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MULTI-SYRINGE-TYPE PUMP

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2 Sheets-Sheet 1

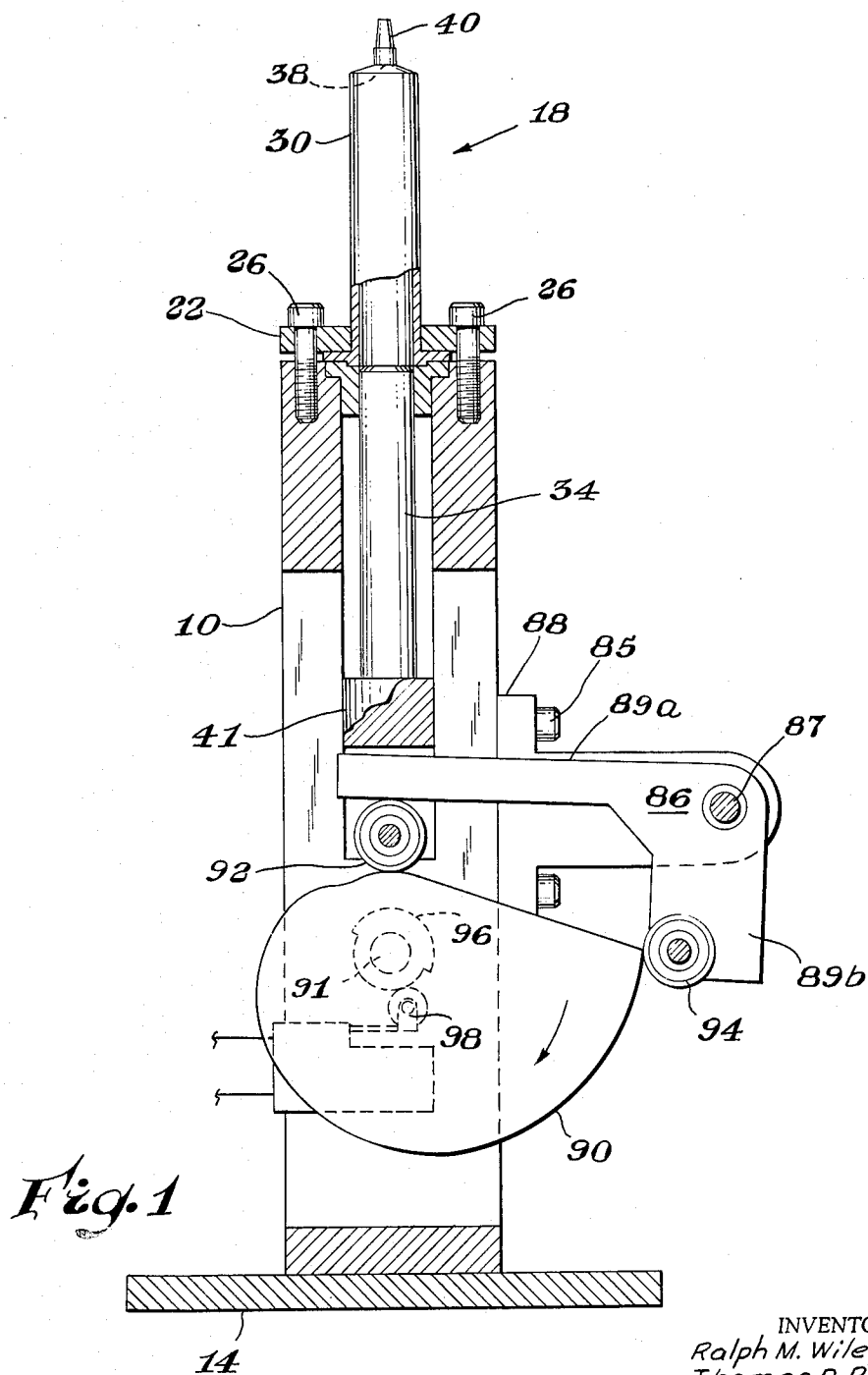


Fig. 1

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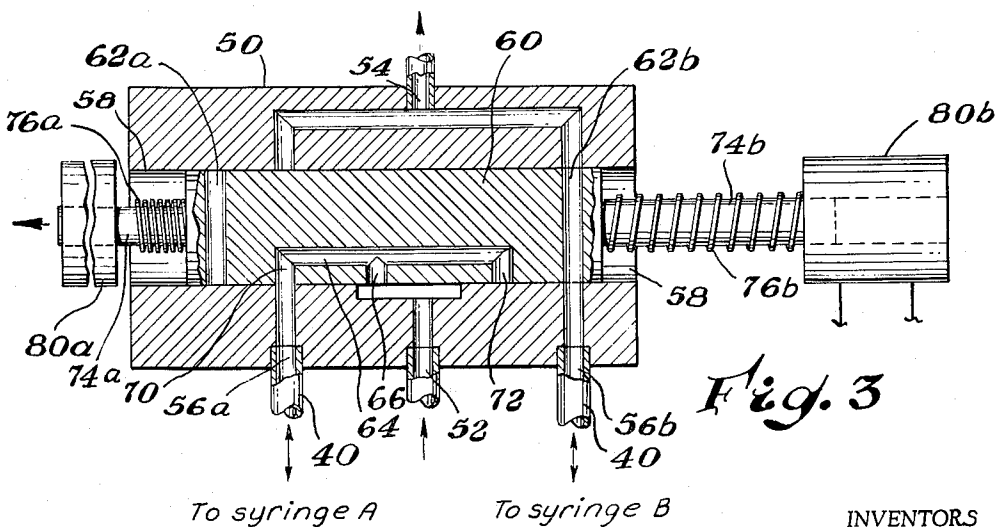
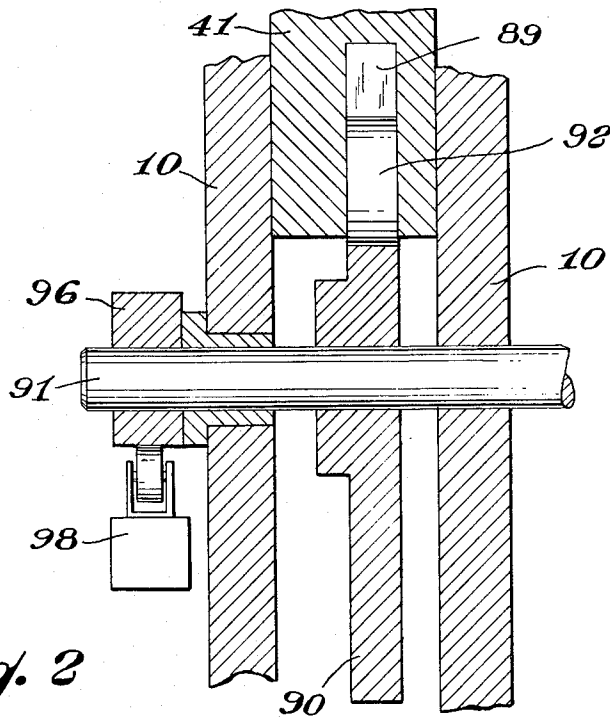
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MULTI-SYRINGE-TYPE PUMP

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This invention relates to multi-syringe-type pumps and, more particularly is concerned with an improved multi-syringe-type pump which has electrically operated inlet and outlet valves system and a mechanism to drive each syringe linearly in two directions.

In conventional syringe-type pumps the return or suction stroke is actuated either by springs, in which case the pump is subject to failure due to sticking of the syringes, or by face cams which add considerably to the cost of manufacture. Further the inlet and outlet valves employed in such syringe pumps are either check valves or mechanically-operated valves. Check valves are subject to the following failures and shortcomings:

(a) Failure to close tightly when the fluid contains dirt or other solid particles in suspension;

(b) reverse flow or leakage during the time required for valve closure;

(c) variations in closure time due to variations in fluid viscosity and/or pressure drop across the valve; and

(d) opening and forward leakage when and if the intake pressure exceeds the discharge pressure.

Mechanically operated valves are subject to one or more of the following disadvantages:

(a) Leakage around valve stems and seals;

(b) high power requirements when seals are made under high pressure to avoid leakage;

(c) slow action when geared directly to the pump mechanism; and

(d) complete failure when spring powered valves or plug-cocks are used to obtain fast valve action.

The present invention avoids these problems by employing (1) a simple plate cam and a pivoted return arm to drive each syringe linearly in both directions and (2) solenoid-operated valves which do not draw power from the pump mechanism, are fast-acting, and precisely timed with the syringe operations by means of an electrical switch actuated by the pump mechanism.

It is an object of the instant invention to provide an improvement in a multi-syringe-type pump which makes unnecessary either the use of springs which can stick or expensive face cams as a driving means for actuating the syringes.

It is an additional object to provide an improved multi-syringe-type pump which does not contain unreliable and inefficient check valves or mechanically operated valves as inlet and outlet valves.

Other objects and advantages of the instant invention will become apparent from reading the detailed description thereof set forth hereinafter in conjunction with the accompanying drawings wherein:

FIGURE 1 is a side elevational view, partially in section of an embodiment of a syringe pump showing the improved driving mechanism of the present invention.

FIGURE 2 is a fragmentary view, partially in section, of the syringe pump depicted in FIGURE 1.

FIGURE 3 is a side elevational view, partially in section of one embodiment of an electrically operated valve mechanism suitable for use in the instant invention.

In general the improvement in a multi-syringe-type pump of the present invention comprises a simple, inexpensive positive plate cam and pivoted return arm device for driving the syringes linearly in both directions and a 4-way electrically operated inlet and outlet valve system for each pair of syringes.

More specifically, and referring to the drawings in more detail wherein like numerals represent like parts in the several views, FIGURE 1 shows one embodiment of the present invention as utilized in a syringe-type pump. The pump shown in FIGURE 1 illustrates a single syringe and includes a body 10 resting on a base 14. A syringe assembly 18, is attached to the body 10 by suitable means such as retainer 22 and bolts 26 as shown. The syringe 18 is comprised of a hollow cylinder 30 and a plunger shaft 34 made to snugly and slidably fit within syringe cylinder 30. The cylinder 30 has an orifice 38 at its end and a nozzle 40 positioned over said orifice as shown. The end of the plunger shaft 34 farthest from said nozzle and orifice has a shoulder 41 which slidably fits within said body 10. Plunger shaft 34, ordinarily, is centered with respect to shoulder 41 thereby assuring alignment of the shaft 34 within cylinder 30 as shaft 34 moves linearly within the cylinder 30 during operation.

The instant improvement to the syringe driving mechanism comprises a positive actuating mechanism for driving the plunger shaft 34 back and forth within the syringe cylinder 30. This device as applied to a single syringe is comprised of an L-shaped elongated member or return arm 86 which is pivotally mounted on body 10 via shaft 87 mounted on bracket 88, said bracket being attached to body 10 by means of threaded bolts 85. Leg 89a of said return arm 86 is positioned in a recess at the bottom of shoulder 41 of the plunger shaft 34 of said syringe 18 above and contacting a cam roller 92 which is rotatably mounted within the recess of shoulder 41 of said plunger shaft 34. A plate cam 90 is pivotally mounted on said body 10 by means of shaft 91 below and contacting cam roller 92. Shaft 91 is driven by power means not shown. A return arm roller 94 is rotatably mounted to a second leg 89b of said return arm 86 near the end opposite the contacting cam roller 92 and is in contact with said plate cam 90. A valve cam 96 is fixedly mounted on the end of shaft 91 on the side of pump body 10 opposite cam 90, said valve cam 96 rotating when said plate cam 90 rotates. A switch 98, e.g. a microswitch, is in contact with valve cam 96. During operation switch 98 is activated by movements of valve cam 96, said switch in turn actuating a solenoid 80 or other mechanism for activating the electrically operated valves as shown in FIGURE 3. In the complete assembly, solenoids 80 and said switch 98 are connected electrically to each other and to a power source not shown.

It is to be understood that in a multi-syringe-type pump a plurality of syringes similar to that described hereinbefore are utilized.

Additionally the improvement of the instant invention comprises a 4-way electrically operated inlet and outlet valve system for each pair of syringes used in a multi-syringe-type pump.

FIGURE 3 depicts one embodiment of such an electrically operated valve of the present invention. In this embodiment, the valve comprises valve frame 50 containing liquid inlet 52, liquid outlet 54, and a pair of syringe passageways 56a and 56b each accommodating a syringe nozzle 40. Valve frame 50 contains a hollow passageway 58 extending the length of said frame. Valve core 60 snugly and slidably fits within the passageway 58.

Valve core 60 contains core passageways 62a and 62b, one of which, depending on the position of the core, at a given position is in line with the corresponding syringe passageway 56a or 56b thereby providing communication with one of said syringe 18 and outlet passage 54. Valve core 60, in addition, contains a three pronged passageway 64, the middle prong 66 of which is always in communication with liquid inlet 52. One of the other two prongs 70 and 72, depending on the position of core passageway 62a or 62b with respect to the corresponding

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syringe passageway 56a or 56b, is in communication with the other passageway 56a or 56b which is not communicating with outlet passage 54. Valve core 60 has core arms 74a and 74b connected to valve frame 50 via spring 76a and 76b respectively. Solenoid winding 80a and 80b encircle core arms 76a and 76b respectively external to frame 50. Spring 76b, connected to core arm 74 and valve core 60, is in tension when the valves are in the position as shown in FIGURE 2. Correspondingly spring 76a connected to core arm 74a, at the depicted position, is in compression. When valve core 60 is in the alternate valving position such that valve core passage 62a mates with syringe passage 56a and prong 72 mates with syringe passage 56b, the spring 76b is under compression with spring 76a being under tension.

The novel drive mechanism shown in FIGURE 1 and the electrically operated valve system of FIGURE 3 during pumping operation function as follows: In the depicted position of plate cam 90, the return arm 86 acting on the cam roller 92 has forced the plunger shaft 34 down and liquid has filled the syringe through the solenoid valve (i.e. valve communication means 56a). During this period syringe B (not shown) is discharging liquid through syringe passage 56b, valve core passage 62b and outlet passage 54. As readily can be seen from FIGURE 1, the plate cam 90 has three separate motions that it imparts to the cam roller 92 in one complete revolution. Approximately 240° of the revolution is uniform rise, approximately 30° dwell time and approximately 90° quick return. As the plate cam 90 continues in a revolution, the cam roller 92 and syringe shaft 34 starts the uniform rise pushing return arm 86 upwards at the same time. At approximately the same time, the valve cam 96 trips a microswitch 98 to reposition one solenoid 80 in the valve assembly so that the liquid can pass out of the one syringe, through the valve and exit from the valve outlet 54 during the 30° dwell time of the cam revolution. At the end of the dwell time the return arm roller 94 contacts the plate cam 90 during the 90° quick return. The return arm 86, especially leg 89a, is lowered by the action of the plate cam 90 on the return arm roller 94, said leg 89a in turn pushing against return arm roller 92 thereby lowering syringe shaft 34 into a lowered position as shown in FIGURE 1. This action is repeated on a cyclic basis during pump operation.

It can be seen from the figures that if two cams of the same design are mounted on a common shaft, but opposed 180° apart on uniform use, a continuous flow of liquid can be pumped with the two syringes through the solenoid valve.

Similarly, the cams and valves in a number of pump assemblies can be so arranged to provide continuous flow of liquid.

The materials of construction for the instant pump depend on the type of liquid to be pumped and the pumping rate desired and is no way a part of the instant invention. Liquids which are suitable for pumping by the present invention include aqueous, acidic, basic, organic and the like.

Various modifications can be made in the improvement of the instant invention without departing from the spirit or scope thereof, for it is to be understood that we limit ourselves only as defined in the appended claims.

What is claimed is:

1. In a multi-syringe-type pump having a body resting

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on a base, a plurality of syringes supported by said body, each syringe having a hollow cylinder, a plunger shaft snugly and slidably fitted within said cylinder, each cylinder having an orifice at its end and a nozzle positioned over said orifice, and a liquid inlet and a liquid outlet in communication with each of said syringes of said pump, the improvement which comprises:

- (a) an electrically operated 4-way inlet and outlet valve system in communication with each pair of said syringes; and
- (b) a two directional plunger drive mechanism in communication with each syringe, said drive mechanism comprising:

- (1) a shaft rotatably mounted in the pump body below said plunger shaft of said syringe;
- (2) power means to drive said shaft;
- (3) a plate cam fixedly mounted on said shaft;
- (4) a cam roller rotatably mounted on the plunger shaft of said syringe and in contact with said plate cam;
- (5) an L-shaped return arm pivotally attached to the pump body, one leg of said L-shaped member being positioned on top of and in contact with said cam roller; said cam roller thereby being positioned intermediate said return arm and said plate cam;
- (6) a return arm roller rotatably mounted on the second leg of said L-shaped return arm and in contact with said plate cam;
- (7) a valve cam fixedly attached on said shaft; and
- (8) a switch contacting said valve cam and activated by said valve cam, said switch electrically being connected to said electrically operated 4-way valve system.

2. The improvement in accordance with claim 1, wherein said electrically operated liquid inlet and liquid outlet valve system is comprised of:

- (a) a valve frame containing a liquid inlet, a liquid outlet, syringe passageways for each of said syringes, and a hollow passageway running the length of said frame;
- (b) a valve core containing two core passageways, one of said core passageways at all times being in line with one of said syringe passageways and the liquid outlet, and a three pronged passageway, the middle prong of which is always in communication with said liquid inlet and one of the other two prongs, depending on the position of the core passageways with respect to the corresponding syringe passageways is in communication with the other syringe passageway which is not in communication with the liquid outlet;
- (c) a pair of springs connecting said frame connected to said each end of said valve core; and
- (d) a solenoid winding encircling each end of said valve core.

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