Aug. 12, 1969 C. E. JACKSON 3,460,482

PUMPING MECHANISMS

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FIG. 1.

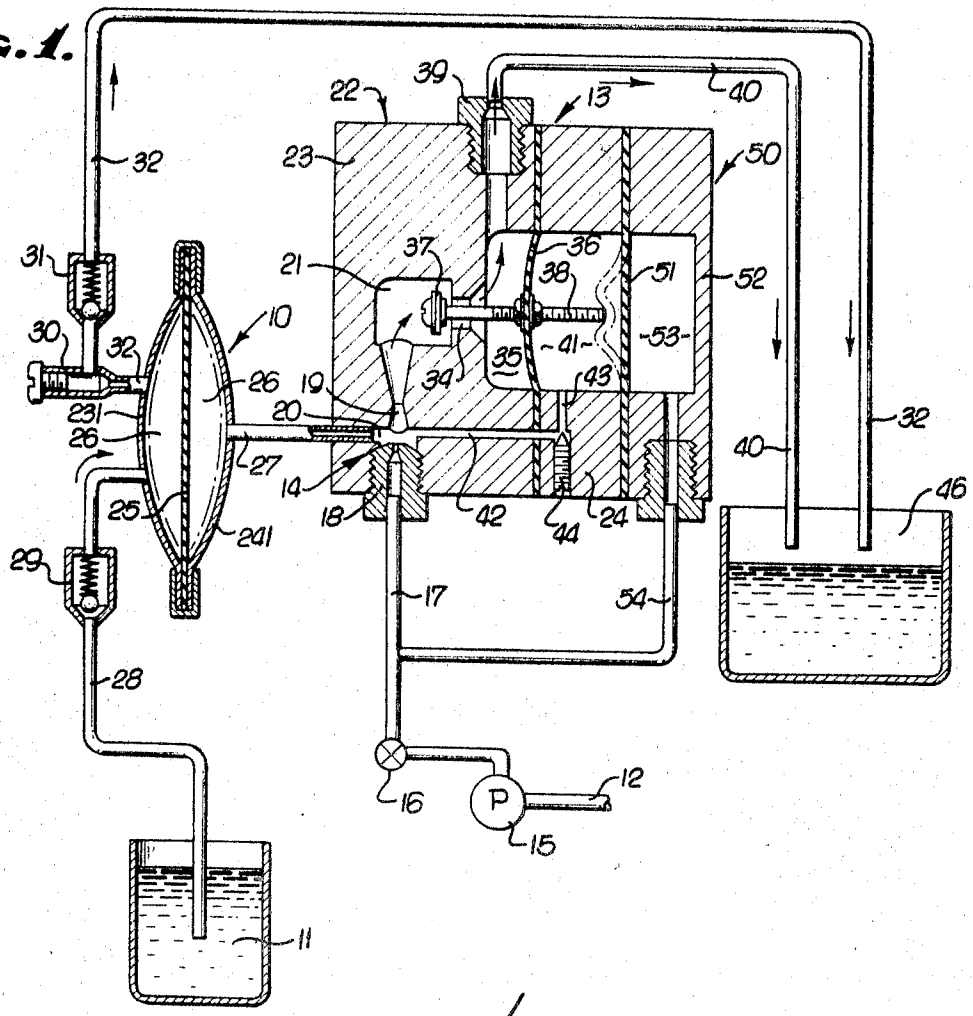


FIG. 2.

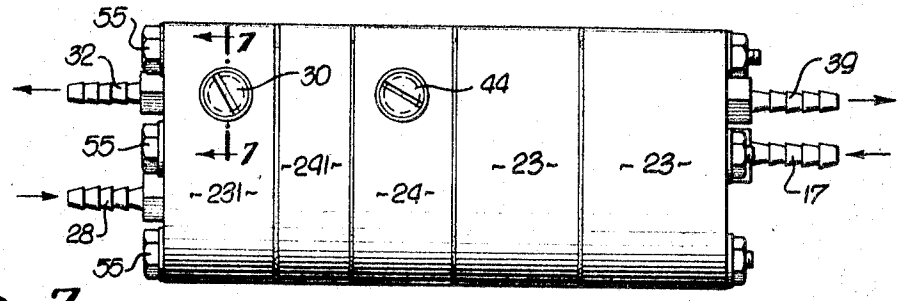
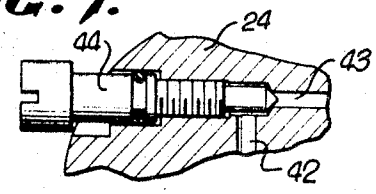


FIG. 7.



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FIG. 3.

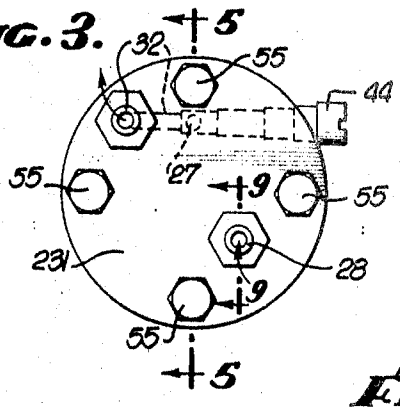


FIG. 4.

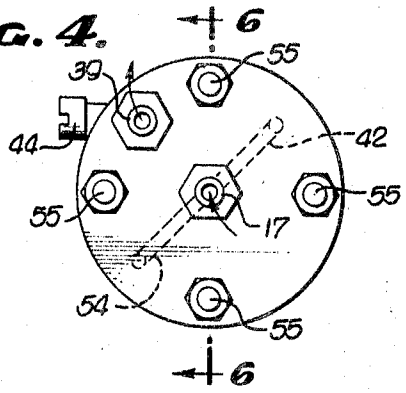


FIG. 5.

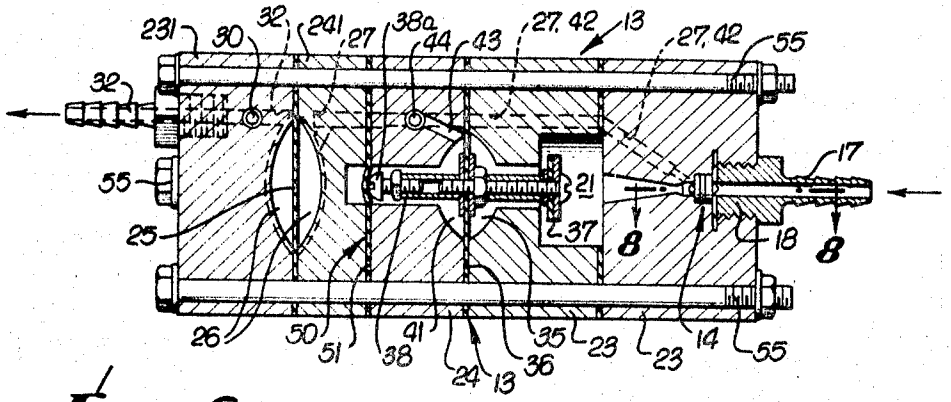


FIG. 6.

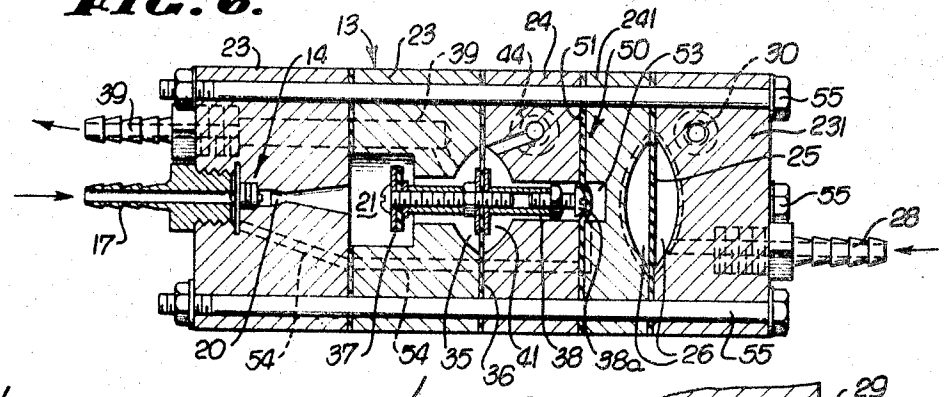


FIG. 8.

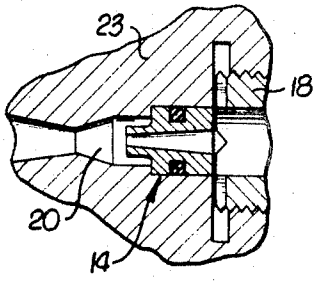
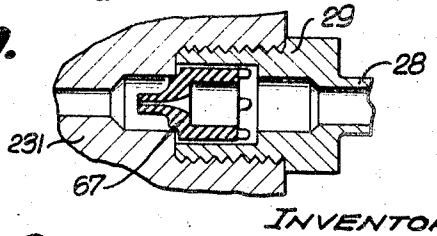


FIG. 9.



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3,460,482

PUMPING MECHANISMS

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Int. Cl. F04b *43/06*; F15b *15/18*; F16h *41/00*
U.S. Cl. 103—152 10 Claims

ABSTRACT OF THE DISCLOSURE

The invention applies to pumping systems wherein a pump operates in response to fluid pressure differentials transmitted from an eductor device through which a motive fluid is discharged and a valved oscillator causes reversal of relatively low and high pressure communications to the pump. It is found that increased inlet motive fluid pressures may tend to accelerate the valve oscillation and to undesirably increase the pump action and output. The present invention provides control means in the nature of a governor which responds to inlet motive fluid increases to restrain ungoverned oscillation of the valve and to correspondingly control the pump action.

This invention relates generally to fluid pumping systems wherein pumping motivation is achieved by the pressure pulsing of a fluid stream with corresponding response by a reciprocally displaceable pumping element. Herein the invention is concerned with improvements in the type of pumping system disclosed in the common assigned Jackson application, Ser. No. 573,943 filed Aug. 22, 1966, on Dual Fluid Pumping System, now Patent No. 3,405,-645 granted Oct. 15, 1968.

The present type of system involves maintaining a flow of fluid which undergoes restriction to create a lower or negative pressure, and intermittently restricting or closing the fluid flow downstream of the restriction to create a higher or positive pressure relative to atmospheric pressure, these pressures being communicated to a pumping element, e.g. diaphragm, which is deflected in response to the pressure changes to pump a second fluid stream. The motive fluid stream, adequately pressurized in accordance with a desired pump output pressure, is discharged through an eductor connected to the motive side of a diaphragm pump chamber so that suction displacement of the diaphragm occurs in response to the eductor-induced pressure reduction. Reverse or pumping displacement of the diaphragm at predeterminable intervals is accomplished by valving intermittently restricting or closing the motive fluid flow downstream from the eductor, thus to create cycled back pressure also transmitted from the eductor to the diaphragm for its pumping actuation.

As in my pending application referred to above, the invention employs a main stream valve-actuating oscillator diaphragm intermittently exposed at one side in accordance with the valve action to atmospheric pressure, and at its opposite side alternately to reduced and full mainstream pressures, all in a manner such that alternating back pressure increases and reliefs caused by the oscillator diaphragm closings and openings of the valve, differentially pressurize the pumping diaphragm at corresponding frequency.

Being subject to influence by variations in positive pressure transmission from the eductor and therefore to increases in the system inlet fluid pressure, it is found that such pressure increases tend to accelerate the valve action and to therefore undesirably increase the frequency of pressure cycling to the pump and consequent pump output rate. For many purposes it is desirable that the

pumping rate be more constant and less affected by inlet pressure increases and that at least any increase in that rate be well below proportionality to the fluid pressure increase.

Accordingly, my general object is to so govern the valve oscillation frequency that increased inlet fluid pressures will not adversely affect or undesirably increase the pumping rate.

Structurally the invention achieves this objective in a simple manner by association with a valve oscillating member, preferably a diaphragm, a second movable valve restraining or biasing member, also preferably a diaphragm, which is displaceable or deflectable in response to inlet fluid pressure increases so as to restrain the valve movement sufficiently to maintain the valve oscillation rate in keeping with the desired pump performance.

The invention will be given more complete explanation in the following detailed description of the accompanying drawings of illustrative embodiments, and in which:

FIG. 1 is an essentially schematic illustration of the pumping system;

FIG. 2 is a plan view of the unitized combination of the pump oscillator and control components;

FIGS. 3 and 4 are respectively left and right end elevations of FIG. 2;

FIGS. 5 and 6 are cross-sections taken respectively on lines **5**—**5** and **6**—**6** of FIGS. 3 and 4;

FIG. 7 is an enlarged fragmentary section on line **7**—**7** of FIG. 2;

FIG. 8 is a fragmentary sectional enlargement of the eductor taken on line **8**—**8** of FIG. 5; and

FIG. 9 is a fragmentary enlarged section on line **9**—**9** of FIG. 3.

In reference first to the general showing of FIG. 1, the principal components of the system include a pump generally indicated at **10** operating to displace, for example, an additive liquid **11** in predeterminable and variable relation with a pressurized fluid fed to the system from line **12**, operation of the pump **10** being controlled by response to the action of a mainstream back-pressure oscillator device **13**. As previously indicated, the pump **10** operates in response to pressure differential transmitted from an aspirator or eductor **14** under frequency or cycling control of the oscillator **13**.

In more particular reference to details, the line **12** fluid, which may be a liquid, is discharged by pump **15** under control of valve **16** through line **17** to be jetted from nozzle **18** into throat **19** so as to produce a reduced pressure or eductor effect in the space **20**. Line **17** delivers inlet fluid subject to pressure variations as for example by varying performance of the pump **15**. The throat **19** may have essentially the illustrated venturi shape enlarging into valve chamber **21**. The eductor, valve and oscillator **13** may be accommodated within a single body **22** comprising sections **23** and **24** related in the FIGS. 2 to 4 structure, and as sections of a single body containing eductor and oscillator components.

The pump **10** preferably is of a diaphragm type which in the diagrammatical showing of FIG. 1 includes body sections **231** and **241** between which is clamped a flexible diaphragm **25** reciprocally displaceable within chamber **26** between the solid and broken line positions shown, in response to differential pressures communicated to one side of the diaphragm by way of passage **27** leading from the eductor chamber **20**. Upon the diaphragm displacement from the broken to solid line positions, the liquid **11** is drawn through line **28** past check valve **29** into chamber **26**, and upon reverse displacement of the diaphragm the liquid is discharged past manually variable valve **30** and ball or other check valve **31** through outlet line **32** for any desired disposition, such as ultimate admixture with the line **17** mainstream.

The oscillator 13, like the pump, is energized by the pressurized line 17 fluid so that both the pumping energy and back-pressure cycling of the pump are energized by the mainstream liquid. Leaving chamber 21 the main fluid stream flows through passage 34 into chamber 35 at one side of the oscillator diaphragm 36, the flow into the chamber being intermittent and under control of valve 37 having a rod 38 connection with the diaphragm. From chamber 35 the fluid escapes through outlet 39 to the discharge line 40.

Chamber 41 at the opposite side of the diaphragm is in communication with the eductor space or chamber 20 by way of passage 42 (through the diaphragm) and passage 43, the communication being variably restrictable as by needle valve 44.

Leaving for later description the structural details of the FIG. 2 to FIG. 9 unitized assembly, the operation of the system may be described with reference to FIG. 1 as applied typically to the delivery of liquid hypochlorite as the number 11 liquid into swimming pool 46 in predetermined accurately meterable proportion to water being delivered to the pool by the usual circulating pump 15, ultimately through line 40.

Assuming first the valve 37 to be open and permitting relatively free flow through the outlet 39 and with the eductor communication with chamber 41 relatively restricted under control of the needle valve 44, the flow velocity through the eductor is sufficiently high to produce reduced or negative pressure communicated through passage 27 to the pumping diaphragm 25, causing the solution 11 to be drawn into chamber 26. Simultaneous communication of the reduced eductor pressure to chamber 41 causes deflection of the diaphragm 36 to close the valve 37. Thereupon the eductor pressure becomes relatively positive and to a degree at which the pump diaphragm 25 is displaced into chamber 26 to discharge the hypochlorite solution through line 32 into the pool water. Closure of the valve 37 causes the increased pressure to be transmitted to chamber 41, deflecting and restoring the diaphragm 36 to its valve-opening condition, thus completing the pumping and back-pressure cyclings of diaphragm 25 and the valve 37. As will be understood, the cycle frequency may be predetermined by combinations of such factors as effective diaphragm displacement values in relation to the pressure of the energizing main water stream, intercommunicating passage sizes, and particularly the degree of restriction in the eductor to chamber 41 communication by needle valve 44.

Upon closure of the valve 37, the chamber 41 pressure increases to a maximum and at a rate in accordance with the fluid inlet pressure from line 17. The effect of increase in that pressure as well as the resulting rate of pressure increase in chamber 41 tends to accelerate the valve opening deflection of the oscillator diaphragm 36. With the valve open, the assumed increased inlet pressure increases the rate of fluid flow through the eductor with consequent increase in the rate at which chamber 41 is depressurized and diaphragm 36 deflects to close the valve. These combined effects tend to accelerate the valve oscillation and consequently the action of the pump 10.

In order to stabilize the discharge rate of the pump against inlet pressure increases I provide a governor, generally indicated at 50, the effect of which is to bias movement of the valve increasingly as the inlet pressure increases beyond normal or a predeterminable amount. The governor 50 preferably is in the simple form of a diaphragm 51 contactable by the valve stem 38, the diaphragm being confined between body sections 24 and 52 and exposed to chamber 53 connected by passage 54 with the inlet 17 so that both chamber 53 and the diaphragm receive inlet pressure variations.

At normal or lower inlet pressure, the diaphragm 51 may have relatively little deflection toward the valve stem 38 and therefore relatively little effect in resisting its valve closing movement. As the inlet and chamber 53 pressure increases, the diaphragm is deflected, as indicated by its broken line condition, toward the valve and in so doing imposes resistance to full valve closure in that the stem is biased oppositely by central deflection of the diaphragm that occurs during full closure of the valve. The latter is thus restrained and its rate of oscillation reduced to the ultimate objective of correspondingly stabilizing the pump operation.

By varying the respective areas of the cross sectional area of passage 34 projected on downstream face at valve 37 and exposed diaphragm 51, and by changing their relative axial or horizontal positions, a variety of control relationships can be obtained as well as essentially straight line governing action.

In accordance with the unitized assembly of FIGS. 2–9, it is possible to incorporate the pumping, control and governor components in a single body structure comprising sections in numbered correspondence with the showing in FIG. 1. The body sections 23, 24, 241 and 231 are held together as by suitable fasteners such as tie bolts 55 in a manner to clamp between them the diaphragms 25, 36 and 51. Body sections 231 and 241 are cavitated to form the pumping chamber 26 communicating with passage 27 leading from the eductor 14 and with the outlet 32.

The oscillator components appearing in FIGS. 5 and 6 correspond with the FIG. 1 showing and hence require no further description other than to identify the communications in their forms suited to the unitized assembly. Here the passages corresponding to 27 and 42 in FIG. 1 are combined (denoted 27, 42) with the branch 43 passage leading to chamber 41, the communication with the pump chamber 26 continuing as passage 27 in FIG. 5. Valve 44 controlling flow through the branch passage 43 appears in FIG. 7. Thus passage 27, 42 extends through diaphragm 36 into section 24, and passage 27 continues into section 241. Passage 54 extends from the inlet 17 within sections 23 through diaphragms 36 and 51 to chamber 53.

In order to vary the positional relation between the valve and diaphragm 51, the stem 38 may be rendered axially variable as by a terminal screw 38*a*.

FIG. 9 shows the use of a rubber self-closing valve 67 instead of a ball check as indicated at 29 in FIG. 1.

I claim:

1. A fluid pumping system comprising a pump having a chamber and a reciprocally displaceable pumping element in said chamber, conduit means connected to the chamber at a first side of said element for conducting fluid to and from the chamber, means forming a fluid passage having an inlet and containing a restricted eductor connected to said chamber at a second side of said element to cause displacement thereof in one direction in response to reduced pressure communicated by virtue of fluid flow from said inlet through the eductor, oscillator means including a valve for intermittently closing said fluid passage at the discharge side of the eductor to the extent of causing transmission intermittently of positive pressure alternating with said reduced pressure from the eductor to said chamber and resultant pumping displacement of said element in an opposite direction, said oscillator means operating in accordance with pressure changes of said fluid so created to open and close the valve, and control means responsive to the inlet fluid pressure and acting to restrain movement of the valve as the inlet pressure increases.

2. A pumping system according to claim 1, in which said oscillator means is in varying pressure communication with said eductor means.

3. A pumping system according to claim 2 in which said control means is responsive to differences between the inlet fluid pressure and pressures communicated from said eductor means.

4. A pumping system according to claim 1, in which

said oscillator means comprises a first movable member for actuating the valve and responsive to said varying pressure changes of the fluid, and said control means comprises a second movable member responsive to the inlet fluid pressure.

5. A pumping system according to claim 1, comprising a single body structure containing both said pump, oscillator means and control means.

6. A pumping system according to claim 1, in which said oscillator means comprises a displaceable diaphragm connected to the valve and said control means comprises a second diaphragm responsive to the inlet fluid pressure.

7. A pumping system according to claim 6, comprising a unit body structure having a pair of sections between which said diaphragms are confined.

8. A pumping system according to claim 1, comprising a body containing said eductor and oscillator means which includes a chamber receiving fluid flow from the eductor and a first diaphragm in the chamber, said valve being connected to the diaphragm and operable thereby to control fluid flow from the eductor into the oscillator chamber at one side of the diaphragm and thence to an outlet, means forming a communication between the eductor and oscillator chamber at the opposite side of the diaphragm, said control means comprising a second valve biasing diaphragm exposed at one side to the pressure in said chamber and at its opposite side to the inlet fluid pressure.

9. A pumping system according to claim 8, in which the valve is engaged with said second diaphragm which increasingly restrains closing of the valve as the inlet pressure increases.

10. A pumping system according to claim 9, in which said pumping element is a diaphragm and the pumping system is contained in a unit body having sections between which all the said diaphragms are separately confined.

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ROBERT M. WALKER, Primary Examiner

U.S. Cl. X.R.

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