

Oct. 5, 1948.

C. A. ELWOOD
CONSTANT FLOW PUMP

2,450,751

Filed March 7, 1946

2 Sheets-Sheet 1

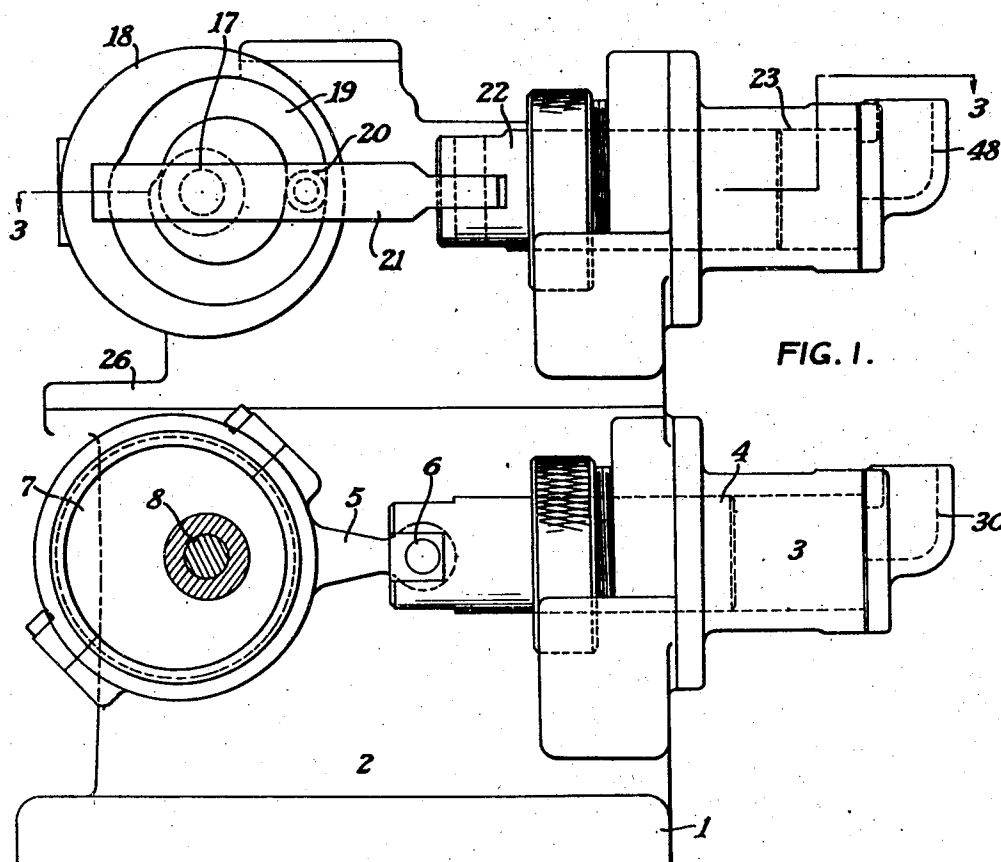


FIG. 1.

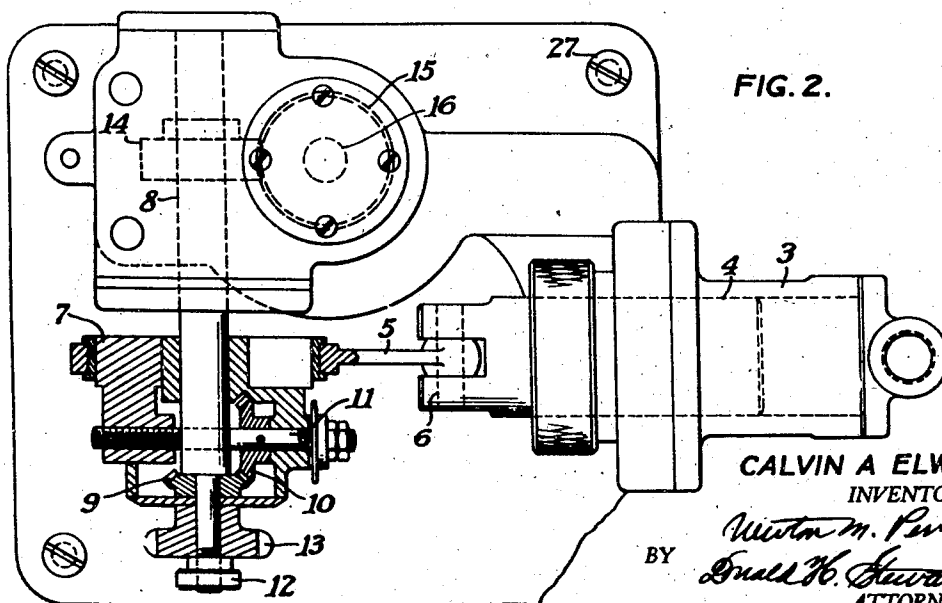


FIG. 2.

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2 Sheets-Sheet 2

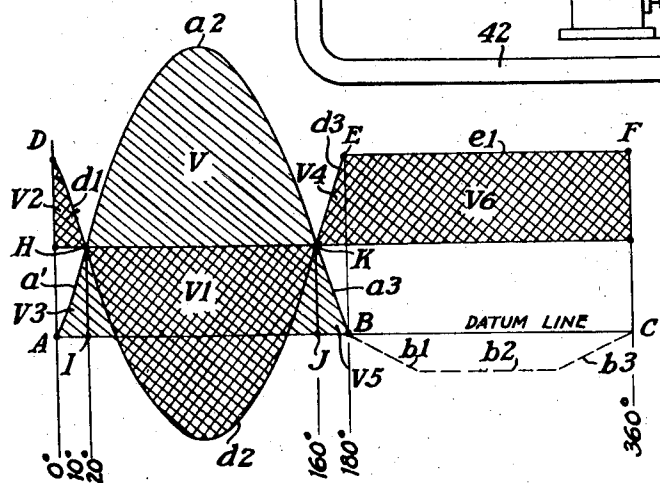
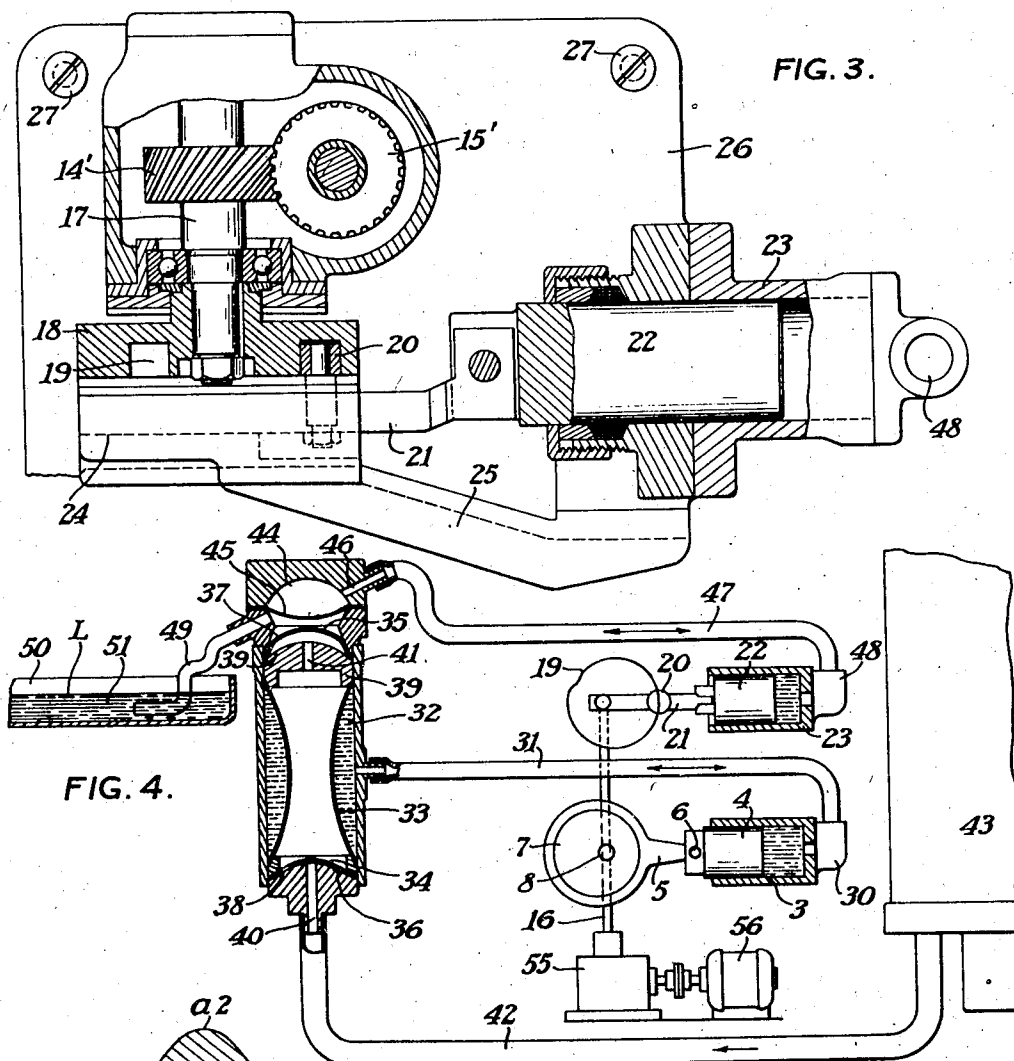


FIG. 5.

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UNITED STATES PATENT OFFICE

2,450,751

CONSTANT FLOW PUMP

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Application March 7, 1946, Serial No. 652,508

8 Claims. (Cl. 103—44)

1

This invention relates to pumps, and particularly to pumps designed to deliver a substantially constant flow of fluid. One object of my invention is to provide a pump by which fluid may be moved at a substantially uniform rate and in which the usual pulsations are reduced to a minimum or are eliminated. Another object of my invention is to provide a pump in which one cylinder is arranged to deliver fluid in surges to a chamber to which a second cylinder is connected in such a manner that the pulsating strokes of the first cylinder are offset by the pulsating strokes of the second cylinder to deliver a substantially constant flow of fluid. A still further object of my invention is to provide a simple type of hydraulically-operated pump particularly adapted for use in feeding fluids which must not be contaminated through contact with lubricated pump parts. Other objects will appear from the following specification, the novel features being particularly pointed out in the claims at the end thereof.

My pump is for an improvement over the metering pump shown in U. S. Patent 2,313,551, Hurlbut, granted March 9, 1943, and a portion of my pump closely resembles, in many respects, the pump shown in this patent. However, my improved form of pump differs from the Hurlbut patent in that I utilize two cylinders so arranged that the fluid delivered in surges by one cylinder is turned into a substantially constant delivery flow through the use of a second cylinder connected into the system.

I am aware that it is not broadly new to provide two hydraulic cylinders operating in timed relation, since such a pump is shown in British Patent 7,172, Carruthers, May 8, 1890. This patent shows a two-cylinder hydraulic pump of the general type I am using, but in this patent one cylinder delivers a surge of fluid during one stroke, and the second cylinder delivers a second surge of fluid during a second stroke. The two cylinders are not arranged as in my invention, so that the surge of one cylinder is offset by the surge in the second cylinder.

Coming now to the drawings wherein like reference characters denote like parts throughout:

Fig. 1 is a side elevation of a pump, certain details being omitted, constructed in accordance with and embodying a preferred form of my invention;

Fig. 2 is a top plan view of the pump shown in Fig. 1 with certain parts in section and shown somewhat diagrammatically;

2

Fig. 3 is a section taken on line 3—3 of Fig. 1, parts being shown in elevation;

Fig. 4 is a schematic part-section and part-elevation view illustrating the principle of my improved pump, and

Fig. 5 is a diagram illustrating the results obtained with my two-cylinder pump in terms of fluid pumped.

My invention comprises broadly a hydraulically-operated pump in which a main cylinder is arranged to deliver surges of fluid in a pulsator as a piston moves pulsating fluid to and from a cylinder while moving with a simple harmonic motion. At the same time a second pulsator, which includes a cam-operated piston, causes pulsating fluid to move to and from a flow chamber in such a manner that the fluid delivered from the flow chamber is moved at a substantially constant rate. If it were not for the limitations imposed by mechanical designs of cams, a perfectly even delivery of fluid could be obtained, but in order to produce a cam-driven pulsator which will withstand wear, a pump can be produced in which there is a scarcely noticeable pulsation at one point and for most purposes this can be considered an even delivery of fluid. Valve design also enters into this problem as an instantly closing valve is generally not obtainable, so that minute variations in flow may result from differential time lag in valve operation. It is comparatively difficult from the practical standpoint to detect the slight variation in flow which may occur with the pump which will now be more fully described.

Referring to Fig. 1, the pump may include a base 1 from which a frame-plate 2 extends upwardly, this frame-plate carrying a cylinder 3, in which a piston 4 may be moved back and forth with a simple, harmonic motion by means of a crank 5. This crank is pivoted at 6 to the piston 4 and driven by an eccentric 7 carried and driven by a power-driven shaft 8. While mechanism including set screw 12, handwheel 13 and bevel gears 9 and 10 are provided for altering the position of eccentric 7 relative to shaft 8 to vary its stroke, this is only a factory adjustment and the stroke will always remain the same with any given cam 18. Gear 10 turns screw 11 carrying the eccentric 7.

The shaft 8 is connected by means of spiral gears 14 and 15 to a vertical shaft 16. A similar pair of gears 14' and 15' drives a shaft 17 to which a cam 18 is keyed, as shown in Fig. 3. From Fig. 1 it will be noted that the cam 18 is provided with a cam slot 19 in which a roller 20, carried

3

by reciprocating link 21 is attached, so that this reciprocating link may drive a piston 22 entering the cylinder 23. The reciprocating link 21 may move in a suitable guideway 24, as best shown in Fig. 3, this guideway being carried by bracket 25 attached to a base plate 26, this plate in turn being preferably attached by screws or bolts 27 to the frame plate 2. The vertical shaft 16 may be driven by any suitable source of power such as motor 56. The two pistons are therefore driven in synchronism by the same power drive.

The cylinder 3 is provided with a fluid outlet 30, this fluid outlet, as indicated more or less diagrammatically in Fig. 4, being connected by means of a pipe 31 to a pulsating chamber 32. This pulsating chamber is provided with a flexible diaphragm 33, a fluid-inlet means consisting of a valve 34 and a fluid-outlet means consisting of a valve 35. These two valves are one-way valves and they may be conveniently made of sheets of perforated flexible material, the perforations 36 and 37 being positioned to lie against valve seats 38 and 39 which are apertured at 40 and 41 to permit surges of the fluid being pumped to pass through the pumping chamber. The inlet opening 40 is connected by a pipe 42 to a supply of fluid 43 and this supply should be positioned to eliminate any appreciable head of fluid entering the pipe 42.

At the end of the outlet valve 35 there is a flow chamber 44 in which there is a flexible wall 45. This flexible wall is positioned in accordance with the flow of pulsating fluid to and from the chamber 44 through the opening 46, pipe 47, and the fluid exit 48 of the cylinder 23. This back-and-forth pulsating flow is caused by the piston 22 which, as above described, is moved by a cam path 19 and a roller 20 as above described.

From the flow chamber above valve 35 a delivery tube 49 leads, in this instance, to a tray 50 so that the fluid 51 being pumped may be maintained substantially at the desired level L. In the present instance I propose to pump a more or less viscous

4

"A" continuing upwardly along the lines *a1*, *a2*, *a3*, and ending at "B," this area designating the displacement of fluid due to the piston stroke in one direction. The return stroke of the cylinder may be designated as "B," *b1*, *b2*, *b3*, and "C." Thus, if the single cylinder 3 were used as a pulsator, the pumped fluid would be delivered in the surge designated broadly as "B" during its stroke from "A" to "B" and, of course, the inlet and outlet valves would be closed and no fluid would be delivered between its stroke from "B" to "C."

To even out this flow, the equalizing cylinder 23 is provided with a cam drive which moves the piston 22 differentially with respect to the piston 4 to offset the surge of the cylinder 3 to such an extent that an even, or substantially even, flow is delivered from the flow chamber through the pipe 49. The cam 19 is so designed that the cylinder 23 may deliver pulsating fluid to the flow chamber 44 above the flexible diaphragm 45 as indicated in the diagram, Fig. 5, as follows: Starting at "D," the stroke of the piston 22 will displace fluid as shown by the line *d1*, *d2*, *d3*, ending at "E," and continuing along the line *e1* to "F." The volume of the roughly triangular area V2 is equal in area to the volume of the roughly triangular section V3 so that the first twenty degrees of the two strokes are equalized. The volume V is greater than the volume V1 by an amount equal to the area, H, I, J, and K. Thus, the stroke in the main cylinder delivers a quantity of pulsating fluid which is even because the surge is offset by the compensating cylinder 23 altering the size of the flow chamber 44.

The roughly triangular areas V4 and V5 offset each other, and the area V6 indicates an even quantity of pulsating fluid delivered by the cylinder 23 during the time of the return stroke of the main cylinder 4, the volume being delivered from the flow chamber 44 due to movement of flexible wall 45. In order to indicate the timing of the two pistons, reference may be had to the following "Table of function" given in degrees of strokes.

Table of function

	Pump 3	Cam Pump 23	Diaphragm 33	Inlet Valve 36	Outlet Valve 35	Diaphragm 45	Outlet 49
0°-20°	Pressure +	Pressure	Contracts (Shown)	Closed (Shown)	Open (Shown)	Pressure (Shown)	Uniform Flow.
20°-160°	Pressure -	Suction	Contracts	Closed	Open	Suction	Do.
160°-180°	Pressure +	Pressure	do	do	do	Pressure	Do.
180°-360°	Suction	do	Expands	Open	Closed	do	Do.

fluid material into a coating pan and I desire to maintain the level L substantially constant so that an even quantity may be applied to a base material to be coated.

It should be noticed that the fluid being pumped never comes in contact with any parts of a pump which require lubrication and, consequently, the viscous fluid cannot be contaminated or diluted as it passes through the pump. It should also be noticed that the pulsating fluid, which is oscillated by the pistons and cylinders, is kept entirely separate from the fluid being pumped, and that the two cylinders operating in timed relation will oscillate the pulsating fluid in the pump and flow chambers as will be hereinafter more fully described. As shown in Fig. 4, the vertical shaft 16 may be driven through a gear reduction contained in the housing 55 from a motor 56.

Referring now to Fig. 5, the pulsating flow of the main pulsating cylinder 3, which as above explained is driven in a simple, harmonic motion, is shown in the diagram by the area starting at

I have illustrated by the diagram of Fig. 5 and the above "Table of function" the relationship of the two cylinders when one is driven by a simple, harmonic motion since I prefer this construction because, in addition to furnishing the fluid to the main pulsating chamber 32 and to the flow chamber 44, the construction of the pump must be such that the inlet valve 34 and the outlet valve 35 will open and close smoothly in the proper relation. It is obvious, particularly from the "Chart of function," that the strokes of the two cylinders are offset in such a manner that when the material being pumped passes too rapidly into the flow chamber 44, the size of this chamber will be increased, and when the fluid is pumped either too slowly, or is not pumped into the flow chamber, the diaphragm 45 will be moved by the cam-operated piston 22 to expel the fluid being pumped from the chamber in an even flow through the pipe 49. It is obvious to one skilled in the art that other means of operating the pistons may be designed and each piston may be driven by a

5

cam instead of having one piston moved with a simple, harmonic motion although I prefer this later motion because of its desirable action upon the inlet and outlet valve.

Where I refer to a "constant" or "even" flow in the specification and claims, I mean this term to be considered as including a substantially constant or substantially even flow as there are liable to be slight deviations from an exact or precise even or constant flow, which may be due to either valve operations or cam design, or both. Nevertheless, the flow is such that an extremely uniform delivery of the pumped fluid may be maintained and for practical purposes it is constant. The fluid being pumped never comes in contact with parts of the pump which need to be lubricated and, therefore, cannot become contaminated.

While I have described a preferred embodiment of my invention, it is obvious that various changes can be readily made therefrom without departing from my invention as defined in the following claims.

I claim:

1. A hydraulically driven pump, comprising, in combination, a flexible suction chamber, a hollow pulsating chamber carrying the suction chamber, inlet and outlet means leading to and from the flexible suction chamber, a flow chamber at the outlet end communicating with the outlet means of the suction chamber, a delivery pipe leading from the flow chamber, a flexible wall in the flow chamber, pistons and cylinders for moving a pulsating fluid to and from the pulsating chamber to exert pressure upon the flexible suction chamber and to and from the flow chamber to exert pressure on the flexible wall in the flow chamber, and means for correlating the respective strokes of the pistons to deliver a constant even flow of fluid through the delivery pipe.

2. A hydraulically driven pump, comprising, in combination, a flexible suction chamber, a hollow pulsating chamber carrying the suction chamber, inlet and outlet means leading to and from the flexible suction chamber, a flow chamber at the outlet end communicating with the outlet means of the suction chamber, a delivery pipe leading from the flow chamber, a flexible wall in the flow chamber, pistons and cylinders for moving a pulsating fluid to and from the pulsating chamber to exert pressure on the flexible suction chamber and to and from the flow chamber to exert pressure on the flexible wall therein, and means for correlating the respective strokes of the pistons to deliver a constant even flow of fluid through the delivery pipe, said means comprising a source of power, and means for differentially driving one piston with respect to the other to offset the surges produced by the other piston.

3. A hydraulically driven pump, comprising, in combination, a flexible suction chamber, a hollow pulsating chamber carrying the suction chamber, inlet and outlet means leading to and from the flexible suction chamber, a flow chamber at the outlet end communicating with the outlet means of the suction chamber, a delivery pipe leading from the flow chamber, a flexible wall in the flow chamber, pistons and cylinders for moving a pulsating fluid to and from the pulsating chamber to exert pressure on the flexible suction chamber and to and from the flow chamber to exert pressure on the flexible wall therein, and means for correlating the respective strokes of the pistons to deliver a constant even flow of fluid through the delivery pipe, said means comprising a source of power, and means for differentially driving one

6

piston with respect to the other and in a generally opposite direction and to a different extent whereby the surges of one piston stroke may be offset by the surges of the other piston stroke.

4. A hydraulically driven pump, comprising, in combination, a flexible suction chamber, a hollow pulsating chamber carrying the suction chamber, inlet and outlet means leading to and from the flexible suction chamber, a flow chamber at the outlet end communicating with the outlet means of the suction chamber, a delivery pipe leading from the flow chamber, a flexible wall in the flow chamber, pistons and cylinders for moving a pulsating fluid to and from the pulsating chamber to exert pressure on the flexible suction chamber and to and from the flow chamber to exert pressure on the flexible wall therein, and means for correlating the respective strokes of the pistons to deliver a constant even flow of fluid through the delivery pipe, said means comprising a source of power, and means for differentially driving one piston with respect to the other, the stroke of one piston being substantially twice that of the other piston and in an opposite direction thereto.

5. A hydraulically driven pump, comprising, in combination, a flexible suction chamber, a hollow pulsating chamber carrying the suction chamber, inlet and outlet means leading to and from the flexible suction chamber, a flow chamber at the outlet end communicating with the outlet means of the suction chamber, a delivery pipe leading from the flow chamber, a flexible wall in the flow chamber, pistons and cylinders for moving a pulsating fluid to and from the pulsating chamber for exerting pressure on the flexible suction chamber and to and from the flow chamber to exert pressure on the flexible wall therein, a source of power for driving the pistons in synchronism, at least one piston drive comprising a cam shaped to move said piston to offset the surges in the pumping chamber caused by the other piston whereby a substantially constant flow may be obtained from the delivery pipe.

6. A hydraulically driven pump, comprising, in combination, a flexible suction chamber, a hollow pulsating chamber carrying the suction chamber, inlet and outlet means leading to and from the flexible suction chamber, a flow chamber at the outlet end communicating with the outlet means of the suction chamber, a delivery pipe leading from the flow chamber, a flexible wall in the flow chamber, pistons and cylinders for moving a pulsating fluid to and from the pulsating chamber to exert pressure on the flexible suction chamber and to and from the flow chamber to exert pressure upon the flexible wall therein, a source of power, a crank driven thereby for moving the piston relative to the cylinder connected to the pulsating chamber, a cam driven by the source of power for moving the piston relative to the cylinder connected to the flow chamber to alter the position of the flexible wall therein to compensate for changes in shape of the flexible suction chamber to reduce surges passing through the delivery pipe.

7. A hydraulically driven pump, comprising, in combination, a flexible suction chamber, a hollow pulsating chamber carrying the suction chamber, inlet and outlet means leading to and from the flexible suction chamber, a flow chamber at the outlet end communicating with the outlet means of the suction chamber, a delivery pipe leading from the flow chamber, a flexible wall in the flow chamber, pistons and cylinders for pulsating a pulsating fluid to and from the pulsating

7

ing chamber to exert pressure on the flexible suction chamber and to and from the flow chamber to exert pressure upon the flexible wall therein, a source of power, means carried thereby to differentially drive the pistons to deliver differential flows of pulsating fluid to the pulsating and flow chambers whereby the fluid delivered from the flow chamber may be substantially constant.

8. A hydraulically driven pump comprising, in combination, a hollow pumping chamber, a flexible suction chamber therein, dividing the pumping chamber into compartments for the pulsating fluid and the pumped fluid, inlet and outlet means leading to and from the flexible suction chamber, a flow chamber at the outlet end of the suction chamber, a flexible wall dividing the flow chamber into compartments for the pulsating fluid and the pumped fluid, a pair of cylinders and pistons, a pipe connecting one of said cylinders with the pulsating fluid compartment of the pumping chamber, a pipe connecting the second of said cylinders with the pulsating fluid compartment of the flow chamber, means for driving the

8

piston of the first cylinder with a simple, harmonic motion, a cam for driving the piston of the second cylinder in timed relation to the movement of the first cylinder piston at varying accelerations whereby the flexible wall of the flow chamber may be moved to offset the surges of the piston moved with a simple, harmonic motion, and a delivery pipe leading from the pumped fluid compartment of the flow chamber to deliver a substantially even flow of the pumped solution therefrom.

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REFERENCES CITED

15 The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,186,972	Hollander et al.	Jan. 16, 1940
2,204,854	Hambly	June 18, 1940
2,307,566	Broune	Jan. 5, 1943
2,313,551	Hurlbut	Mar. 9, 1943