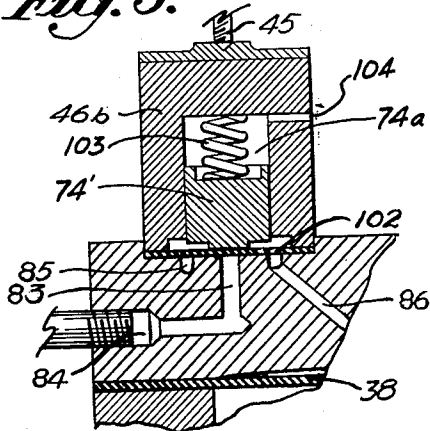
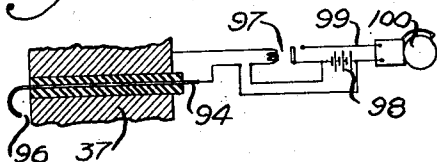


Fig. 6.



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2 Sheets-Sheet 2

Fig. 2.

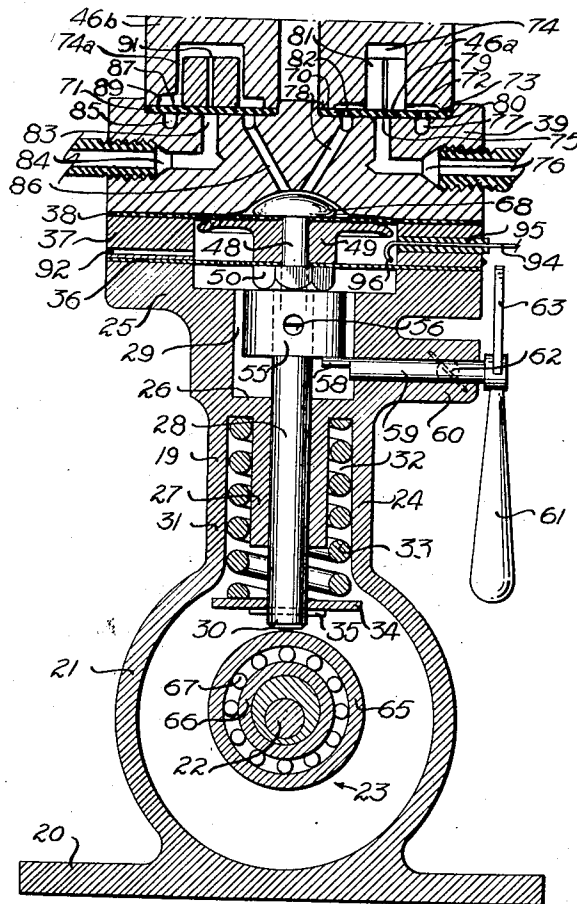


Fig. 4.

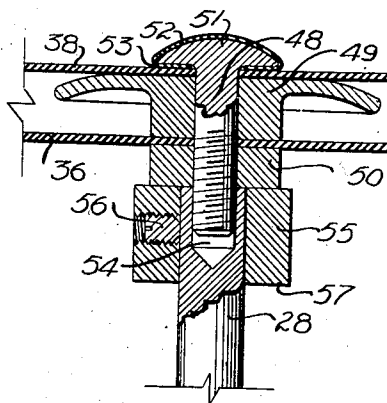
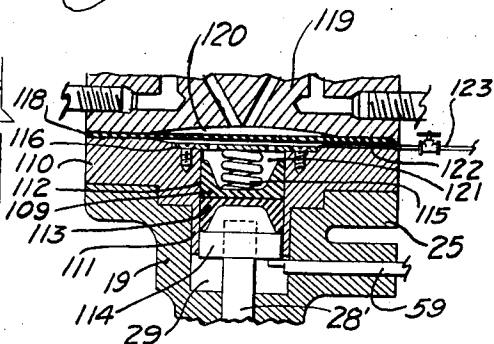


Fig. 7.



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2,323,950

PROPORTIONAL FEEDER

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7 Claims. (Cl. 103—150)

My invention relates to proportional feeders and relates in particular to a simple fluid feeding device incorporating a novel and effective diaphragm pump.

Fluid feeding devices of the type disclosed herein are extensively employed for the purpose of delivering measured quantities of selected fluids or liquids into fluids to be treated. The invention is of especial utility as a means for feeding highly poisonous or corrosive treating agents into water for the purification thereof, for the reason that a very accurate measurement of the treating fluid into the water to be treated is obtained.

It is an object of the present invention to provide a self contained proportional feeder having its own source of power and a pump element driven thereby, with means whereby the output of the pump element may be controlled within close limits, and wherein the pump element may be adjusted at will of the operator to deliver any desired quantity of treating fluid within a relatively wide range.

It is an object of the invention to provide a proportional feeder of simple, yet durable construction which may be employed to pump a proportional quantity of feeding solution into a zone of positive pressure or into a zone of negative pressure. A further object of the invention is to provide for a proportional feeder a novel pump element of such form that the body and fluid engaging parts thereof may be readily made of non-corrosive or non-metallic material.

A further object is to provide a proportional feeding pump having a novel inlet valve structure which may be readily dismantled for inspection and having a closure element which may be readily replaced.

A further object of the invention is to provide a proportional feeding pump having a discharged valve structure which may be employed to feed either against a high pressure or through which the fluid may be fed into a zone of reduced pressure or partial vacuum, without danger of the pressure differential producing an excess feeding of the solution.

A further object of the invention is to provide a simple and effective means for actuating the reciprocating element of the proportional feeding pump. A further object of the invention is to provide a novel construction for a diaphragm pump wherein rupture of the pumping diaphragm will not result in leakage of the solution which is pumped thereby, into the driving mechanism. Accordingly, the invention may be used for the

proportional feeding of highly corrosive liquid. A further object of the invention is to provide a proportional feeder embodying a diaphragm pump and having means whereby rupture of the pumping diaphragm is immediately brought to the attention of the attendant, or by which a signal is provided at a point remote from the pump.

It is a further object to provide a proportional feed pump having simple and practical means for securing the valve elements in operative position, without exposing metal parts to contact with the material being pumped.

A further object is to provide a simple and effective means for securing the pumping diaphragm to the push rod whereby it is actuated, and further to provide a simple and effective control or the amplitude of reciprocation of the pumping diaphragm. A further object is to provide a drive mechanism for a pumping diaphragm having a novel and effective means for supporting and guiding the push rod for the diaphragm, and for producing reciprocation of the push rod with minimum vibration or pounding effect.

Further objects and advantages will be brought out in the following part of the specification.

Referring to the drawings which are for illustrative purposes only:

Fig. 1 is a side elevation of a self contained proportional feeder embodying my invention.

Fig. 2 is an enlarged cross-section on a plane represented by the line 2—2 of Fig. 1.

Fig. 3 is a plan view of the pump unit shown in Fig. 1.

Fig. 4 is a fragmentary sectional view showing the manner in which the push rod is connected to the diaphragms.

Fig. 5 is a fragmentary section showing the discharge valve assembly arranged for delivery into piping in which a partial vacuum exists.

Fig. 6 is a diagrammatic view showing the alarm system for indicating leakage of corrosive liquid through the pumping diaphragm.

Fig. 7 is a fragmentary sectional view of schematic character to show the manner in which the head of the proportional feed pump may be converted to a form for operation against high pressures.

In the device shown in Fig. 1 I provide a base 10 which supports drive means 11 and a pumping unit 12. The drive means 11 comprises a motor 13 and a reducing gear 14 which may be driven from the motor 14 as by means of a belt 15 and pulleys 16 and 17. It is contemplated that the speed at which the input shaft

18 of the reducing gear 14 may be driven at a continuous desired speed by a suitable pulley and belt arrangement, and that companion step pulleys may be employed if desired, but this will not be ordinarily necessary for the reason that for each particular job a suitable combination of pulleys 16 and 17 will be selected, and such variations as may be required in the quantity of fluid fed by the device may be made by use of a simple adjustment in the pumping unit, as will be hereinafter described.

As shown in Figs. 1 and 2 the pumping units 12 comprises a supporting member 19 comprising a base 20, a hollow body 21 having form of a cylinder disposed on a horizontal axis co-axial with the output shaft 22 of the speed reducer 14, so that the output shaft 22 may project through bearing means 23 into the hollow body or casing 21 or an eccentric 23.

A hollow column 24 extends upward from the casing 21 and has at the upper ends thereof a flange 25 which lies at a substantially horizontal plane. The hollow column 24 has an intermediate wall 26, and projecting downward from this wall 26 there is a tubular wall 27 which forms a guide for a push rod 28, the lower end 30 of which is in position for engagement by the eccentric 23, and the upper end of which projects into a chamber 29 which lies in the upper part of the hollow column 24 and within the flange 25, above the dividing wall 26.

The tubular wall 27 is of such size relative to the wall 31 of the column 24 as to provide around the tubular wall 27 and below the wall 26 a space 32 to receive nearly all of a coil spring 33, the lower end of which engages a washer 34 which is secured on the lower end of the push rod 28 as by means of a counter pin 35, the coil spring 33 accordingly urging the push rod 28 downward after each lifting thereof by the eccentric 23.

A guard diaphragm 35, of suitable flexible material, such as a sheet of rubber, is disposed across the upper base of the flange 25, and above the diaphragm 36 a spacer ring 37 is placed, which on a separate base receives a working diaphragm 38. A pump body 39 is clamped against the annular portion of the diaphragm 38 which lies over the upper surface of the rings 37, by use of a pair of screws 40, and a complement comprising four studs 41, which securing members pass through spaced openings in the body 39 and the ring 37 into threaded engagement with the flange 25. As shown in Figs. 1 and 3 the studs 41 have spacer sleeves 42 thereon, and the upper ends of the studs 41 receive a plate 43 which is held against the upper ends of the sleeves 42 by nuts 44. The plate 43 lies in a plane substantially parallel to the outer end base of the pump body 39, and carries thumb screws 45 which serve as means to clamp against the outer base of the pump body 39 valve covers 46 which comprise cylindrical bodies, there being pressure plates 47 against the outer faces of the valve covers 46, through which the pressure of the screws 45 is transmitted to the valve covers 46.

As shown in Fig. 2, the diaphragms 36 and 38 are connected to the outer end of the push rod 28 by means of a screw 48 a spacer 49 and a lock nut 50. Therein I have provided a simple and efficient means for connecting the central portions of the diaphragms to the push rod, and in such manner that the head 51 of the screw 48 is protected from contact with the solution

being pumped. The head 51 is encased in a cap 52 of rubber which has an annular lip 53 to extend across the inner face of the head, so that when the stem of the screw is passed through the central opening in the diaphragm 38, the wall or lip 53 of rubber will engage the surface of the diaphragm 38. The spacer 49 surrounds that portion of the screw 48 between the diaphragm 36 and 38, and the lock nut 50 is tightened down against the lower face of the diaphragm 36, thereby clamping the central portion of the diaphragm 36 tightly against the spacer 49 and clamping the central portion of the diaphragm 38 between the spacer and the lip 53 of the rubber cap 52 which conceals the head 51 of the screw 48. The lower end of the screw 48 threads into an opening 54 in the end of the push rod 28. A collar 55 is secured on the upper end of the push rod 28, as by means of a set screw 56, the lower face 57 of this collar cooperating with an adjusting means comprising a cam or eccentric 58 formed on the inner end of a shaft 59 which projects out through a boss 60 projecting laterally from the upper portion of the column 24. A handle 61, fixed on the outer end of the shaft 59, provides means whereby the shaft may be rotated to adjust the cam or eccentric 58, and means are provided for locking the shaft in any position of adjustment such locking means being shown as a set screw 62 which is threaded through one side of the boss 60 so that the inner end thereof may be brought into clamping engagement with a side portion of the shaft 59. For indication of the various positions of adjustment of the eccentric 58, a dial is associated with the shaft 59, such dial comprising a semicircular plate 63 fixed on the inner ends of the handle 61 concentric with the shaft 59, this plate having graduations 64 which traverse a point or marker 65a carried by the ring 37, when the handle 61 is swung through an angle of 90°.

The cam or eccentric 58 by rotation of the shaft 59 may be raised or lowered relative to the collar 55, thereby limiting the distance through which the push rod 28 may be moved downward by the spring 33. The distance that the push rod 28 may be raised is determined by the position and throw of the eccentric 23. Since the forward or upward movement of the push rod 28 is equal to the return movement thereof, the distance through which the push rod 28 is reciprocated, and accordingly the amplitude of flexure of the diaphragm 38 may be changed by moving the eccentric 58. The characteristics of the eccentric 23 determines the maximum distance to which the push rod may be raised. The eccentric 58 provides a stop which is engaged by an operative part of the push rod 28 when the lifting force of the eccentric 23 is removed from the push rod. In Fig. 2 the eccentric 58 is shown in its highest position wherein it holds the push rod 28 in a position at least as high as the highest point to which the push rod is raised by the eccentric 23. Accordingly, there is at this time no operative engagement between the eccentric 23 and the push rod, and the push rod accordingly is maintained stationary so that no pumping effect is obtained. As the eccentric 58 is rotated from its raised position to a lower position, the push rod 28 is allowed to drop into a position where it will be engaged and reciprocated by the eccentric 23 as the same rotates.

The eccentric 23 comprises an outer ring 65 which makes rolling engagement with the lower

end face of the push rod 28 during such times as the eccentric 23 is in engagement with the push rod, this ring 65 is turnable upon an eccentric body 66 mounted on the end of the shaft 22 within the casing 21. In the practice of the invention I prefer to interpose antifriction bearing means between the outer ring 65 and the inner eccentric body 66, such anti-friction means being shown in the form of bearing balls 67 installed between the cooperating parts 65 and 66 in the general manner employed in ball bearings.

In the inner face of the pump body 39, there is a depression or pump chamber 68, the lower wall of which is formed by the diaphragm 38. The valve covers 46, individually referred to as inlet valve cover 46a and outlet valve cover 46b rest in shallow recesses 70 and 71 in the outer face of the pump body 39. The valve cover 46a has a shallow depression 72 in the lower face thereof, lying within an annular lip 73, and an opening 74 preferably coaxial, projects from the central portion of the depression 72. The valve cover or body 46b is in general similar to the valve body cover 46a, with the exception that the opening 74a is larger than the opening 74 of the member 46a. In the bottom wall of the recess 70 there is an opening 75 lying at the inner end of a fluid inlet passage 76. In the bottom wall of the recess 70 there is a second opening in the form of an annular channel 77 which communicates through an inlet duct 78 with the upper portion of the pumping chamber 68. The opening 75 constitutes the inlet port of an inlet valve which has as a closure member the central portion of a flexible rubber disc 79 having openings 80 there-through communicating with the channel 77. The disc 79 is held in the recess 70 by the pressure of the lip 73 of the cover 46a. Means may be provided to urge the central portion of the disc 79 toward closing relation to the port 75, such means being shown as a weight 81. The space 82 in the cover 46a and above the diaphragm or valve disc 79, is in communication with the inlet duct 78 through the annular channel 77 and the openings 80, so that when the diaphragm 38 is moved downward to perform a suction stroke the reduction in pressure in the space 82 result in a raising of the central portion of the disc 79 through a distance sufficient to permit fluid to flow from the port 75, across the lower face of the central portion of the disc 79 to the channel 77 and thence through the inlet duct 78 to the pumping chamber 68.

The outlet valve of the pump is very similar to the inlet valve disclosed in the foregoing paragraph. An outlet opening or port 83, in the bottom wall of the recess 71, communicates with an outlet passage 84. A second opening, in form of a channel 85, is formed in the bottom wall of the recess 71 in a position surrounding the port 83, and this channel 85 is connected through an outlet duct 86 with the upper portion of the pumping chamber 68. A valve disc, of flexible material such as sheet rubber is held in the bottom of the recess 71 by the valve cover 46b. This valve disc 87 has a central opening 88 communicating with the outlet port 83 so that the back pressure which is transmitted through the outlet passage 84 may be constantly exerted in the space 89 above the diaphragm or valve disc 87, such pressure accordingly tending to hold the disc 87 tightly against the bottom wall of the recess 71 so as to prevent a reverse flow of liquid from the outlet port 83, under the central portion of the disc 87 to the channel 85. Means for yieldably

urging the central portion of the disc 87 toward the bottom wall of the recess 71 may be provided in form of a weight 90, vertically slidable in the opening or recess 74a and having an opening 91 therein for free transmission of fluid pressure from the outlet port 83 to the space 89 within the cover 46b. During the pumping stroke of the diaphragm 38 fluid under pressure is forced outward through the duct 86 to the channel 85, from which it flows under the central portion of the disc 87 to the outlet port 83.

The diaphragm 38 being made of rubber or a rubber compound, fabric reinforced where necessary, is corrosive-resistant. The pump body 39, due to its simple form may be readily made from one of the corrosive-resistant materials or plastic. Also, the valve covers 46a and 46b may be made of corrosive-resistant material. It will be recognized that the pump body 39 and the valve covers 46a and 46b may be readily molded from glass or porcelain.

The ring 37 has an opening 92 to connect the space 93 with the exterior of the pumping unit. The guard diaphragm 36, during the operation of the pump, is merely flexed back and forth without doing any work; therefore, if it is made of sheet material of at least as high a quality as the diaphragm 38, it will not rupture prior to rupture of the working diaphragm 38. Accordingly, the diaphragm 36 provides a wall which will prevent leakage of corrosive fluid down into the reciprocating mechanism. Any corrosive material which may leak through the diaphragm 38 into the space 93 will pass out through the bleeder passage to the exterior where it will be noted by an attendant.

My invention also provides an alarm for advising that rupture of the working diaphragm 38 has occurred. Such alarm comprises an electrode 94 which extends through the ring 37, and is supported by an insulator 95 in such position that the inner end 96 of the electrode will be within the chamber 93 spaced from the inner wall of the ring 37. A relay 97 is connected in series with a battery 98, the electrode 94 and the ring 37. When energized, the relay 97 closes a circuit 99 which includes the battery 98 and a signaling device such as a bell 100. Accordingly, corrosive liquid which leaks into the space 93 through the ruptured working diaphragm 38 will bridge between the end 96 of the electrode and the ring 37, thereby closing the relay circuit which in turn will close the single circuit and cause the bell 100 to ring, thereby advising that rupture of the diaphragm 38 has taken place.

My invention also provides a simple and effective discharge or outlet valve for use where the personal feeder delivers measured quantities of a treating solution into a low pressure zone, for example into a pipe line or container wherein a condition of partial vacuum is maintained. As shown in Fig. 5 this vacuum proof outlet valve may have essentially the same construction as the outlet valve shown in Fig. 2, but employing therein a valve closure disc 102 which is imperforate, instead of the centrally perforated disc 87 of Fig. 2. Accordingly, the outlet valve structure shown in Fig. 2 may be readily converted so as to operate against a vacuum instead of against pressure, by substituting the imperforate disc 102 for the disc 87. I have, therefore, in Fig. 5 given those parts of the outlet valve structure which are the same as those shown in the upper left hand corner of Fig. 2 the same identifying numerals. The suction or partial vacuum in the passage 83

has the result of drawing the central portion of the valve disc 102 tightly down against the mouth of the passage 83. To supplement the action of the partial vacuum existing in the passage 83 a weight 74', or the combination of this weight 74' and a spring 103 may be employed to urge the central portion of the disc 102 against the mouth of the passage 83. Also, it may be found desirable to form in the valve cover 46b an opening 104 to connect the chamber 74a of the cover member 46b with exterior, so that atmospheric pressure may be maintained in the chamber 74a. During the upward movement of the diaphragm 38, as during a pressure stroke, liquid under pressure will be forced upward through the passage 18 to the annular channel or port 85, and this pressure will lift the central portion of the valve disc 102 to permit discharge of liquid from the channel 85 to the mouth of the discharge passage 83.

The form of my invention shown in Figs. 1 and 2 is adapted for feeding of a fluid against low and medium pressures. In Fig. 7 I show a form of the invention adapted for feeding of a fluid against relatively high pressure such as would cause the rapid breaking down of a diaphragm which is reciprocated by mechanical means. In the form of the invention shown in Fig. 7 I employ the casing or supporting member 19 and the reciprocating mechanism shown therein in Fig. 2, having removed the spacer ring 37 of Fig. 2 from the flange 25 of the member 19, I place thereon an adaptor ring 110 having an annular wall 111 to extend down into the chamber 29. The adaptor ring 110 has a ground and polished bore in which a piston may reciprocate, this piston 109 comprising a pair of cup shaped sealing elements of rubber compound or synthetic rubber, such as employed in hydraulic brake mechanisms. On the upper end of a push rod 28' I provide a head 114 which fits into the lower cup 113, which lower cup is placed with its flanges faced downwardly. The upper cup 113 is placed in back to back relation to the lower cup so that its flanges will face upward. Upward movement of the push rod 28' and the head 114 accomplishes upward movement of the cup members 113, and a spring 115 is placed in compression above the upper cup member 113 to provide pressure to move the cup members downward when the application of a lifting force to the push rod 28' is removed. The upper end of the spring 115 is engaged by a spider or perforated plate 116 which extends across the upper end of the bore 112.

A diaphragm 118 is clamped across the upper face of the ring adaptor 110 by means of a pump body 119, the construction of which is essentially the same as that of the body 39 shown in Fig. 2, with the exception that it has a shallow depression 120 in the upper face thereof to form a pumping chamber. The space below the diaphragm 118 and above the upper cup member 113 is filled with a liquid to form a hydraulic body which may be reciprocated vertically by the piston 109. To fill the space 121 with liquid, a passage 122 is provided to which a valved injection pipe 123 is connected. When the piston 109 is moved upward, the pressure of the liquid in the chamber 121 above the piston is applied equally to all parts of the lower face of the diaphragm 118, and the diaphragm 118 is displaced upward without concentration of rupturing stresses around the edges thereof, even though the reacting pressure against which the proportioning pump is operated is very high.

I claim as my invention:

1. In a proportional feeder of the character described, the combination of: a body of non-corrosive material having an inner face and an outer face, there being inlet and outlet ducts leading from said inner face to said outer face; a diaphragm extending across said inner face of said body; an annular member to clamp said diaphragm against said body; bolt means projecting through said body, the inner ends of said bolt means engaging said annular member and the outer ends of said bolt means extending from said outer face of said body; valve means to cooperate with said inlet and said outlet ducts; valve bodies lying in cooperating relation to said outer face of said body to cover said valve means; holding means supported by the projecting portions of said bolt means to clamp said valve bodies against said body, the clamping force exerted by said holding means being transmitted through said valve bodies to said body to force the same toward said annular member; and means for reciprocating said diaphragm.

2. In a proportional feeder of the character described, the combination of: a body of non-corrosive material having an inner face and an outer face, there being inlet and outlet ducts leading from said inner face to said outer face; a diaphragm extending across said inner face of said body; a ring engaging the peripheral portion of said diaphragm; a second diaphragm extending across the rear face of said ring, there being a chamber formed within said ring and between said diaphragms; audible alarm means operating in consequence of leakage of fluid into said chamber; valve means cooperating with said inlet and outlet ducts; and means for reciprocating said diaphragms.

3. In a proportional feeder of the character described, the combination of: a pump body having an inner face and an outer face, there being inlet and outlet ducts leading from said inner face to said outer face; a diaphragm extending across the inner face of said body; a clamping member having an annular wall to clamp said diaphragm against said body; clamping means extending from said clamping member to a point beyond the outer face of said body, there being parts on said clamping means to force said body toward said annular wall of said clamping member; valve means to cooperate with said inlet and outlet ducts, said valve means comprising valve bodies arranged to be clamped against the outer face of said body; holding means for said valve bodies carried by the portions of said clamping means which project from the outer face of said body, operative to clamp said valve bodies against said outer face of said pump body; and means for reciprocating said diaphragm.

4. In a proportional feeder of the character described, the combination of: a pump body having an inner face and an outer face, there being inlet and outlet ducts leading from said inner face to said outer face, and inlet and outlet passages formed in said body so that the inner ends thereof communicate with the outer face of said body respectively adjacent to and spaced from the outer ends of said inlet and outlet ducts; a diaphragm extending across the inner face of said body; a clamping member having an annular wall to clamp said diaphragm against said body; clamping means extending from said clamping member to a point beyond the outer

face of said body, there being parts on said clamping means to force said body toward said annular wall of said clamping member; valve means to cooperate with said inlet and outlet ducts, said valve means comprising a pair of flexible discs, one of which covers the adjacent ends of said inlet duct and said inlet passage and the other of which covers the adjacent ends of said outlet duct and said outlet passage, and a pair of cup shaped valve bodies disposed so that the lips thereof will clamp the edges of said discs against said pump body, one of said discs having an opening therethrough connecting said inlet duct with the interior of the valve body which clamps it against said pump body and the other of said discs having an opening therethrough connecting said outlet passage with the interior of the valve body which clamps it against said pump body; holding means for said valve bodies carried by the portions of said clamping means which project from the outer face of said body, operative to clamp said valve bodies against said outer face of said pump body; and means for reciprocating said diaphragm.

5. In a proportional feeder of the class described, the combination of: a pump body having an inner face and an outer face, there being a fluid duct leading from the inner face of said body to the outer face thereof; a diaphragm extending across the inner face of said body; a wall by which said diaphragm may be clamped against said body; valve means to cooperate

with the outer end of said duct, said valve means comprising a valve body adapted to be clamped against said outer face of said body; clamping means extending from said wall to a point beyond the outer face of said pump body, said clamping means having cooperating parts to force said pump body toward said wall whereby said diaphragm will be clamped between them, and having parts operative to force said valve body against said outer face of said pump body; and means for reciprocating said diaphragm.

6. In a proportional feeder of the class described, the combination of: a pump body having an inner face and an outer face, there being a fluid duct leading from the inner face to the outer face thereof; pumping means adjacent the inner face of said pump body; valve means to cooperate with the outer end of said duct, said valve means comprising a valve body adapted to be clamped against said outer face of said pump body; and clamping means extending from said pumping means to said valve means and having parts cooperating to force said pumping means toward said inner face of said pump body and force said valve body toward said outer face of said pump body.

7. A device as described in claim 6 wherein said pump body has a recess in said outer face thereof and said valve means has parts extending into said recess.

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