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[54] **DOUBLE ACTING PUMP**

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[52] **U.S. Cl.** **417/362,** 417/419, 417/486

[51] **Int. Cl.** **F04b 35/04,** F04b 23/06

[58] **Field of Search**.... 417/362, 486, 419, 426–429, 417/522

[56] **References Cited**

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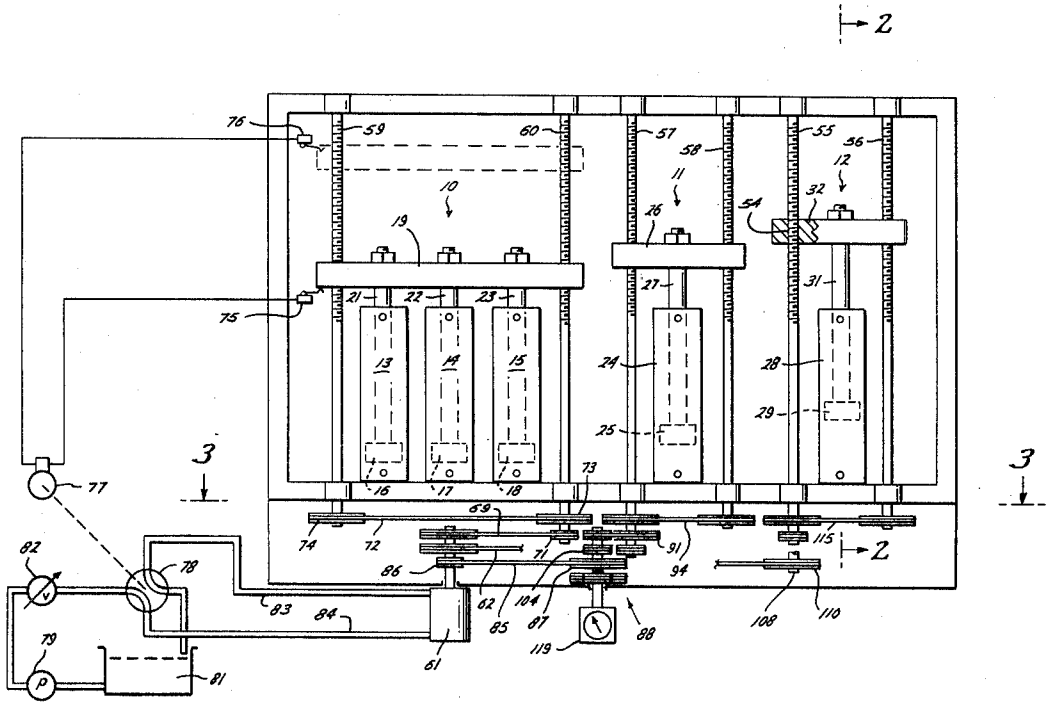
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Primary Examiner—William L. Freeh

[57] **ABSTRACT**

A pump for pumping a plurality of fluids simultaneously each section of the pump employing pistons and cylinders in pairs with the piston simultaneously moving in opposite directions so that the total output of each pair of pistons is constant. Several sections of the pump run at different rates of speed from a single variable speed motor. While the ratio of output between the pump sections remains the same, the total output of the entire pump is variable.

2 Claims, 3 Drawing Figures



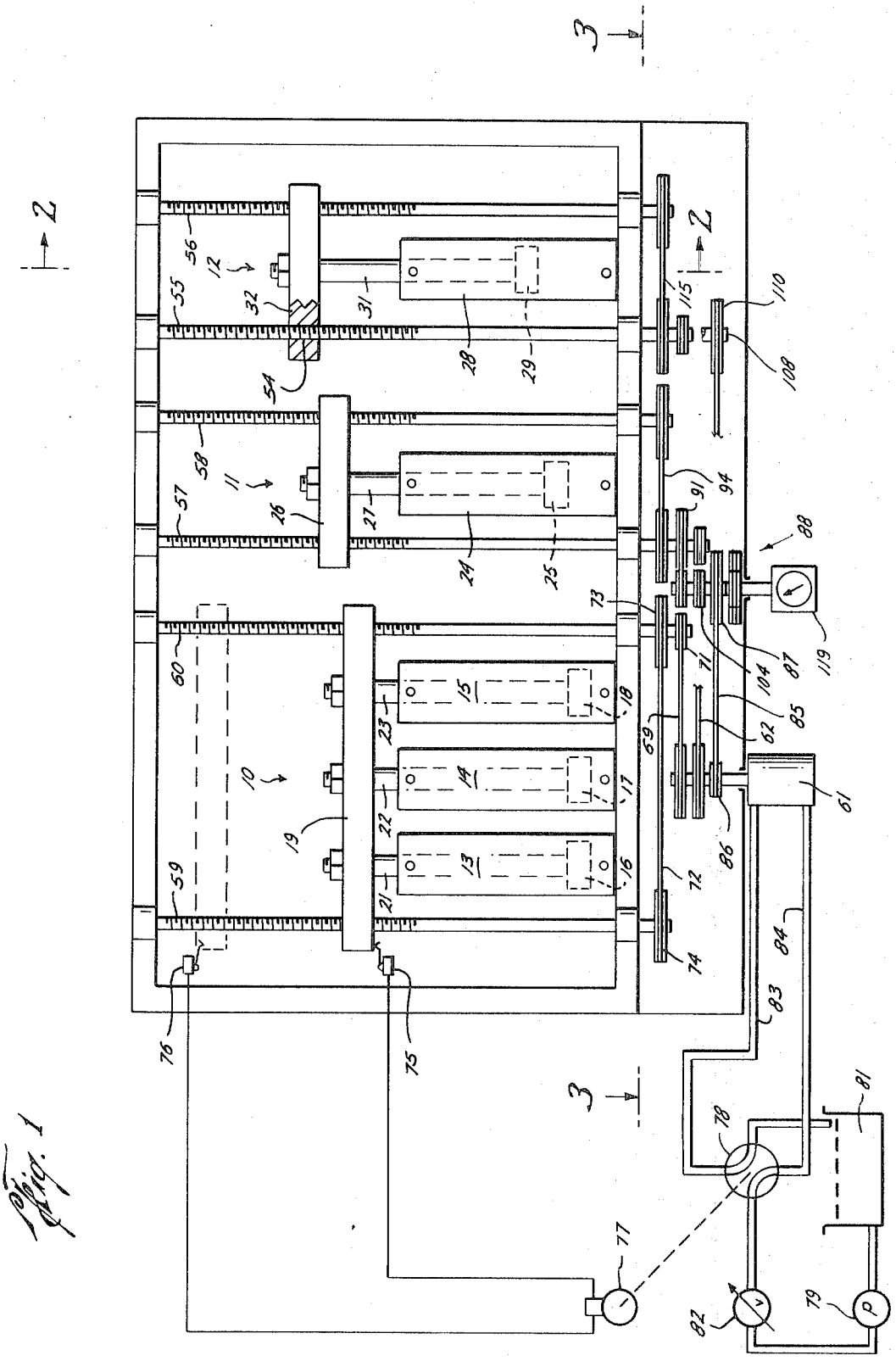

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Fig. 1

Fig. 2

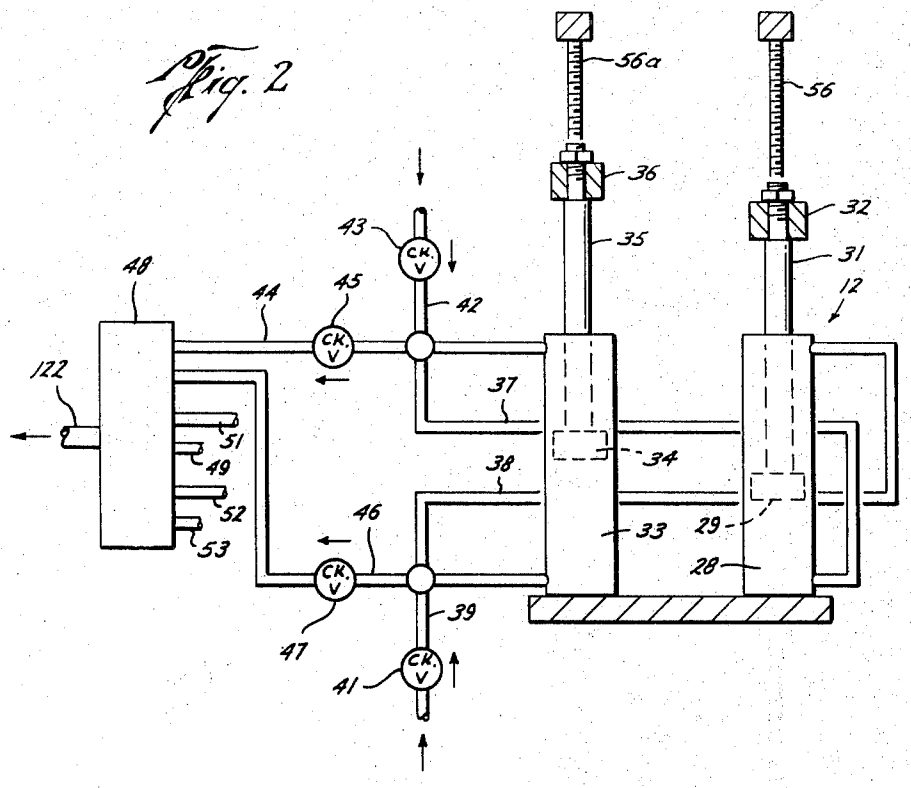
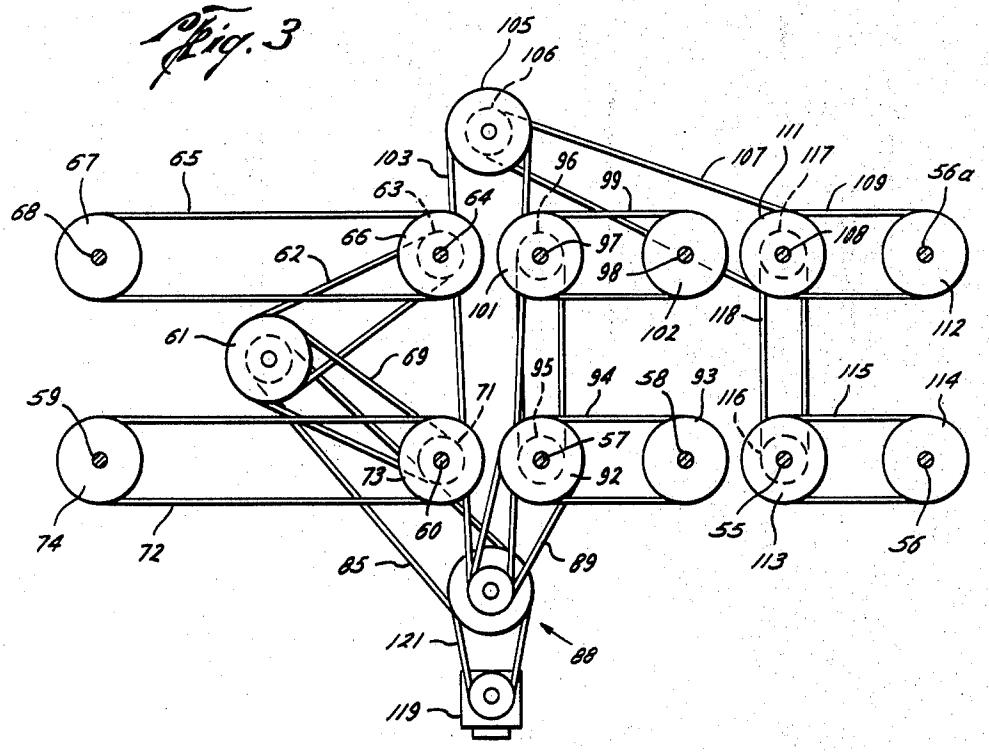

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Fig. 3


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DOUBLE ACTING PUMP

This invention relates to pumps, and more particularly to a piston type pump in which a double acting pump has a substantially constant output. In its preferred form, the pump simultaneously pumps a plurality of liquids at different rates, with the rate of the output of each section of the pump being substantially constant, and with the total output from the entire pump being variable.

An object of this invention is to provide a pump of the double acting piston type in which the output of the pump may be constant.

Another object is to provide a piston-type pump of the double acting variety which is capable of pumping at a constant rate a plurality of fluids at selective total volumes with the ratio of the several fluids being pumped remaining constant at any selected total volumetric output.

Other objects, features and advantages of the invention will be apparent from the drawings, specifications, and the claims.

In the drawings wherein like numerals indicate like parts, and wherein an illustrative form of this invention is shown:

FIG. 1 is a schematic elevational view of apparatus in accordance with this invention, with a portion of the drive system omitted for clarity and showing only the front row of pistons and cylinders and associated structure, there being an identical row of pistons and cylinders and associated structure immediately behind those shown;

FIG. 2 is a view along the lines 2—2 of FIG. 1, illustrating a piston and cylinder and associated structure of the first as well as second rows and illustrating schematically the manifolding of one section of the pump;

FIG. 3 is a view along the lines 3—3 of FIG. 1, illustrating the drive train for the pump.

The pump is designed to pump a plurality of liquids and therefore is constructed in sections. The section indicated generally at **10** being designed to pump the greatest volume, the section indicated generally at **11** to pump an intermediate volume, and the section indicated generally at **12** to pump the smallest volume.

Section **10** includes the cylinders **13, 14** and **15,** and their associated pistons **16, 17** and **18** respectively. The several connecting rods **21, 22** and **23** are mounted on cross head **19.** There is a second identical bank of pistons and cylinders (not shown) associated with section **10** and all six of these pumping units will be running at the same constant relatively higher speed than the other sections.

The intermediate pumping section **11** is made up of a pair of pumping units with the cylinder **24** and the pump plunger **25** of one unit being shown connected to the cross head **26** by connecting rod **27.** The other pumping unit is identical in size and is positioned directly behind this pumping unit. Each of these two pumping units operate at the same speed, which is less than the speed of movement of the cross head **19** of the pumping section **10.**

In like manner the pumping section **12** includes a pair of pumping units, and includes the cylinder **28** having the piston **29** therein reciprocated by the connecting rods **31** and cross head **32.** The other pumping unit (FIG. 2) includes cylinder **33** having the piston **34** reciprocal therein by connecting rod **35** and cross head **36.**

All sections of the pump are identical in construction except that the section **10** includes a larger number of pistons and cylinders which are manifold together.

A description of the section **12** will give an understanding of how all of sections are constructed. Reference is made to FIGS. **1** and **2.**

A pair of conduits connect the rod end of each cylinder to the other end of the other cylinder. Thus, conduit **37** connects the rod end of cylinder **33** to the other end of cylinder **28.** In like manner conduit **38** connects the rod end of cylinder **28** to the other end of cylinder **33.**

In order to provide for flow of fluids through the pump, an inlet pipe **39** controlled by poppet valve **41,** provides for introduction of fluid into conduit **38.** In like manner, an inlet pipe **42** controlled by poppet valve **43** provides for flow of fluid into the ocnduit **37.** Flow from the pump is provided for by outlet pipe **44** which is connected to the conduit **37** and controlled by the poppet valve **35** and outlet pipe **46** connected to the conduit **38** and controlled by the poppet valve **47.**

In operation the pistons **29** and **34** will move in opposite directions as will be explained hereinafter. As plunger **34** is moving downwardly, plunger **29** will be moving upwardly. Thus, the conduit **37** will be in suction and fluid will be drawn into the system through line **42.** At the same time, conduit **38** will be in compression and fluid will be exhausted through line **38** and outlet pipe **46** to the mixing head **48.** On the reverse stroke, fluid flow will be reversed.

The bore in the two cylinders, as well as the connecting rod in the two cylinders, are of identical diameter. Thus in the pumping stroke, no matter what the direction of the two pistons may be, the volumetric output is the same. This is true because the cross-sectional area of cylinder **33** plus the cross-sectional area of the annulus between the wall of cylinder **28** and rod **31** is equal to the sum of the cross-sectional area of the cylinder **28** plus the annulus between the wall of cylinder **33** and the rod **35.** The total volumes being equal and the speed of the pistons being equal, the output will be equal.

Pumping section **11** will be identical to that just explained, and will be connected to the mixing head through the conduits **49** and **51** (FIG. **2**).

In the case of the pumping section **10,** the manifold lines which are comparable to manifold line **37,** for each of the three pairs of cylinders, will be connected together. In a like manner, the manifold line for each of the pairs which are comparable to conduit **38** will be connected together so that the entire output of pumping system **10** can be fed through a single poppet valve such as poppet valve **47** to the lines **52** and **53** which lead to the mixing head **10** (FIG. **2**). Obviously the several manifold lines from pumping unit **10** could each pass through a separate set of poppet valves before all being connected into lines **52** and **53** if desired.

The means for reciprocating the cross heads is provided by a plurality of screws in cooperation with worm gears in the cross heads. One of the gears is shown at **54** cooperating with the screw **55.** In a like manner, the cross head **32** runs on a second screw **56.** Pumping section **11** runs in like manner on screws **57** and **58** and pumping section **10** runs on screws **59** and **60.** As previ-

ously pointed out, for each set of screws shown in FIG. 1, there is an identical set of screws immediately therebehind on which the cross head of the corresponding pumping units are located. Note in FIG. 2 the screw 56A for the second cross head 36.

Any desired system of reciprocating the cross heads at a substantially constant velocity may be utilized. One of the simplest and preferred forms is that shown in the drawings. All of the screws 55, 56, 57, 58, 59 and 60 are right-hand threads and all of the screws of the second bank including screw 56A, are left-hand threads so that all of the screws may be rotating in one direction to provide for movement of the cross heads of one bank in opposite directions from the cross heads of the other bank.

Details of the drive system are shown in FIGS. 1 and 3. In the preferred form, the screws are driven by a sprocket and chain system from a single prime mover 61.

For section 10 a chain 62 from the prime mover 61 drives a sprocket 63 which rotates screw 64 on the rear bank of the pumping units. A chain 65 extends from the sprocket 66 on screws 64 to a sprocket 67 on screws 68 of the rear bank of the pumping section 10. In like manner, a chain 69 cooperates with sprocket 71 on screw 60 and a chain 72 is trained around sprockets 73 on screws 60 and sprocket 74 on screw 59. Thus rotation of the arbor of the motor 61 (preferably hydraulic) will result in simultaneous rotation of the screws 59, 60, 64 and 68 at the same rate of speed. As screws 64 and 66 are of a different hand than screws 59 and 60, the cross heads and hence the pistons will move in opposite directions at the same rate of speed.

In order to provide for reversal of direction of rotation of the several screws and thus movement of the cross heads and pistons, a pair of limit switches 75 and 76 (FIG. 1) are positioned to be engaged by the cross head 19 at the limits of its travel. These switches operate the switching motor 77 which reverses the valve 78 in the hydraulic system leading into the motor 61 and provide for reversing the direction of rotation of the motor.

In order to provide for rotation of the motor a suitable pump 79 draws fluid from the reservoir 81 and passes it through a regulator valve 82 to the reversing valve 78 and thence through conduits 83 and 84 to the motor 61 and return to the reservoir 81.

Power for the other two pumping sections is provided by a chain 85 trained over sprocket 86 on the motor arbor (FIG. 1) and sprocket 87 on the idler cluster indicated generally as 88.

Power for the pump section 11 is provided by a chain 89 which drives the sprocket 91 (FIG. 1). Sprocket 92 on screw 57 is connected to sprocket 93 by chain 94 to drive these two sprockets in unison. Sprocket 95 on screw 57 drives sprocket 96 on screw 97. Screw 97 and screw 98 are tied together by a chain 99 and sprockets 101 and 102.

Power for the pumping section 12 is provided by chain 103 connecting the sprocket 104 (FIG. 1) on the idler 88 with sprocket 105 (FIG. 3) of a second idler. A second sprocket 106 on the second idler carries chain 107 which is trained over a sprocket 110 (FIG. 1) on screw 108. A chain 109 is trained over sprockets 111 and 112, which are carried by screws 108 and 56A to tie these two sprockets together. In like, screw 55 and screw 56 are connected together by a pair of sprockets 113 and 114 over which a chain 115 is trained. Sprocket 55 receives its power by sprocket 116 which is connected to a like sprocket 117 on screw 108 by chain 118.

The speed of operation of the system may be noted from an indicator 119 which is driven by a chain 121 from the idler 88.

The entire system may be readily regulated by the regulator valve 82 which controls the amount of fluid which passes through the motor 61 and in this way an infinite variety of speeds of the system may be provided.

From the above, it will be seen that all of the objects of this invention have been attained. Each section of the pump puts out a constant volume as identical pumping units of the positive displacement type operate in opposite directions so that the volumetric output from each pair of pistons and cylinders is identical. The relative speed between the several sections is controlled by the size of the sprockets delivering power to each section. Thus, by simply changing the sprocket sizes, the relative proportions of liquids which each section will deliver may be varied.

When the cross head 19 reaches either extremity of travel, it energizes one of the limit switches 75 and 76. As a hydraulic motor is utilized, the reversal of direction of the hydraulic motor occurs almost instantaneously. While there is a finite period of time at which the cross head is at rest, this is so small a period of time that it may be ignored for most pumping operations and the cross heads may be considered to move at a constant rate of speed. Thus, the system may be utilized to supply three liquids to the mixing head 48 and thence out through a distribution line 122 to a point of application. For instance, this pump is to be utilized with a machine for forming continuous panels of spaced apart sheets of material with the section therebetween filled with insulation material. The insulation material is provided by this pumping system which mixes polyurethane with a suitable catalyst and a suitable fire inhibitor and distributes the mixed liquid through the outlet spray member 122 on to a continuously moving panel of sheet material. For purposes of this type of system, the short pause in reversing directions in the cross heads is immaterial and the system may be considered to provide liquids at a constant rate.

With such a system as described above it will be apparent that the infinitely variable rate of delivery of fluid will permit the panel making machine to run at any desired speed, as the pump of this invention will deliver, at any desired volume, the necessary plastic for expansion between panels passing through the machine.

It will be apparent that the pump may be used in any instance in which it is desired to pump a plurality of liquids and maintain exactly the desired proportions of material from the several sections of the pump as positive displacement types of pumps are used in which the amount of slippage by-passing the piston during the pumping stroke is substantially nill.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as the details of the illustrated construction may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. A pump for mixing a plurality of liquids comprising:

a plurality of sections each for pumping a fluid at a selected rate;

each section comprising;

at least one pair of associated cylinders and pistons therein of identical size;

a pair of conduits connecting the rod end of each cylinder to the other end of the other cylinders;

an inlet and an outlet pipe connected to each of said conduits;

poppet valves in each inlet and outlet pipe preventing reverse flow therein;

means for reciprocating each pair of associated pair of pistons in opposite directions at the same rate of speed including a plurality of cross-heads, a rod connecting each piston to a cross-head, each cross-head having at least one worm gear, and an associated screw cooperating with each worm gear to drive the cross-heads;

means for simultaneously reciprocating the rods of all sections and for reversing the direction of reciprocation of all rods of all sections simultaneously, including motor means, and means connecting the motor means to said screws and rotating the screws of each section at the same speed and the screws of different sections at different speeds whereby the volume of fluid pumped by each section is constant during a given unit of time.

2. The pump of claim 1 wherein all screws are rotated in the same direction and screws associated with the cross heads reciprocating associated cylinders are of left and right hand threads so that the cross heads will move in opposite directions simultaneously.

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