July 12, 1966 C. N. JOHNSON 3,260,212

SELF-POWERED VARIABLE FLUID PROPORTIONER

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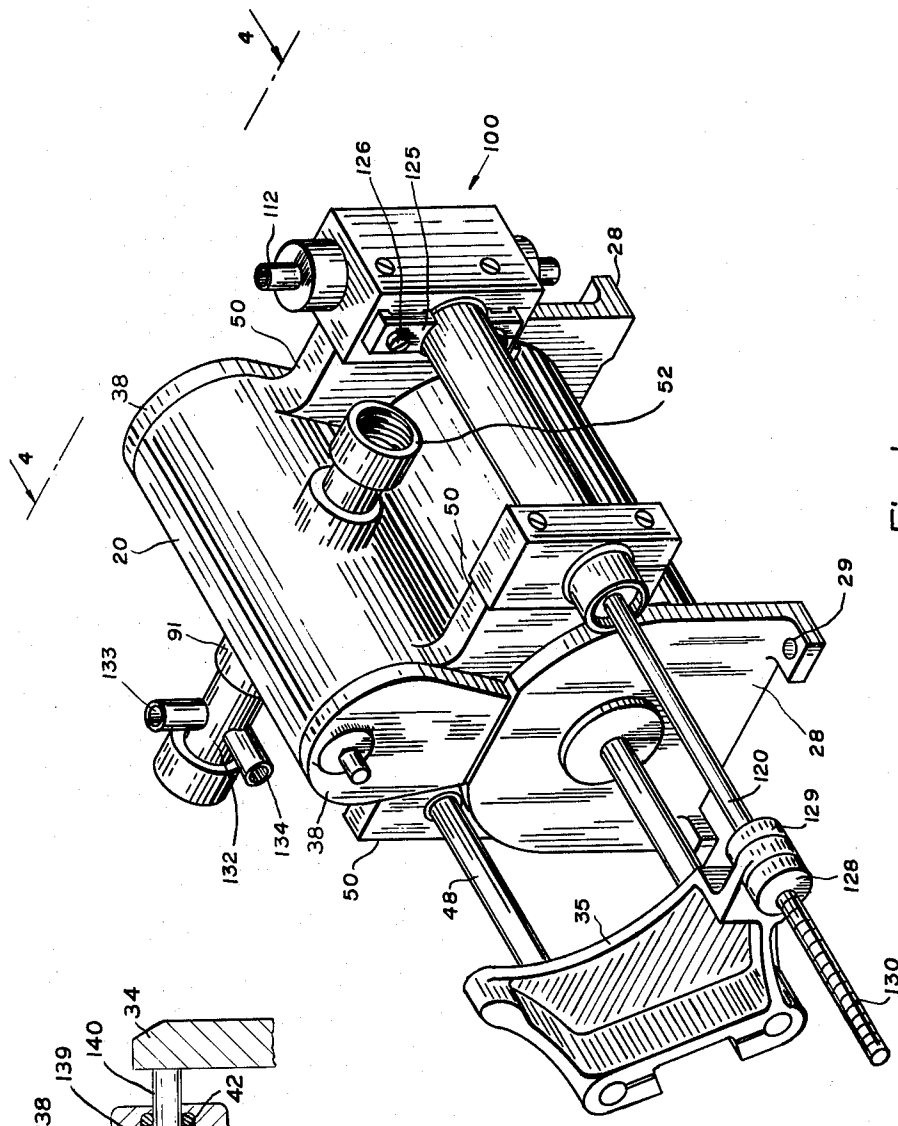



Fig. 1

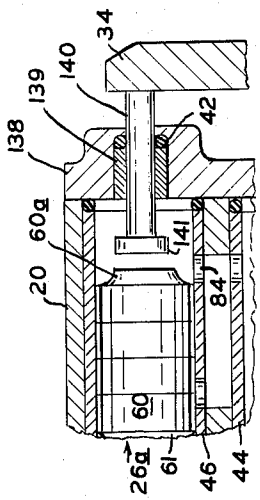



Fig. 2B

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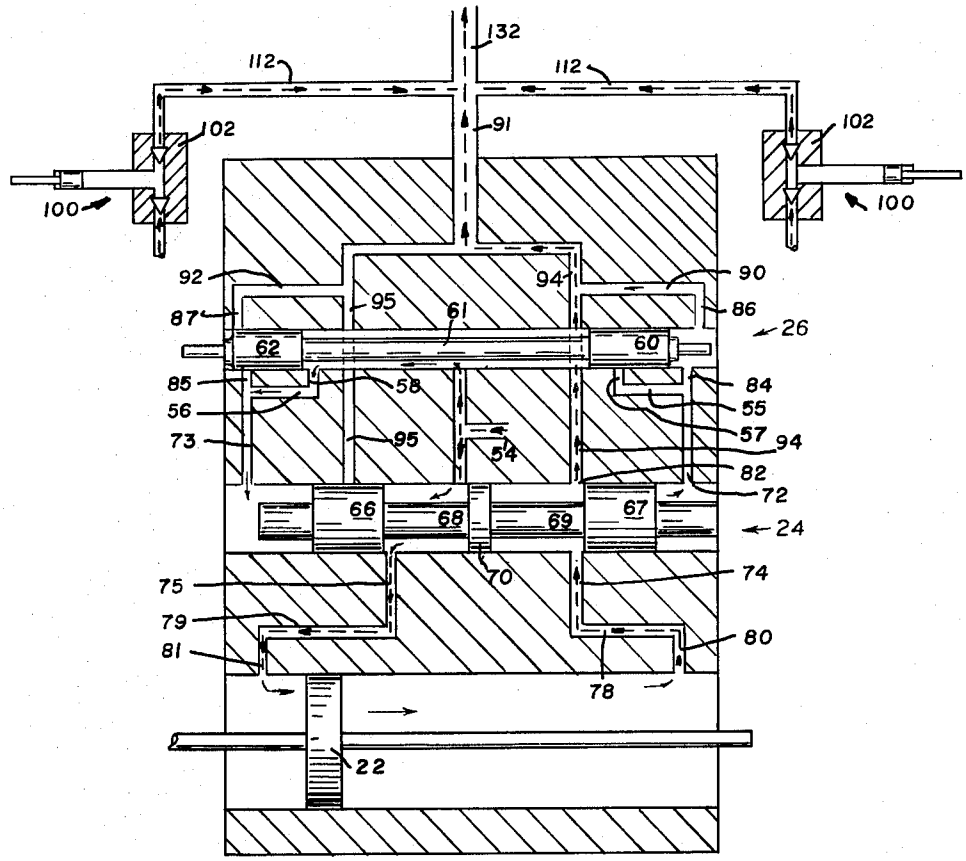



Fig. 12

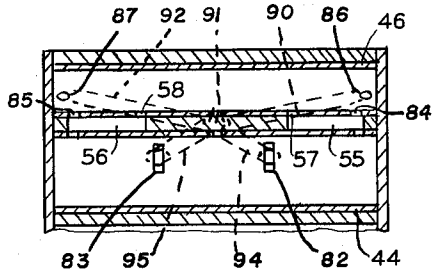



Fig. 2A

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SELF-POWERED VARIABLE FLUID PROPORTIONER

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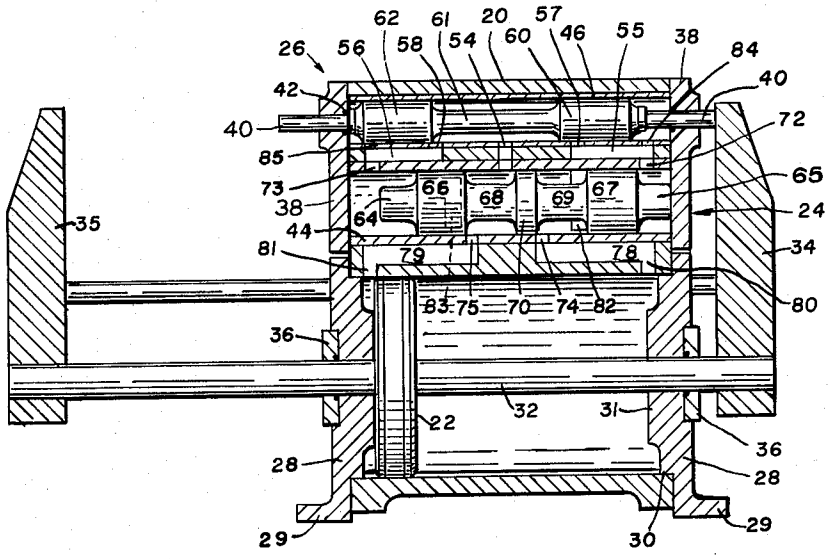



Fig. 2

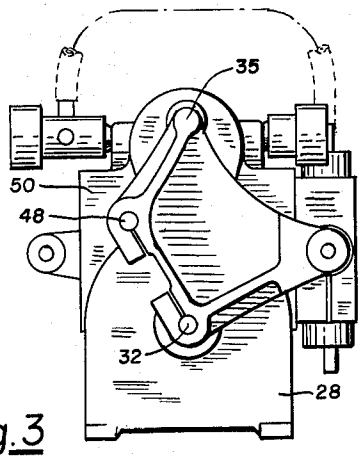



Fig. 3

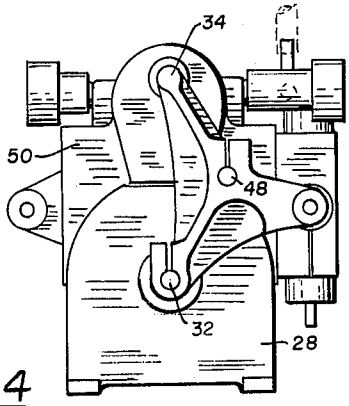



Fig. 4

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SELF-POWERED VARIABLE FLUID PROPORTIONER

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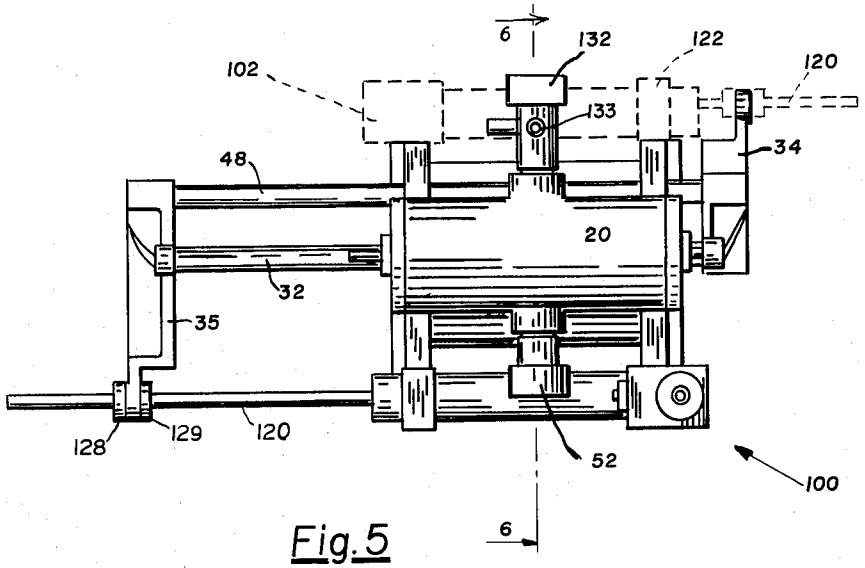



Fig. 5

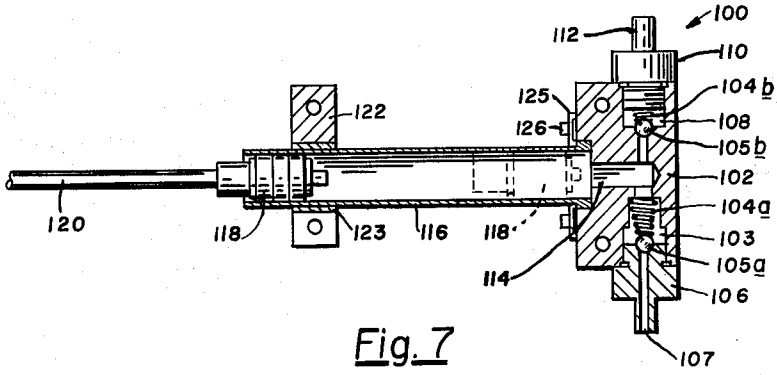



Fig. 7

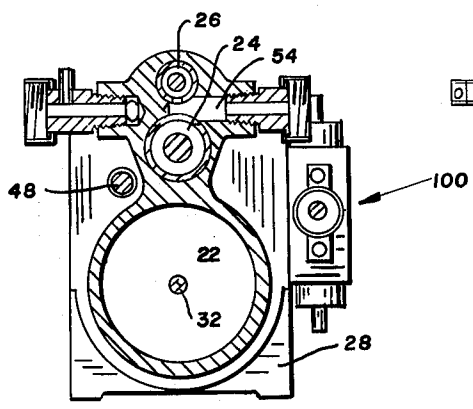



Fig. 6

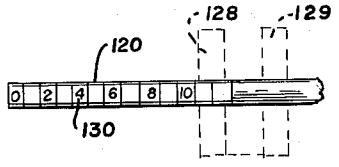



Fig. 5A

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SELF-POWERED VARIABLE FLUID PROPORTIONER

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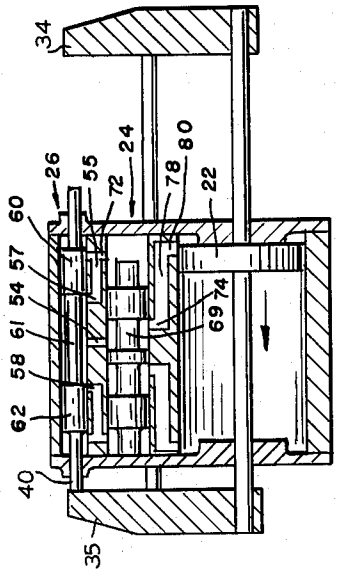



Fig. 9

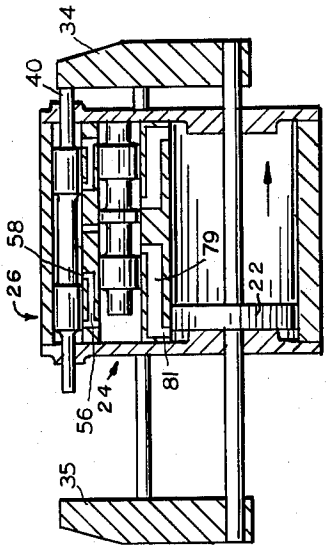



Fig. 11

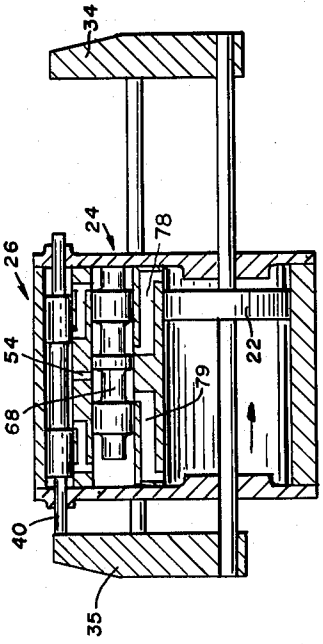



Fig. 8

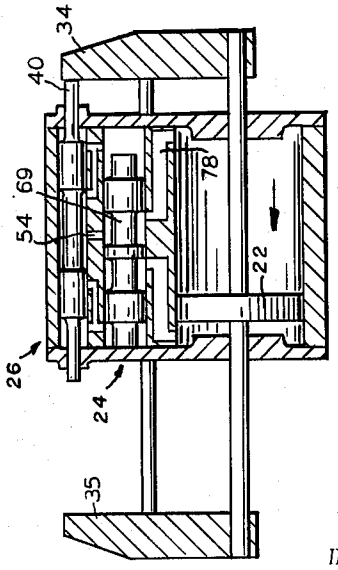



Fig. 10

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United States Patent Office 3,260,212 Patented July 12, 1966



3,260,212

# SELF-POWERED VARIABLE FLUID PROPORTIONER

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Filed Feb. 5, 1965, Ser. No. 430,572
16 Claims. (Cl. 103—38)

This invention relates to a self-powered variable fluid proportioning apparatus for the admixing of small determinate amounts of a treating fluid to a pressurized flowing fluid. More particularly this invention relates to a self-powered fluid motor actuating one or more adjustable fluid pumps to add one or more treating fluids in determinate amounts to a pressurized flowing fluid.

Even more particularly this invention relates to a fluid motor of the reciprocating piston type and having a directional valve and a pilot valve, said fluid motor having means to actuate one or more fluid pumps each arranged to discharge an adjustably determinate amount of treating fluid into the pressurized fluid powering the fluid motor.

In the treating of poultry and livestock as well as treating water systems used for the irrigating of trees and certain crops, many types of equipment have heretofore been used and proposed for introducing one fluid such as chemicals, vaccines, nutrients, sanitizing ingredients and drugs into a main fluid stream such as water. In the main these systems and the apparatus used therewith have been bulky, unreliable and often quite complicated. These systems have not been susceptible for automatic self-powering operation and/or for portable and continuous operation. Further these systems are not readily susceptible to a positive regulation of the operation of the system by the manipulation of the flow of the treated fluid at any point subsequent to the fluid motor.

It is an object of this invention to provide a self-powered fluid motor adapted to drive one or more adjustable fluid pumps and to feed the discharge of these pumps into the pressurized flow of the fluid powering the fluid motor, It is a further object of this invention to provide a self-powered, self-starting fluid motor adapted to receive and discharge a first pressurized fluid flow such as water and to this fluid flow feed one or more fluid treating agents in adjustable selected proportions.

It is a further object of this invention to provide a small, inexpensive, continuously-operable apparatus having a high degree of efficiency and durability and which is easily portable and is adaptable to semi-permanent or permanent installations. Said apparatus being adapted for remote control. It is a further object of this invention to provide a fluid powered proportioning apparatus in which one or more adjustable discharge pumps may be readily interchanged to provide rapid differences of volume or to prevent unwanted chemical reactions resulting from the changing from one drug or chemical to one of a different composition or basic element.

The attainment of these and other objects are provided in the instant invention which utilizes a self-powered fluid motor having a reciprocating piston whose reciprocation is controlled by a directional valve which is moved by the flow from a pilot valve which is activated for a portion of its stroke by means connected to the piston and for the balance portion of its stroke may be activated by fluid power. This self-powered fluid motor is operable over a wide range of pressures and flow rates of fluid under pressure. One or more removable piston pumps with an adjustable delivery means is driven by the fluid motor and from these pumps are delivered small determinate amounts of other fluids such as chemical solutions, vaccines and/or nutrients which pump deliveries are fed into the stream of fluid which supplies the operating power for the fluid motor. The fluid motor and removable pumps are contemplated to be assembled into a simple compact unit readily transportable to the use site.



There has thus been outlined rather broadly the most important features of the present invention in order that a detailed description thereof that follows may be better understood and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereafter and which will form the subject of claims appended hereto. Those persons skilled in the art will appreciate that the conception on which the present disclosure is based may readily be utilized as the basis for designing other structures for carrying out the several purposes of this invention. It is important, therefore, that the claims be regarded as including such equivalent constructions as do not depart from the concept and scope of this invention.

A specific embodiment of the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawings, forming a part of the specification wherein:

FIG. 1 represents an isometric side view of the liquid proportioner apparatus of this invention;

FIG. 2 represents a sectional view of the apparatus of FIG. 1 with the section being taken on the longitudinal center line of the piston and valve apparatus;

FIG. 2A represents a fragmentary sectional view of the apparatus as seen in FIG. 2 but with both the directional and pilot valve removed so as to show the discharge ports as arranged in the bores of these valves;

FIG. 2B represents a fragmentary sectional view of the apparatus of FIG. 2 and showing an end portion of an alternate pilot valve construction;

FIG. 3 represents an end view of the left end of the apparatus taken in the direction of the arrows shown in FIG. 1 and showing a pump on the near side;

FIG. 4 represents an end view of the right end of the apparatus taken in the direction of the arrows shown in FIG. 1 and showing a pump disposed on the rear side;

FIG. 5 represents a plan view of the apparatus of FIG. 1;

FIG. 5A represents a fragmentary enlarged view of the end of the pump rod and the indicia disposed thereon;

FIG. 6 represents a lateral cross sectional view of the apparatus taken on the line 6—6 of FIG. 5;

FIG. 7 represents a sectional view of a pump as used in conjunction with the apparatus;

FIG. 8 represents a somewhat diagrammatical cross sectional view of the apparatus with the piston moving to the right and being a short distance from the end of its rightward stroke;

FIG. 9 represents a somewhat diagrammatical cross sectional view similar to the view of FIG. 8 but with the piston at the extreme right of its stroke;

FIG. 10 represents a view similar to the view of FIG. 8 but with the piston moving to the left and being a short distance from the end of its leftward stroke;

FIG. 11 represents a view similar to the view of FIG. 8 but with the piston having moved to the extreme left of its stroke; and

FIG. 12 represents a somewhat diagrammatic flow diagram to illustrate the operation of the apparatus of this invention.

Referring now particularly to the drawings wherein similar characters designate corresponding parts throughout, the general arrangement of the components forming the preferred embodiment of the liquid proportioner apparatus includes a housing **20** which as seen in FIGS. 1–6 is preferably made as a casting, and as reduced to practice is of aluminum alloy. This housing as seen in FIGS. 1 and 6 is preferably formed to economically provide for three longitudinal bores with provision for fluid passageways and with wall thicknesses sufficient to withstand fluid pressures of about two hundred pounds per square inch.

The lower bore as seen in FIG. 6 is the largest bore and houses the piston 22. Immediately above and of smaller diameter is the bore carrying the directional valve 24 while immediately above valve 24 is the top bore carrying the pilot valve 26. For the convenience of precisely machine finishing these bores both ends of the bores are open and the ends of the housing 20 are also machine finished so that the ends of these bores may be closed by end caps. In the preferred embodiment a lower end cap 28 having foot portions 29 is used to close both ends of the piston bore. It is to be noted that cap 28 has an internally shouldered portion 30 adapted to snugly seat in the piston bore. Inwardly on the lower end cap is an inner cushion or stop portion 31 of substantially less diameter than the piston 22 the stop portion extending inwardly toward the piston and providing therewith a circular fluid chamber when said piston 22 is moved adjacent to the stop portion 31 of the end cap 28.

Central of the shouldered portion 30 and in axial alignment are piston rod bearing journals formed in each end cap 28. These bearing journals carry a double ended piston rod 32 which extends through the end cap 28 an amount sufficiently great so that when piston 22 is at the far end of the bore the rod projection on the near end will be such as to permit mounting thereon of an actuating arm 34 or 35. As seen in FIG. 2 there is an arm 34 mounted on one end of the piston rod 32 and an arm 35 of slightly different configuration on the other end of the piston rod 32. A pressure packing gland 36 or seal is also provided on each lower end cap 28, this pressure packing gland 36 surrounds the piston rod 32 and in the mounting to end cap 28 is urged into contact with the rod 32 so as to prevent unwanted fluid from the piston chamber to flow to the outside of the end caps 28.

The remainder of each end of the housing 20 is closed by an upper end cap 38. The bore containing the directional valve 24 is closed by the end cap 38 so as to form a solid flat end wall. The bore containing the pilot valve 26 is likewise closed by a portion of the same end cap 38 however this portion of the end cap is made with a journal hole to receive a reduced end portion 40 of pilot valve 26. As reduced to practice in this embodiment the end caps 38 are made of cast aluminum with the journaled hole machined so as to slidably retain the end portion 40 while at the same time retaining a fluid stop means which may be an O-ring 42 surrounding the reduced end portion 40 while at the same time the O-ring is retained in a recess in the journaled hole.

Referring particularly to FIGS. 2 and 6 it is to be noted that in the present embodiment the directional valve 24 is movable in a bore which has a separate sleeve liner 44, this liner is a light press fit in the cast housing and is machined to provide a smooth sliding internal bore for directional valve 24. As reduced to practice this sleeve is made of mechanical steel tubing and permits the easy forming in its walls of holes and openings for the flow of fluid to be hereinafter described. In a similar manner the pilot valve 26 is carried in a bore having a separate sleeve liner 46 which liner is a light press fit in the cast housing and which in addition to providing a smooth sliding bore for pilot valve 26 also enables holes to be easily formed in its walls. In the present embodiment sleeve liner 46 is made of steel mechanical tubing and the holes drilled therein are disposed to meet various fluid passageways to be hereinafter described.

As seen in FIGS. 3 and 4 the arms 34 and 35 have provisions for clamping onto piston rod 32 and as further seen in FIGS. 1, 5 and 6 are maintained in a prescribed alignment by being additionally clamped to a guide rod 48 which is carried in and is reciprocable in bushed holes in laterally extending lug portions 50 on the same side of housing 20. The upper portions of arms 34 and 35 are formed so as to engage the reduced end portions 40 of pilot valve 26. The arms 34 and 35 are additionally extended laterally to provide means to activate a pump to be later described.



Referring now to FIGS. 1, 2, 5 and 6 it is to be noted that the pressurized fluid providing power for the fluid motor, said fluid usually being water, enters the apparatus through inlet port 52 which may be conventionally threaded to receive a pipe or hose end not shown. Internally of the housing 20 and in the wall separating the directional valve 24 and pilot valve 26 there is a fluid passageway 54 which as seen particularly in FIGS. 2 and 6 coincide with appropriately formed slots in the sleeve liners 44 and 46 to provide a simultaneous supply of fluid under pressure to both pilot valve 26 and directional valve 24. Also formed in this wall separating the valves 24 and 26, and as viewed in FIG. 2, is a right longitudinal passageway 55 and a left longitudinal passageway 56. Through sleeve 46 a drilled hole 57 extends from the pilot valve chamber into the left end of right longitudinal passageway 55. Also through sleeve 46 a similarly drilled hole 58 extends from the pilot valve chamber into the right end of left longitudinal passageway 56. It is to be noted that pilot valve 26 in this embodiment has the portion intermediate the reduced end portions 40 formed with an enlarged right portion 60, an intermediate reduced portion 61 and an enlarged left portion 62. The enlarged portions 60 and 62 are made to be a precise sliding fit in the bore of sleeve liner 46 while the reduced portion 61 is sufficiently reduced to provide a free fluid flow from passageway 54 to either drilled outlet hole 57 or 58.

The valve 26 when assembled is adapted to be moved longitudinally in the bore by light fluid pressure. In use when the valve is started to be shifted by arm 34 or 35 immediately pressure enters behind portion 60 or 62 the light fluid pressure may urge the valve to the full shift movement. However if valve 26 is restrained in its movement by dirt, roughness or any other reason whatsoever, the arm 34 or 35 will shift the valve an amount sufficient to uncover outlets 57 or 58 and permit the flow sequence to be made to directional valve 24.

The directional valve 24 as seen in FIG. 2 is formed with reduced end portions 64 and 65 on the respective left and right ends thereof. Left and right enlarged portions 66 and 67 are formed adjacent these ends. Reduced intermediate portions 68 and 69 are each disposed inwardly of the enlarged portions 66 and 67 and are separated by a central enlarged portion 70. The enlarged portions 66, 67 and 70 are formed to be a precise sliding fit in the bore of the sleeve liner 44 while the reduced portions are of a sufficiently reduced size to permit a free flow thereby of the fluid providing the power to the unit. The directional valve 24 is made less than the length of the bore between upper end caps 38, the distance being sufficient for the reciprocation of the valve 24 to cover and uncover the fluid passageways to be hereinafter described. As reduced to practice the valve 24 is made with diameters 66, 67 and 70 being about one inch while diameters 64, 65, 68 and 69 are about one-half inch. This valve is about four and one-half inches long while the sleeve liner 44 is about four and seven-eighths inches long thus providing an end movement of about three-eighths of an inch of the valve 24 in the liner 44. As seen in FIG. 2, the liner 44 in addition to the fluid passageway 54 is provided with a fluid inlet means to each end of the valve 24. From the right long passageway 55 pressurized fluid is deliverable by means of drilled hole 72 to the right end chamber formed by valve 24 and sleeve 44. A like drilled hole 73 extends from the left end of left long passageway 56 through the wall of sleeve 44 and to the left end chamber formed by valve 24 and sleeve 44. In the opposite wall of the sleeve 44 there are provided a right inlet drilled hole 74 and a left inlet drilled hole 75. A right and left cast passageway 78 and 79 is formed in the cast wall between the bores for the directional valve 24 and the piston 22. The left end of right passageway 78 receives the flow from drilled hole 74 from whence it travels along this passageway until it reaches the right end thereof where it flows through a

cast or drilled hole **80** into the piston chamber. In a like manner the flow through drilled hole **75** passes into the right end of cast passageway **79** and travels along this passageway until it reaches the left end of the passageways where it flows through a cast or drilled hole **81** into the left end of the piston chamber.

It is to be further noted that there is provided a fluid discharge passageway **82** through the side of sleeve **44**. As seen in FIG. 2 this passageway **82** is behind and slightly to the left of the enlarged portion **67**. As viewed in FIG. 2A this port **82** is to the right of a similarly placed port **83** which is located below drilled hole **58** and displaced in the same manner as is port **82** to drilled hole **57**. These sets of holes are only related by physical proximity and not by purpose. It is to be noted that when directional valve **24** is in the position shown in FIG. 2 the port **82** is open to the portion of the directional valve **24** that forms the reduced diameter portion **69**. At the same time the port **82** is open, the port **83** is closed by the enlarged portion **66** of the valve **24**. When the valve **24** is moved to the extreme left, port **82** will be closed by enlarged portion **67** while port **83** will be open to the reduced diameter portion **68** of the valve **24**.

Referring now to FIGS. 2 and 2A and the sleeve **46** that is used with the pilot valve **26**, there are in addition to the inlet **54** and drilled holes **57** and **58** an additional set of drilled holes **84** and **85**. Drilled hole **84** is to the right of hole **57** and is aligned to communicate with the right long passageway **55** at the right end thereof. Drilled hole **85** is to the left of hole **58** and is aligned to communicate with the left long passageway **56** at the left end thereof. Radially disposed toward the back side of the sleeve **46** and at each end of the sleeve there are drilled holes **86** and **87**. Drilled hole **86** extends through the wall of sleeve **46** and discharges into the outer end of an angularly cast or drilled passageway **90** which is shown in dotted outline. The inner end of passageway **90** terminates at a discharge outlet **91** which is also shown in dotted outline. In a manner similar to hole **86** the drilled hole **87** extends through sleeve **46** and discharges into the outer end of an angularly cast or drilled passageway **92** which is shown in dotted outline. The inner end of passageway **92** also terminates at this same discharge outlet **91**.

Referring now to the portion of the sleeve **44** as seen in FIG. 2A port **82** discharges into the outer end of an angularly cast or drilled passageway **94** which is shown in dotted outline. Passageway **94** has its inner end terminating at the discharge outlet **91**. Port **83**, in like manner, discharges into the outer end of an angularly cast or drilled passageway **95** whose inner end also terminates at the discharge outlet **91**. Passageway **95** is shown in dotted outline in FIG. 2A.

Referring now to the pump particularly shown in FIGS. 1, 5, 6 and 7 the preferred embodiment provides for a pump which can be readily replaced for the purpose of repair, replacement or for a change in size. As shown the pump assembly is generally designated as **100**. A valve body **102** is provided with an inlet chambered passageway **103** to retain the components of a ball check system consisting of a spring **104***a* and a ball **105***a* and a screw plug **106** having a passageway **107** terminating in a ball seat adapted to retain the ball **105***a* in flow sealing position. Oppositely disposed from the inlet is an outlet chambered passageway **108** adapted to retain the components of a ball check system also using a spring **104***b*, and a ball **105***b* and a screw plug **110** which is recessed to retain a substantial portion of spring **104***b* and which has an outlet passageway connecting to a tube or hose **112**. The chambered passageway **108** has a ball seat formed therein to receive and retain the ball **105***b* in flow sealing position. A transverse passageway **114** receives both inward ends of both inlet passageway **103** and outlet passageway **108** and extends from this juncture to terminate at the cylinder receiving recess formed in the outer vertical wall.

As seen in FIG. 7 the pump **100** is preferably made with a piston sleeve **116** having a shoulder on one end and a relatively constant outer diameter for the remaining length. The sleeve shoulder may be chamfered for mounting in a like chamfered seat. The internal bore is simply a constant bore throughout the length of sleeve **116**. A piston **118** may be made of chevron type rings assembled on a plunger rod **120**, the piston being adapted to be snugly movable in the bore of sleeve **116** and to be reciprocatable therein. A front clamp block **122** is adapted to support and clamp the sleeve **116**. This clamp block is made with a support hole of a sufficient size so that the shoulder of the piston sleeve will pass therethrough. A split bushing **123** having an inside diameter adapted to slip on the outside diameter of the sleeve **116** and having an outside diameter adapted to slide in the hole in clamp block **122** is mounted on sleeve **116** so as to support the forward portion of the pump **100** when it is fastened to the housing **20**. The shouldered end of sleeve **116** is mounted in body **102** and is clamped into fluid sealing position by means of clamp straps **125** which straps are urged and maintained in removable position by means of screws **126** as seen in FIGS. 1 and **7**.

Referring now to FIGS. 1, 2 and 5 it is to be noted that pump rod **120** extends through arm **35** and may have retaining means thereon so as to provide a connection with arm **35** by means of collars **128** and **129** which collars may be releasably clamped on the rod by means of set screws not shown. Rod **120** is a slip fit in the hole provided for it in arm **35**. By positioning collar **129** on rod **120** so that at the inner limit of the inward movement of arm **35** the piston **118** is at the desired position adjacent the shoulder end of sleeve **116**, the inward movement of the pump stroke can be predetermined and set. In like manner collar **128** can be set for a predetermined outward stroke. It is to be noted in FIGS. 1 and 5A that graduations are provided in the rod **120**. Upon this rod is disposed indicia **130** and corresponding marks which permit collars **128** and **129** to be set to give the predetermined inward and outward movement of rod **120**. By positioning and clamping collar **128** on rod **120** so as to provide a space between collars **129** and **128** that is greater than the width of arm **35** a lost-motion stroke is provided. Calibration of the pump and the indicia **130** permits the collar **128** to be visually located and clamped on rod **120** so as to provide pump **120** with a predetermined length of stroke to give a predetermined volume discharge from zero to the pump maximum capacity.

In operation as piston **118** is at its inner or most right position as viewed in phantom outline in FIG. 7 it is ready to move left on the suction stroke. As piston **118** moves leftward from the position indicated in phantom outline to the position shown in solid outline it draws in fluid from the treating supply. This treating fluid will flow through passageway **107** and into passageway **103** the inrush of fluid causing ball **105***a* to move upwardly slightly compressing compression spring **104***a*. As the piston is on this suction stroke the ball **105***b* is drawn even more tightly into seating and sealing position in the outlet passageway **108**.

When the piston has reached its selected outward movement as exemplified in solid outline in FIG. 7 it is then ready to start its pumping or expelling stroke. On the inward or rightwardly directed movement of arm **35** the arm will engage collar **129** and move rod **120** inwardly. The piston **118** will push the treating fluid now in the sleeve **116** toward the transverse passageway **114**. Ball **105***a* having returned to a seat position at the termination of the suction stroke will be urged by the pressure more tightly into a seating and sealing position. The increase of pressure in passageway **114** will cause ball **105***b* to move away from its seat in passageway **108** and cause spring **104***b* to slightly compress. The fluid being ex-

pelled will travel up passageway 108 and out through hose or pipe 112.

It is to be noted that the description of the pump 100 as mounted on the near side in FIG. 1 will also apply to a pump mounted on the opposite side as indicated in phantom outline in FIG. 5 and shown in end view in FIG. 4. Such an oppositely mounted pump would have its valve body 102 at the left as seen in FIG. 5 and will have the front clamp housing 122 at the right with rod 120 being driven by arm 34. It is to be further noted that as reduced to practice the outlet 91 (FIGS. 1 and 5) has a collecting nipple 132 having inlets 133 and 134 disposed thereon. In the usual practice where it is desired to feed the treating solution into the discharge of the piston 22 the pump discharge is fed through hose 112 to inlet 133 of collector nipple 132.

In the alternate directional valve arrangement shown in FIG. 2B the directional valve 26 has been modified by having reduced end portions 40 removed and leaving enlarged portions 60 and 62 with outwardly facing reduced shoulder portions 60*a* and 62*a* (62*a* being the same as 60*a* but not shown). End cap 38 now identified as 138 has been modified to permit O-ring 42 to be located intermediate the ends of the bore and a bearing 139 which may be of oil-impregnated bronze is inserted in an enlarged portion of this bore. This bearing 139 provides a means of retention of the O-ring 42 and additionally provides a bearing seat or bore for carrying a pusher pin 140. This pin is formed with a head portion 141 adapted to be engaged by shoulder 60*a*. The head, in addition, prevents accidental discharge of pin 140 through the bore when a reduced fluid pressure enters the chamber through drilled hole 84. It is to be noted that hole 84 is used to discharge previously trapped fluid from cavity 65 of the directional valve 84. In this alternate embodiment the pusher 140 is made of a length so that when the arm 34 has moved the pusher to the maximum inward movement the end 141 will be a short distance from the end 60*a* when valve 26*a* is at the maximum position to the left as seen in FIG. 2B. The additional movement of valve 26*a* to the left is provided by fluid pressure entering from drilled hole 84 as it is uncovered by the moving valve 26*a*. Additionally, moving valve 26*a* may be assisted in its movement to the left by the fluid under pressure seeking escape from inlet 54, around 61 and out hole 58 and into chambered end 64 where it shifts the directional valve 24. The operation of valve 26*a* is discussed below. The economies provided by the making of valve 26*a* of three parts is also reflected in repair and maintenance. Pusher pins 140 being separately operable to move the valve 26*a*, precise alignment of the three moving components is not necessary so that manufacture, assembly and repair is simplified.

*Use and operation*

The pump and fluid power apparatus shown in FIG. 1 with or without an additional pump 100 mounted on the far side is connected to a liquid pressure source which is usually water. This fluid supply enters the motor at inlet port 52 and at a pressure which in practice may range from five to one-hundred p.s.i. From port 52 the fluid enters fluid passageway 54 and is directed by directional valve 24 to one end of piston 22. Piston 22 is reciprocated thereby and by this means activates pump or pumps 100. Reference is now directed to FIGS. 8 through 12 inclusive and the operational sequence illustrated therein. In FIG. 12 is shown a diagrammatic flow diagram of the apparatus with the directional valve 24, the pilot valve 26 and the piston 22 disposed in the relative physical arrangement as shown in FIG. 8 therefore in the description of FIG. 8 reference is also directed to the flow diagram of FIG. 12. In FIG. 8 the exterior end of left reduced end 40 of directional valve 26 is just being contacted by arm 35 and piston 22 is traveling to the right in the direction of the arrow. The incoming fluid power being fed to the apparatus enters fluid passageway 54 and through the passageway formed by reduced internal portion 68 the fluid passes through hole 75, left passageway 79, hole 81 and into the bore of piston 22. As the piston 22 moves toward the right it causes the fluid to be expelled from the right side of piston 22. This fluid as it is being expelled passes from the piston bore through hole 80, right passageway 78 and drilled hole 74 into the passageway formed by the reduced internal portion 69 then through port 82, passageway 94 and out discharge outlet 91.

In FIG. 9 the arm 35, driven by piston 22 is now at the position of having completed its rightward movement and in so doing has pushed pilot valve 26 to the right. Drilled hole 58 is now covered by left enlarged portion 62 and drilled hole 57 is uncovered by right enlarged portion 60. The fluid under pressure entering the chamber around reduced internal portion 61 now is permitted to flow through drilled hole 57, the right long passageway 55 through drilled hole 72 and into the right end chamber of directional valve 24. The pressure built up in this right end chamber pushes valve 24 leftward to the position shown in this FIG. 9 whence the flow of pressurized fluid entering the directional valve from fluid passageway 54 is caused to flow in the passageway formed around the reduced intermediate portion 69 and through drilled hole 74, right passageway 78 and hole 80 and into the circular chamber to the right of piston 22 whence the pressure developed therein causes piston 22 to move leftward.

In FIG. 10 the exterior end of right reduced end 40 of directional valve 26 is just being contacted by arm 34 and piston 22 is traveling to the left, as indicated by the arrow. The incoming fluid power being fed to the apparatus enters fluid passageway 54 and through the passageway formed by reduced internal portion 69 the fluid passes through hole 74, right passageway 78 and hole 80 as described above with FIG. 9.

In both FIGS. 9 and 10 the fluid on the left side of piston 22 is urged out of the piston chamber by the advancing piston. The expelled fluid passes through hole 81, left passageway 79, hole 75, through the passageway of reduced internal portion 68 and through port 83 and passageway 95 to and out the outlet 91.

In FIG. 11 the pilot valve 26 has been moved to the extreme left by the arm 34. Directional valve 24 has been moved to the right by the flow of fluid through the uncovered drilled hole 58, left long passageway 56 and through drilled hole 73 into the left end chamber of the directional valve 24. Fluid flows to the piston 22 to start it moving to the right, the fluid entering from fluid passageway 54, past the reduced internal portion 68, the hole 75, the left passageway 79 and finally through 81 to the piston chamber on the left side of piston 22.

The chambered ends of both ends of directional valve 24 and pilot valve 26 and 26*a* are provided with means to drain these chambered ends as the valves are moved toward them. In FIGS. 2, 2A, 2B and 12 reference is had to the passageways and openings shown therein and the fluid flow that provides for the drain of the chambered ends. In FIG. 12 the piston 22 is moving to the right and the directional valve 24 has been moved to the right to provide an inlet flow to piston 22 through hole 75, left passageway 79 and hole 81. The fluid previously trapped in the chambered end of valve 24 has been discharged therefrom by passing to the exit 91 through the drilled holes 72 and 84, through the chambered end of valve 26 and through drilled hole 86 and passageway 90.

When the pilot valve 26 is moved to the right, as caused by piston 22 approaching the end of the rightwardly moving stroke, the fluid evacuated by the rightwardly moving valve 26 is discharged through drilled hole 86 and passageway 90 to outlet 91. The directional valve 24 is moved leftwardly by fluid under pressure entering uncovered hole 57, right passageway 55 and drilled hole 72, evacuates fluid in the chamber 64 at the other end

of the valve 24. The previously trapped fluid in this end moving counterflow to the arrows shown in FIG. 12, passes up the drilled holes 73 and 85, through the now formed chamber at the left end of valve 26 and out drilled hole 87 and passageway 92 to outlet 91.

It is to be noted that holes 86 and 87 as seen in FIG. 2A are of relatively small size, as for example three-sixteenths inches in diameter, and they are disposed to be barely covered by the enlarged portions 60 and 62 only when they are at the extreme limits of movement of valve 26. It is not essential that these holes be covered however it is essential that holes 84 and 85 are covered at certain periods of operation so that when fluid enters either hole 57 or 58, the hole at the other end of the passageway is covered to secure pressure in chambers 64 or 65. As the pilot valve 26 is shifted from right-to-left and from left-to-right the flow of fluid along reduced portion 61 assists in the shifting of the valve 26. The pressure in cavity 61 seeks pressure relief by moving toward holes 57 or 58 whichever is opposite the now contacted pusher 40 or 140. To a limited extent the uncovering of holes 84 and 85 as valve 26 is cycled permits pressurized fluid to enter the chamber and assist in the moving of the valve 26.

In operation the fluid enters the motor and as directed by directional valve 24 pushes piston 22 either to the right or left. Following the sequence of FIGS. 8–11, the rightward moving piston carries arm 35 into engagement with pilot valve 26. In FIG. 9 the pilot valve 26 has been pushed to the right and fluid flowing to the right end of directional valve 24 has caused valve 24 to move to the left causing the pressure fluid to flow to the right side of the piston 22. In FIG. 10 the piston 22 has carried arm 34 into engagement with the outboard end of pilot valve 26 and in FIG. 11 the leftward movement of piston 22 and arm 34 has moved pilot valve 26 to the extreme left causing the pressure fluid to flow to the left end of directional valve 24 which, in turn, has caused valve 24 to move to the right causing the stream of pressure fluid to flow to the left side of piston 22. As noted above, pilot valve 26 is assisted in its movement from left-to-right and right-to-left by the fluid flow around the reduced diameter 61 of pilot valve 26. Pilot valve 26*a* being similar in all respects to valve 26 except that pusher pin 140 is separately operable to engage and push valve 26*a*, the valve 26*a* is identical in flow sequence and control as is valve 26. The use of fluid flow assist on the movement of valve 26 or 26*a* eliminates the necessity of springs or other like assisting means and simplifies manufacture and maintenance.

Movement of arms 34 and 35 has caused pumps 100 to be activated and the treating fluid being fed in through passageway 107 is delivered by tube or hose 112 to collecting nipple 132. If it is desired the treating fluid can be fed to the incoming stream prior to delivery to inlet port 52. The pumping unit 100 is preferably made in a variety of piston sleeve sizes to suit individual needs, each pump being calibrated in its adjustable range, and each one is separably adjustable even though mounted on the same power unit. Each pump is interchangeable on the same valve body 102, and the proportion to be delivered to the main stream can be instantly set within the range of the pump by adjusting the lost motion of the pump stroke as shown by the calibration on rod 120 as shown by indicia 130.

It is to be further noted that the fluid motor shown and described can be stopped or slowed by restricting the flow delivered into a delivery pipe from outlet 91. The motor can be stopped merely by shutting off the discharge so that the fluid on the discharge side of the piston is allowed to be compressed and brought to the same pressure as the incoming fluid flow. When brought into static balance the motor will stop. When the discharge is opened to permit the discharge to flow, the static balance will no longer be in effect and the piston 22 will start to move as directed by the flow through directional valve 24. As there is no point where the motor can be in exact balance the motor is self-starting from any point in the cycle.

The terms "right," "left," "up," "down," "in," "out" and similar terms are applicable to the apparatus as described in conjunction with the accompanying drawing and it is to be noted that such terms are merly for the purpose of description and do not necessarily apply to a position in which the apparatus may be constructed or used.

It will be appreciated that changes in the details of construction as shown and described may be made by those skilled in the art without departing from the spirit and scope of this invention as defined in the appended claims.

Having now disclosed novel means whereby a self-starting fluid motor is arranged to activate one or more pumps to deliver a selected quantity of treating fluid to the main effluent stream and whereby means are provided for the simple replacement of a pump body of one calibrated capacity by a pump body of a different capacity.

I claim:

1. A self-powered variable fluid proportioner having a fluid motor and at least one fluid pump, the motor and pump in combination comprising: (1) a fluid motor having a housing providing a fluid inlet and outlet for a main stream of fluid; (2) a reciprocable piston carried in the housing and having rods extending from both ends of the housing; (3) a directional valve carried by the housing and having a movable piston flow control means adapted to receive from the fluid inlet an influent stream under pressure and to selectively feed said influent stream to one of two sides of the piston to cause the piston to move in the motor housing, said piston flow control means selectively feeding the effluent fluid stream from the other side of the piston to the fluid outlet; (4) a pilot valve carried in the motor housing and adapted to receive a portion of the influent pressurized stream of fluid and to selectively feed this influent stream to one of two ends of the directional valve to move this valve to one of two flow control positions; (5) a pair of actuating arms each attached to one end of the rod of the piston to move with the piston, a portion of each arm adapted to engage means to move the pilot valve in the housing to change the selective feed of the influent stream from the pilot valve; (6) at least one positive-displacement chamber pump removably mountable on the motor housing, said pump having a readily removable barrel, piston and piston rod to provide for a change in size, capacity and materials; (7) means for a driving connection between the pump and one of the piston actuating arms; (8) means to vary the driving connection between the piston actuating arm and pump to adjust the pump displacement relative to the motor effluent stream discharge rate; (9) means to receive and conduct a treating fluid to the pump; and (10) means to conduct the treating fluid from the pump for admixture with the main stream of fluid used by the fluid motor.

2. A self-powered variable fluid proportioner as in claim 1 in which the means to move the pilot valve includes reduced end portions on the pilot valve, each reduced end portion extending beyond the housing and adapted to be contacted and moved by the actuating arm attached to the piston, the arm actuation moving the pilot valve from a first flow control position to a second flow control position.

3. A self-powered variable fluid proportioner as in claim 1 in which the means to move the pilot valve includes a free-floating piston, a pair of shouldered pusher pins carried by and movable in the housing, each pin adapted to engage an end of the piston and to be moved when the other end of the pin is contacted and moved by the actuating arm attached to the rod of the piston.

4. A self-powered variable fluid proportioner as in claim 1 in which the directional valve includes a free-

floating piston having a right and left enlarged end portion adapted to slide in a piston bore, an intermediate reduced portion inwardly adjacent each enlarged end portion and a central enlarged portion between the intermediate reduced portions, the central enlarged portion disposed so as to be moved to each side of the fluid inlet to provide a fluid path to one of two ends of the reciprocatable piston, and the right and left enlarged end portions disposed to seal a first fluid discharge means when the first adjacent intermediate reduced diameter portions are presented to the fluid inlet and the other end portion is disposed to uncover a second fluid discharge means extending from the bore portion occupied by the other second intermediate reduced portion.

5. A self-powered variable fluid proportioner having a pressure operated fluid motor and at least one fluid pump, the motor and pump in combination comprising: (1) a fluid motor housing having a fluid inlet and outlet; (2) a first reciprocable piston carried in a piston bore in the housing; (3) a directional valve carried by the housing and having flow control means adapted to receive from the fluid inlet an influent pressurized stream and to selectively feed this influent stream to one of two sides of the first piston to cause said piston to move in the piston bore, the directional valve providing means to selectively feed an effluent stream from the other side of the first piston to the fluid outlet; (4) a pilot valve carried by the housing and adapted to receive a portion of the influent stream and to selectively feed this received portion to the directional valve to move the valve to one of two flow control positions; (5) actuating means attached to the first piston to move the pilot valve to change the selective feed from the pilot valve; (6) at least one positive-displacement chambered pump removably mountable on the motor housing, said pump having a readily removable barrel, piston and piston rod to provide for a change in size, capacity and materials; (7) means for a driving connection between the pump and one of the piston actuating means; (8) means to vary the driving connection between the piston actuating means and pump to adjust the pump displacement relative to the motor effluent stream discharge rate; (9) means to receive and conduct a treating fluid to the pump; and (10) means to conduct the treating fluid from the pump for admixture with the main stream of fluid used by the fluid motor.

6. A self-powered variable fluid proportioner as in claim 5 in which each pump includes (1) a valve body; (2) a fluid inlet system having a one-way fluid flow means permitting fluid to flow only to the valve body; (3) a fluid outlet system having a one-way fluid flow means permitting fluid to flow only from the valve body; (4) a piston sleeve receiving means in the valve body, said receiving means having connecting means to the fluid inlet and outlet systems; (5) a piston sleeve having one end adapted for the removably mounting thereof in fluid tight relationship in the sleeve receiving means in the valve body; (6) a piston reciprocatable in the piston sleeve; and (7) a piston rod attached to the piston and connected to the piston actuating means.

7. A self-powered fluid proportioner as in claim 6 in which the pump piston sleeve is supported at its other end and in which the actuating means attached to the first piston is an arm attached to a rod extending from the piston, said arm having a guideway to slidably receive the rod of the pump piston, and in which the means to vary the driving connection between the piston actuating means and the pump are releasably clamped collars on the piston pump rod, the collars being disposed in a selected position to give a precise length of pump piston stroke with every stroke of the first piston.

8. A self-powered fluid proportioner as in claim 6 in which the one-way fluid flow means of both the pump inlet and outlet systems are ball check valves.

9. A self-powered variable fluid proportioner having a fluid motor and at least one fluid pump the motor and pump in combination comprising: (1) a fluid motor housing having an inlet for a main pressurized influent fluid stream and an outlet for a main pressurized effluent fluid stream; (2) a reciprocatable first piston carried in a piston bore in the housing and having rods extending from both ends of the housing; (3) a directional valve carried by the housing and having flow control means adapted to receive from the fluid inlet the influent pressurized stream and to selectively feed this influent stream to one of two sides of the first piston to cause said piston to move in the piston bore, the directional valve providing means to selectively feed the effluent stream from the other side of the first piston to the fluid outlet; (4) a pilot valve carried in a bore in the housing and having ports adapted to receive from the common fluid inlet a portion of the influent stream and to selectively feed this received portion to the ends of the directional valve to move said valve to one of two flow control positions; (5) a pair of actuating arms each clampably attached to one end of the rod of the piston to move with the piston, a portion of each arm adapted to engage means to move the pilot valve in the housing to change the selective feed of the influent stream from the pilot valve to the directional valve; (6) at least one positive-displacement chambered pump each removably mountable on the motor housing, said pump including a valve body, a treating fluid inlet system connected to the valve body, a treating fluid outlet system connected to the valve body, one-way flow means in the valve body to permit the fluid in the inlet system to flow only inward and to permit the fluid in the outlet system to flow only outward, a piston sleeve having one end adapted for removably mounting in fluid tight arrangement in a sleeve seat in the valve body, the sleeve having connecting means to the treating fluid inlet and outlet systems, a pump piston having a rod extending from one end thereof said pump piston reciprocatable in the piston sleeve; (7) a guideway in the actuating arm adapted to slidably receive the pump piston rod; (8) a pair of releasably clamped collars on the piston pump rod the collars disposed in a selected position to give a precise length of stroke to the pump piston in response to a full stroke of the first piston; (9) means to conduct the treating fluid from the treating fluid outlet system of the pump to the main stream of pressurized fluid.

10. A self-powered variable fluid proportioner as in claim 9 in which the one-way flow means in the pump body are a pair of ball-check valves and in which the piston sleeve of the pump has a chamfered end adapted to seat in a like chamfered recess in the valve body, the piston sleeve having a shoulder means for engagement by a clamp means to urge the chamfered end in the recess and in which the pump piston rod has indicia disposed thereon in calibrated arrangement to permit ready adjustment of the releasably clamped collars.

11. A self-powered proportioner as in claim 10 in which the pilot valve includes a free-floating piston, a pair of shouldered pusher pins carried by and movable in the housing, each pin adapted to engage an end of the free-floating piston and to be moved when the other end of the pin is contacted by and moved by the inwardly moving actuating arm attached to the first piston, the free-floating piston having a reduced center portion adapted to receive a portion of the influent flow and to pass this flow to one of two ports and passageways whereby the portion of influent flow is directed to one of the two ends of the directional valve.

12. A self-powered variable fluid proportioner having a fluid motor and at least one fluid pump, the motor and pump in combination comprising: (1) a fluid motor having a housing providing a fluid inlet and outlet for a main stream of pressurized fluid; (2) a first reciprocatable power piston carried in a bore in the housing and having rods extending from both ends of the housing; (3) a directional valve including a free-floating piston longitudinally movable in a piston bore in the housing, this floating piston having a right end enlarged portion, a cen-

tral enlarged portion and a left end enlarged portion, each enlarged portion providing a precise sliding fit in the piston bore and right and left reduced portions intermediate the right and central and central and left enlarged portions; (4) a fluid inlet port in the piston wall the port connecting to the housing inlet, the port disposed to be adjacent each side of the central enlarged portion of the directional piston as the piston is moved to its limits of longitudinal movement; (5) a fluid passageway in the housing providing a fluid conducting means extending from the piston bore portion occupied by the left reduced portion of the directional piston to an end of the bore carrying the first power piston; (6) another fluid passageway in the housing providing a fluid conducting means extending from the piston bore portion occupied by the right reduced portion of the directional piston to the other end of the bore carrying the first power piston; (7) a pair of fluid passageways in the housing providing a fluid conducting means from the piston bore portion of the directional valve to the main fluid outlet, the port in the wall of the piston bore being disposed in the bore wall so as to be closed by an enlarged end portion of the directional piston when the fluid inlet port in this bore wall is open to the intermediate reduced portion of the directional piston that is adjacent the enlarged end, said port also being disposed to be open to the same intermediate reduced portion when the fluid inlet port is open to the other intermediate reduced portion of the directional piston whereby the movable piston provides flow control means to receive from the fluid inlet an influent stream and to selectively feed this stream through a port open to a reduced intermediate portion of the directional piston to the end of a bore carrying the first power piston and to carry from the other end bore of this first power piston an effluent stream to the other reduced intermediate portion of the directional piston and thence through an open port and fluid passageway to the housing fluid outlet; (8) a pilot valve carried in the motor housing and adapted to receive a portion of the influent pressurized stream of fluid and to selectively feed this influent stream to one of two ends of the directional valve to move this valve to one of two flow control positions; (9) a pair of actuating arms each attached to one end of the rod of the piston to move with the piston, a portion of each arm adapted to engage means to move the pilot valve in the housing to change the selective feed of the influent stream from the pilot valve; (10) at least one positive-displacement chamber pump removably mountable on the motor housing, said pump having a readily removable barrel, piston and piston rod to provide for a change in size, capacity and materials; (11) means for a driving connection between the pump and one of the piston actuating arms; (12) means to vary the driving connection between the piston actuating arm and pump to adjust the pump displacement relative to the motor effluent stream discharge rate; (13) means to receive and conduct a treating fluid to the pump; and (14) means to conduct the treating fluid from the pump for admixture with the main stream of fluid used by the fluid motor.

**13.** A self-powered variable fluid proportioner as in claim **12** in which the pilot valve includes a piston having enlarged end portion providing a precise sliding fit in a piston bore in the housing and a reduced piston portion intermediate of and extending from enlarged portion to enlarged portion; an outlet port providing means for the influent stream to enter the pilot valve at a point in the piston bore which is disposed to be adjacent the reduced intermediate portion as the pilot piston is moved, said port connected by a passageway to the fluid inlet serving the directional valve, a pair of fluid inlet ports formed in the piston bore, each port extending from the pilot piston bore to an end chamber forming a part of the directional valve arrangement, each inlet port disposed to be open to the reduced intermediate portion of the piston when the enlarged end of the piston adjacent thereto is shifted to that end of the piston bore and this port to be disposed to be closed by this enlarged end when the piston is shifted to the other end of the piston bore.

**14.** A self-powered variable fluid proportioner as in claim **13** in which the pilot valve has a fluid discharge passageway at each end of the pilot valve piston bore said passageway for the expelling of fluid entrapped by the shift movement of the pilot piston, each passageway having its inlet port disposed adjacent the end of the piston bore and to be open during the movement of the pilot piston, the passageway discharging into the fluid outlet of the housing; and a fluid passageway from each end chamber of the directional valve to an end portion of the pilot valve piston bore, the discharge port of this passageway being disposed in the pilot valve piston bore so as to be closed by the enlarged portion of the pilot valve piston when said piston is shifted to feed a portion of the pressurized inffuent fluid to the one chambered end of the directional valve and the discharge port in the pilot piston bore to be opened to permit the entrapped fluid in this chambered end of the directional valve to flow to the fluid outlet of the housing when the pilot valve is shifted to feed the pressurized influent stream to the other chambered end of the directional valve.

**15.** A self-powered variable fluid proportioner as in claim **14** in which the means to move the pilot valve includes reduced end portions on the pilot valve, each reduced end portion extending beyond the housing and adapted to be contacted and moved by the actuating arm attached to the piston, the arm actuation moving the pilot valve from a first flow control position to a second flow control position.

**16.** A self-powered variable fluid proportioner as in claim **14** in which the means to move the pilot valve includes a pair of shouldered pusher pins each disposed in an end of the piston bore and movable therein, each pin adapted to engage an end of the piston and to be moved when the other end of the pin is contacted and moved by the actuating arm attached to the rod of the first reciprocatable piston.

**References Cited by the Examiner**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 492,188 | 2/1893 | Burnham | 91—314 X |
| 1,527,018 | 2/1925 | Smith | 103—47 |
| 2,954,737 | 10/1960 | Hoover | 103—38 |

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