United States Patent

Tanner

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[54] FLUID PROPORTIONING SYSTEM

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[52] **U.S. Cl.** **222/61**, 222/71, 222/250, 222/335

[51] **Int. Cl.** **G01f 11/44**

[58] **Field of Search** 73/195; 222/14, 61, 65, 71, 222/76, 129.4, 249, 250, 280, 335

[56] **References Cited**

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[57] **ABSTRACT**

A plurality of cylinder and piston assemblies for connection on their inlet sides to respective fluid sources and on their outlet sides to a common vessel, the cylinder-and-piston assemblies each including valve means operable to communicate a selected side of the respective piston with one of the associated supply fluid and common vessel, and communicate the other piston side with the other of the supply fluid and common vessel, the valve means being interconnected for operation in predetermined relation.

5 Claims, 7 Drawing Figures

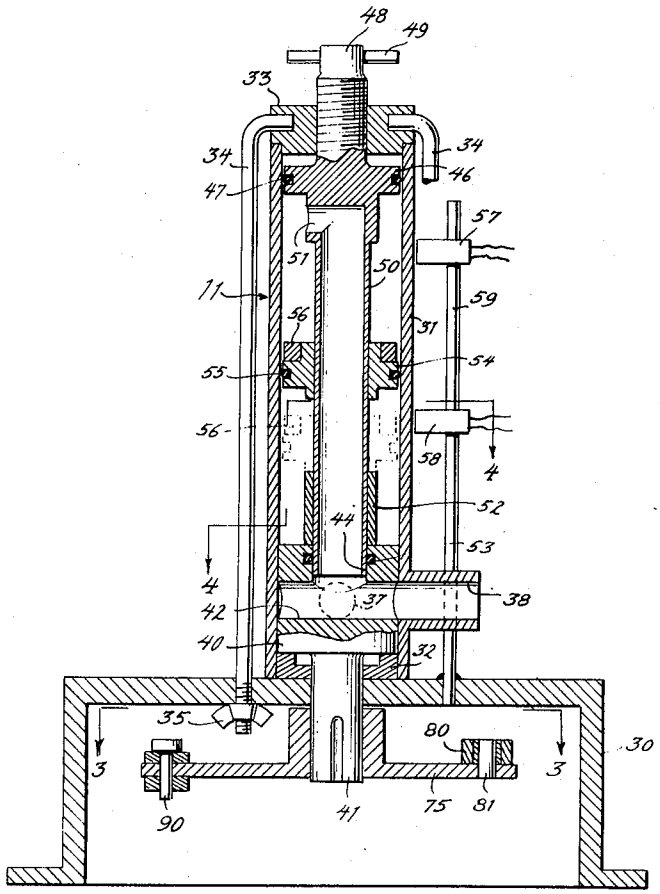


Fig. 1.

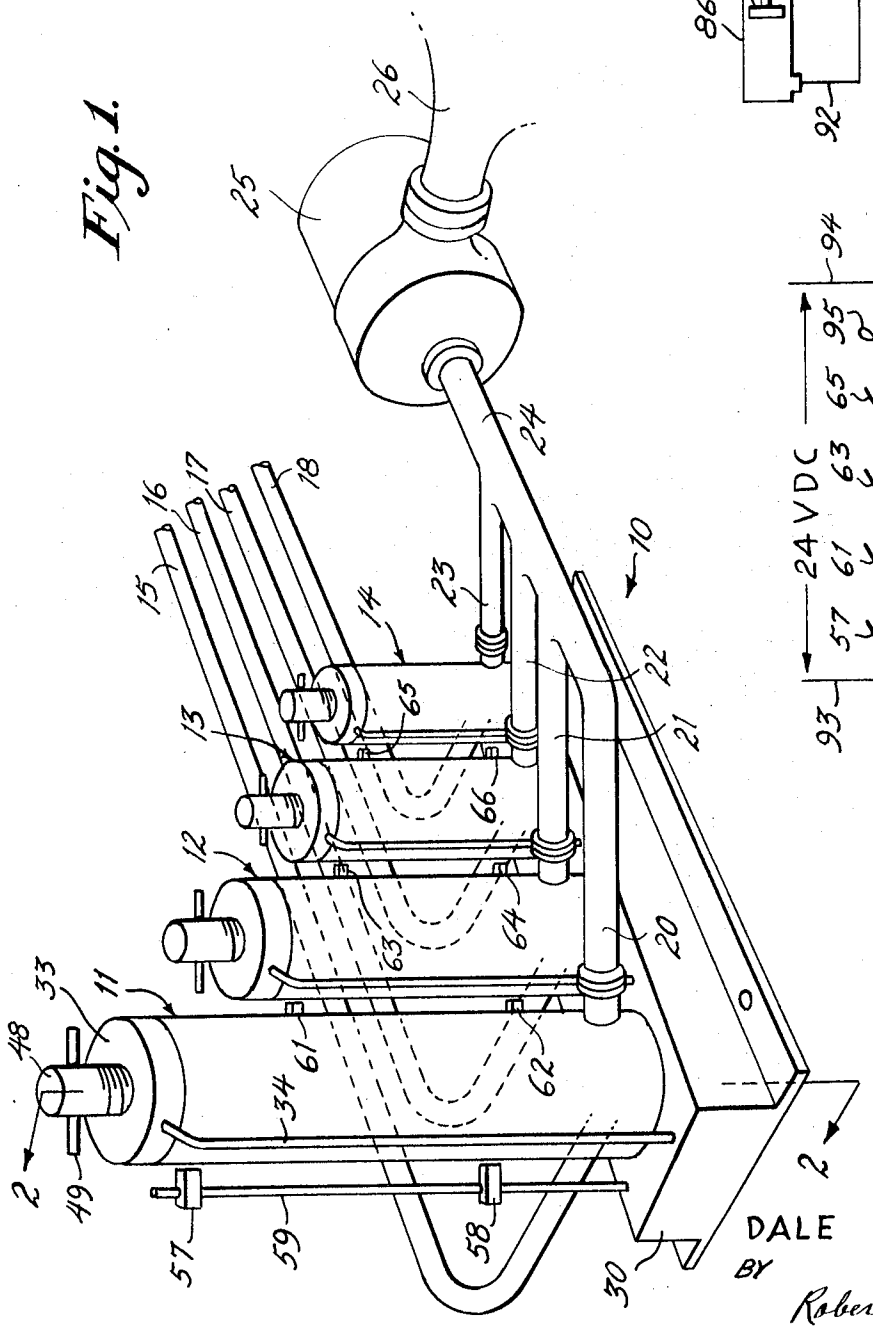


Fig. 7.

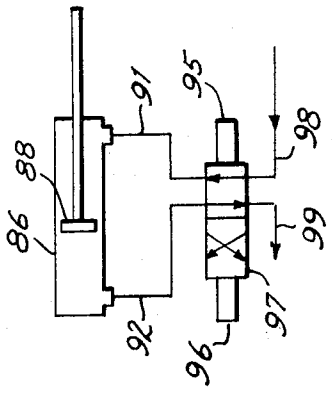
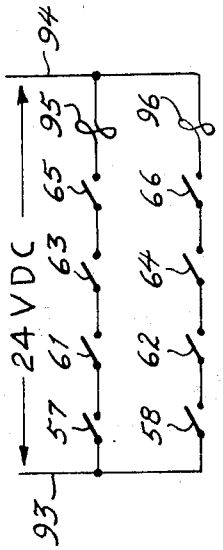


Fig. 6.



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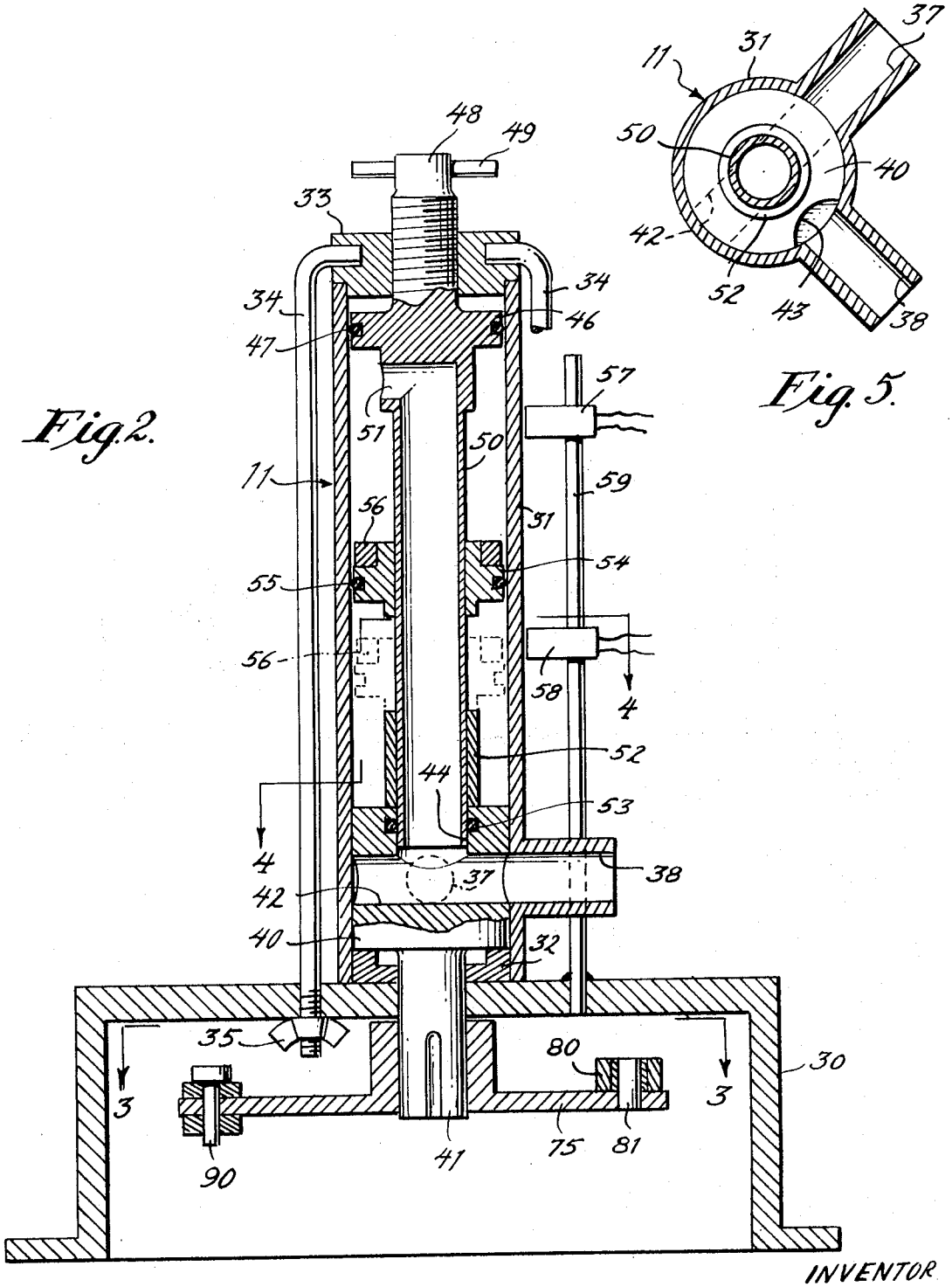
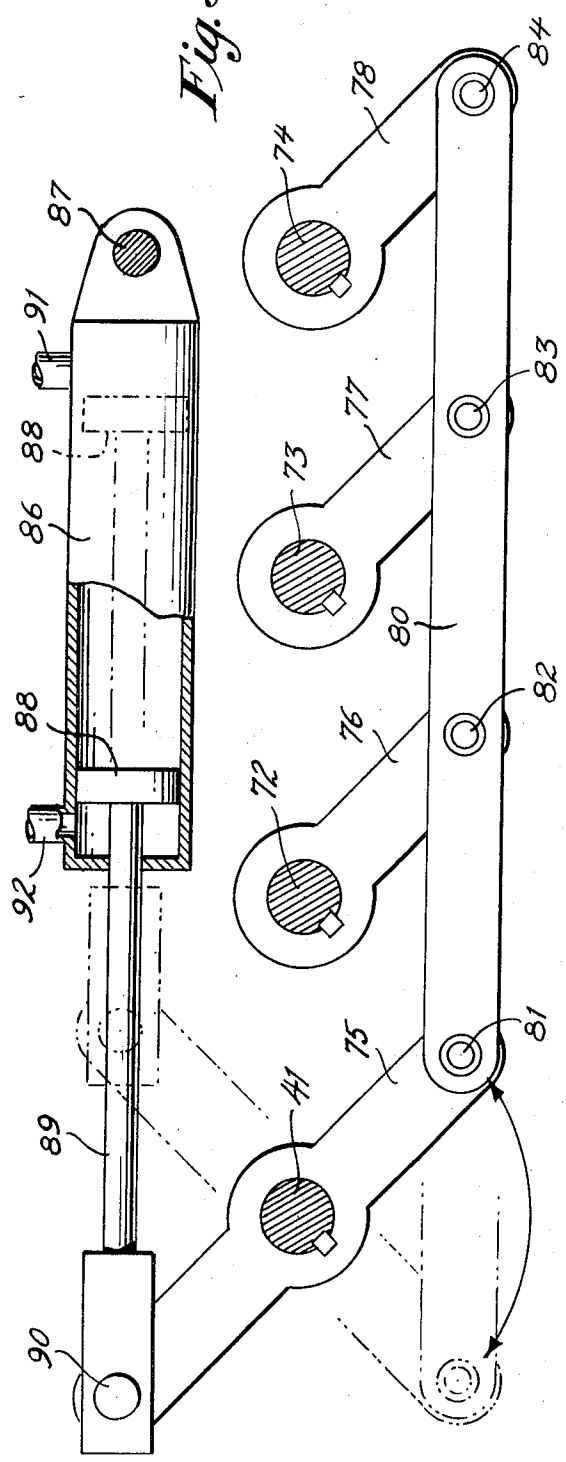


Fig. 2.

Fig. 5.

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Fig. 3.



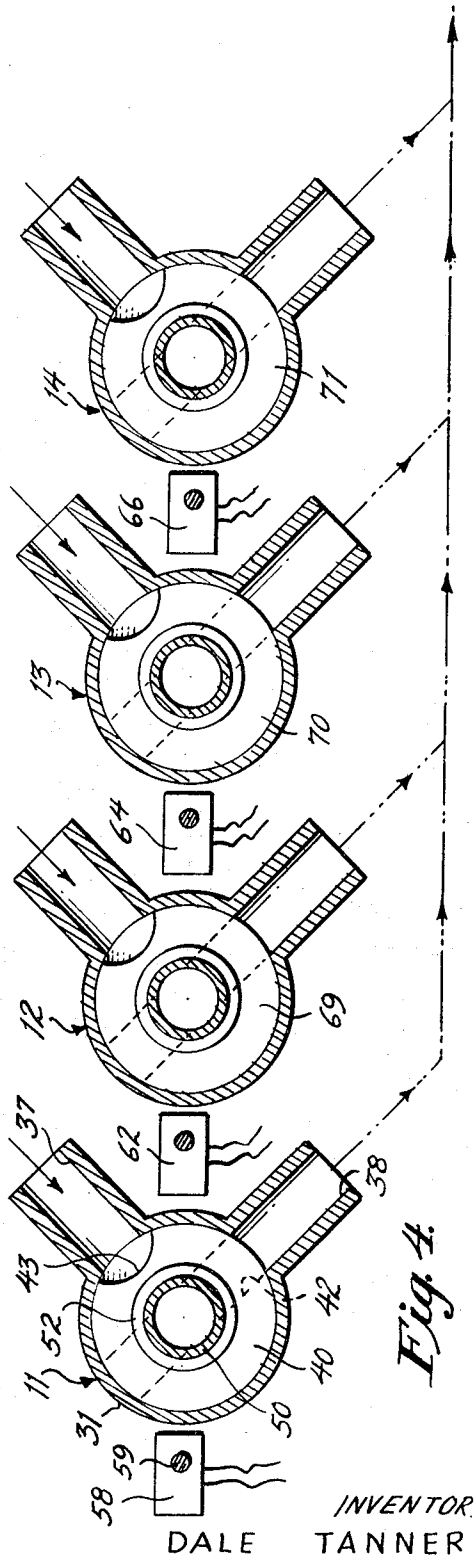


Fig. 4.

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FLUID PROPORTIONING SYSTEM

BACKGROUND OF THE INVENTION

In the proportioning, mixing or blending of fluids, there have heretofore been problems in controlling the accuracy or precision of proportioning, this usually requiring accurate speed control of several pumps. In addition to the problems of pump control, these prior systems were relatively expensive, both initially and subsequently, requiring investment in a plurality of pumps, drive means therefor, pump controls, fittings and connections, as well as regular maintenance and replacement parts.

SUMMARY OF THE INVENTION

Accordingly, it is an important object of the present invention to provide a fluid proportioning system for the continuous mixing or blending of separate fluids which eliminates the need for individual pumps for each fluid, to thereby considerably reduce the necessary capital expenditure for such a system, as well as eliminating considerable auxiliary equipment and the cost thereof, to greatly simplify the instant system and assure high reliability in operation throughout a long useful life with a minimum of maintenance and repair.

It is still another object of the present invention to provide a fluid proportioning system of the type described wherein a plurality of metering devices are operable in response to differential pressures of the fluids involved, and operatively associated with each other to assure a predetermined proportionate metering by the respective metering devices of their associated fluids.

It is still another object of the present invention to provide a fluid proportioning system having the advantageous characteristics mentioned in the preceding paragraphs wherein the relative proportions metered by the respective metering devices is readily adjustable within a wide range for a great degree of versatility in use.

Other objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings, which form a material part of this disclosure.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, which will be exemplified in the construction hereinafter described and of which the scope will be indicated by the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view illustrating a fluid proportioning system in accordance with the teachings of the present invention.

FIG. 2 is a sectional elevational view taken generally along the line 2—2 of FIG. 1.

FIG. 3 is a partial horizontal sectional view taken generally along the line 3—3 of FIG. 1.

FIG. 4 is a partial horizontal sectional view taken generally along the line 4—4 of FIG. 2.

FIG. 5 is a partial sectional view similar to FIG. 4, but illustrating an alternate condition of operation.

FIG. 6 is a schematic representation of electrical circuitry of the present invention.

FIG. 7 is a diagrammatic representation of the electrical circuitry of FIG. 6 in association with an actuating mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now more particularly to the drawings, and specifically to FIG. 1 thereof, a proportioning system is there generally designated 10, and includes a plurality of separate fluid metering devices 11, 12, 13 and 14, each being connected to a respective source of fluid supply, as by respective conduits 15, 16, 17 and 18. The several metering devices 11, 12, 13 and 14 are additionally connected in fluid communication through respective conduits 20, 21, 22 and 23, which

merge into a single conduit 24 and pass therefrom to a pump 25. The pump 25 may discharge say to a vessel 26, for further use or dispensing of the blended fluid, as will appear more fully hereinafter.

The overall fluid proportioning system, as shown in FIG. 1, may utilize metering devices 11–14 similar to that disclosed in my prior U.S. Pat. No. 3,487,980. Further, the metering devices 11–14 may each be substantially identical, and may be of the same dimensions or dimensions differing from each other, as illustrated in FIG. 1. However, as will appear more fully hereinafter, the several metering devices 11–14 are each individually adjustable for achieving the desired proportions of fluids.

The metering device 11 is shown in detail in FIG. 2, one such showing being sufficient, as the several metering devices 11–14 may all be identical. The metering devices 11–14 may all rest in upstanding relation on a hollow platform or base 30. The metering device 11 includes a generally vertically disposed open ended tubular casing or cylinder 31. The lower end of the cylinder or casing 31 is effectively closed by seating on the hollow platform or base 30, and is further provided in its lower end with a bearing 32. The upper end of the cylinder or casing 31 may be closed by a cover or plug 33. The metering device 11 may be secured in position on the hollow base 30 by any suitable means, such as elongate tie members or hold-down rods 34 each extending from the upper end closure or plug 33 to and through the upper wall of hollow base 30. A wing nut 35, or other suitable means may be detachably secured to each hold-down 34, to removably retain the respective metering assembly in position.

The cylinder or casing 31 of metering device 11 is provided in its lower region with an inlet or through fitting 37 for connection in fluid communication with the inlet or supply conduit 15. The several metering devices 12–14 are similarly provided with inlets or fittings for connection to respective inlet conduits 16, 17 and 18. The inlet 37 is located in a lower region of the casing 31, adjacent to and spaced above the base 30.

In substantially the same horizontal plane as the inlet 37, the cylinder or casing 31 is further provided with an outlet or through fitting 38 for connection in fluid communication with the conduit 20. Similarly, the casings or cylinders of metering devices 12–14 are provided with outlets for respective connection to outlet conduits 21, 22 and 23. The outlet 38 is angularly spaced from the inlet 37, say 90°.

A cylindrical, plug-like valve member 40 is seated in the lower interior region of cylinder 31, being axially rotatable therein, and provided with a coaxial shaft 41 extending downward rotatably through the bearing 32 and upper wall of base 30 to the interior thereof. The valve member 40 is formed interiorly of the cylinder 31 with a diametral through hole or passageway 42 located generally in the plane of inlet 37 and outlet 38. Further, the valve member 40 is rotatable in the cylinder 31 to dispose the passageway 42 in fluid communication with one of the inlet and outlet 37 and 38, and is swingable or rotatable to dispose the passageway in communication with the other of the outlets. At a location angularly displaced from the diametral passageway 42, the valve member 40 is formed with a peripheral cutout or port 43 which extends generally vertically from the horizontal level of the inlet and outlet 37 and 38, upward through the upper side of the valve member. In addition, the valve member 40 is formed centrally with a coaxial bore 44 extending vertically upward from the mid-region of passageway 42 through the upper side of the valve member. It will now be appreciated that the valve member 40 is shiftable between angularly spaced positions, being 90° in the illustrated embodiment, wherein the passageway 42 is shiftable between communication with inlet 37 and outlet 38, and the port 43 is shiftable between communication, respectively, with outlet 38 and inlet 37. That is, the port 43 communicates with the inlet 37 when passageway 42 communicates with outlet 38, as seen in FIGS. 2 and 4, while the port 43 communicates with outlet 38 when

the passageway 42 communicates with inlet 37, as seen in the position of FIG. 5.

An upper end member or plug-like stop is generally designated 46 and disposed conformably rotatably within an upper region of the cylinder 31. The upper end member or stop 46 may be provided with a sealing ring 47 or other suitable sealing means in sealing engagement between the stop member 46 and cylinder 31. A coaxial externally threaded extension or shaft 48 projects upwardly from the stop member 46 in threaded engagement through the upper end member or closure 33, and may be provided with a manually actuable handle or rod 49. By this means, the position of the stop member 46 is selectively adjustable vertically relative to the cylinder 31.

Depending coaxially from the stop member 46 is a hollow tubular extension or shaft 50 which engages slidably and conformably in the vertically opening bore 44 of valve member 40. Suitable sealing means, such as a sealing ring 53 may be interposed in sealing relation in the bore 44 between the surface thereof and the hollow tubular extension 50. The hollow shaft or tube 50 has its lower end open for permanent communication therethrough with the interior of bore 44 and consequently with passageway 42. In addition, the upper end of the hollow tube 50 opens laterally, as at 51 from the stop member 46 into the upper interior region of the cylinder 31.

A lower end stop member or spacer tube 52 is circumposed about the hollow shaft or tube 50 at the lower end thereof, resting on the upper surface of valve member 40. Additionally, a piston 54 is freely reciprocable in the cylinder 31, being rotatably circumposed about the hollow tube 50 and movable vertically between upper and lower positions in abutting engagement with the upper stop member 46 and lower stop member 52, respectively. The piston 54 may also be provided with suitable sealing means 55 in sealing relation between the piston and cylinder 31. Further, the piston is provided with at least a ferrous metal portion, say a ring 56 of magnetic material. Advantageously the remainder of the structure will be non-magnetic in character.

Externally of the cylinder 31 of metering unit 11, at vertically spaced locations, are a pair of upper and lower piston sensing devices, such as proximity switches 57 and 58. These switches may be suitably mounted in spaced relation, as on a standard 59 fixed to the base 30, the switches being vertically adjustable on the standard. The proximity switches 57 and 58 are respectively responsive to movement of the piston with its magnetic part 56 upward and downward. In the illustrated embodiment, as will appear more fully hereinafter, the upper and lower proximity switches 57 and 58 are alternately closed upon movement of the piston 54 to its upper limiting position and to its downward limiting position, the latter being shown in phantom in FIG. 2. Similarly, the several metering units 12, 13 and 14 are provided with upper and lower limit switches, such as proximity switches, the metering device 12 having upper and lower proximity switches 61 and 62, while the metering device 13 includes upper and lower proximity switches 63 and 64, and the metering device 14 includes upper and lower proximity switches 65 and 66. The proximity switches 61–66 of the metering units 12–14 all operate in a manner similar to the first described proximity switches 57 and 58, say to close upon movement of the associated piston into proximity with the respective switch.

The additional metering devices 12, 13 and 14 each include in its lower region a plug-like axially rotatable valve member, substantially identical to the valve member 40, and respectively designated 69, 70 and 71. The valve members 69, 70 and 71 cooperate with their respective cylinder inlets and outlets in substantially the same manner as the first described valve member 40, and are each further formed with a coaxial depending shaft, as at 72, 73 and 74, respectively, which may each be identical to the shaft 41 of valve member 40.

The shafts 41 and 72–74 depend rotatably from their respective valve members 40 and 69–71, into the hollow base 30. A generally horizontally disposed, double ended crank arm 75 is keyed to the depending valve member shaft 41, while a plurality of crank arms 76, 77 and 78 are each respectively keyed to the depending valve member shafts 72, 73 and 74. The several crank arms 75–78 may all be in substantial parallelism, as illustrated in FIG. 3, and connected together by a single bar or link 80 extending in spaced parallelism with a plane extending through the axes of shafts 41 and 72–74, and respectively pivotally connected to the crank arms 75–78 by pivots 81, 82, 83 and 84. Thus, the several valve members 40 are positively connected together for simultaneous, equiangular rotation about their respective axes. As best seen in FIG. 4, the several valve members 40 and 69–71 are all in angular alignment with each other, so that their operation in their respective cylinders is all identical at the same time. For example, in the illustrated condition the internal passageway of each valve member 40 and 69–71 is in alignment with its adjacent outlet, and the generally vertically extending, peripherally located port of each valve member is located in communication with the respective cylinder inlet. Upon shifting movement of the bar link 80, to swing the valve members 40 and 69–71 90°, the locations of their respective passageways and ports relative to the cylinder inlets and outlets is reversed, as indicated in FIG. 5.

In addition, an actuating cylinder 86 may be mounted in the base 30, as by a pivot 87 at one end of the cylinder. A piston 88 is reciprocable in the cylinder 86 and provided with an externally extending piston rod 89 having its distal end pivotally connected, as by a pin 90, to the crank arm 75 remote from the pivot pin 81. The cylinder 86 may be provided adjacent to opposite ends with respective ports or fluid passageways 91 and 92, the alternate ingress of fluid through said passageways effecting reciprocation of the piston 88, and swinging of the several crank arms 75–78. The alternate position of arm 75 is shown in phantom, corresponding to the phantom position of the actuating piston 88.

An electrical schematic of FIG. 6 may be employed, wherein the several upper sensing means or proximity switches 57, 61, 63 and 65 are all connected in series, and between a pair of supply conductors or lines 93 and 94 across a suitable voltage supply. The lower sensing or proximity switches 58, 62, 64 and 66 are also connected in series with each other, and also connected across the supply lines 93 and 94, so as to be parallel with the series connected upper proximity switches. A solenoid 95 is connected in series with the upper proximity switches 57, 61, 63 and 65, while a solenoid 96 is connected in series with the lower proximity switches 58, 62, 64 and 66. Thus, the solenoid 95 will be energized upon closure of all the upper proximity switches, while the solenoid 96 will be energized upon closure of all the lower proximity switches.

As seen in FIG. 7, being a pneumatic diagram, the cylinder 86 has its conduits 91 and 92 connected to a reversing valve 97 which is shifted between its opposite positions by the solenoids 95 and 96. The reversing valve is, in turn, connected to a source of pressurized fluid, as by a supply conduit 98, and to a low pressure or exhaust conduit 99. Upon alternate energization of solenoids 95 and 96, the cylinder conduits 91 and 92 are alternately connected in fluid communication with the supply conduit 98 and exhaust conduit 99 to effect repeated reciprocation of the piston 88 in cylinder 86.

In overall operation, as shown in the position of FIGS. 1–4, the single pump 25 effectively reduces the fluid pressure at the outlets 20–23 relative to the inlet conduits 15–18. If desired, the inlet conduits 15–18 may afford gravity feed, or additional pumps may be provided if desired.

By the pressure differential of the inlet fluids over the outlet fluids, the inlet fluids enter through the port 43 of valve member 40, and the corresponding ports of respective valve members 69–71, to pass into the respective metering devices 11–14 beneath the pistons thereof. The several pistons of the metering devices 11–14 are thereby moved upward to a limiting position in abutting engagement with the corresponding upper end stop member, as at 46 in metering device 11, to

energize or close the several upper end proximity switches **57**, **61**, **63** and **65**. This action, as described, serves to discharge fluid from within each of the cylinders of units **11–14** above the respective pistons downwardly through the associated hollow tubes, such as designated **50**, and thence outward through the passageway of the valve members **40** and **69–71**.

Upon closure of the several upper end proximity switches **57**, **61**, **63** and **65**, the solenoid **95** is energized to effect reversal of valve **97** to shift the piston **88** to its opposite extreme position. This effects pivotal movement of the several valve members **40** and **69–71** from the position shown in FIG. **4** to that illustrated in FIG. **5**.

Thereupon, the pressure differential against the inlet conduits **15–18** is communicated through the internal diametral passageway of each valve member **40** and **69–71**, upward through the hollow tube thereof into the respective cylinder on the upper side of the associated piston to shift the pistons downward. This downward movement of the piston **54**, and corresponding pistons of metering units **12–14** effects discharge of fluid from below the pistons outwardly through the port **43** and corresponding ports of the valve members **69–71** to the outlet conduits **20–23**. Upon movement of the piston **54** and corresponding pistons of the remaining metering devices to their lowermost limiting position, say in abutment with the stop sleeve **52** and corresponding stop members, the several pistons effect closure of the lower end proximity switches **58**, **62**, **64** and **66**, the upper end limit switches, of course, have been opened upon downward movement of the pistons. The solenoid **96** is thereby energized to operate the reversing valve **97** and effect return of the pneumatic system of FIG. **7** to its original condition, for repetition of the above-described cycle of operation.

From the foregoing, it will now be appreciated that the fluid proportioning or continuous blending system of the instant invention provides a highly sanitary construction for use in the food and drug industries, permitting of quick and easy disassembly and reassembly for cleaning or replacement of parts, is extremely simple and economical in construction and operation, requiring only a single pump regardless of the number of fluids being handled, permits of a great range of volumetric adjustment by replacement or substitution of the stop sleeves or spacers **52**, and further permits of fine volumetric adjustment, even during operation, by rotation of threaded stem **48** to vertically adjust the position of upper end stop member **46**.

Although the present invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it is understood that certain changes and modifications may be made within the spirit of the invention.

What is claimed is:

1. A fluid proportioning system comprising a plurality of cylinders, a plurality of fluid inlets each opening into a respective cylinder and adapted for connection in fluid communication with a respective fluid source, a piston in each cylinder and reciprocable therein between opposite limiting positions, a plurality of fluid outlets each opening from a respective cylinder for communication with a common vessel, valve means in each cylinder selectively positionable to communicate the associated inlet to a selected side of the associated piston and communicate the associated outlet to the other piston side, operating means interconnecting said valve means for simultaneous shifting thereof between selected positions, and actuating means for actuating said operating means only upon completion of the strokes of all of said pistons, whereby the frequency of reciprocation of all the pistons is equal, said pistons being freely reciprocable in respective cylinders independently of each other, for separate and independent piston reciprocation responsive to pressure differential between inlet and outlet fluids, and selectively positionable limit means in each cylinder for independently limiting piston movement to selected positions.

2. A fluid proportioning system comprising a plurality of cylinders, a plurality of fluid inlets each opening into a respective cylinder and adapted for connection in fluid communication with a respective fluid source, a piston in each cylinder and reciprocable therein between opposite limiting positions, a plurality of fluid outlets each opening from a respective cylinder for communication with a common vessel, valve means in each cylinder selectively positionable to communicate the associated inlet to a selected side of the associated piston and communicate the associated outlet to the other piston side, operating means interconnecting said valve means for simultaneous shifting thereof between selected positions, and actuating means for actuating said operating means only upon completion of the strokes of all of said pistons, whereby the frequency of reciprocation of all the pistons is equal, said pistons being freely reciprocable in respective cylinders, for piston reciprocation responsive to pressure differential between inlet and outlet fluids, said valve means each comprising a rotary valve member located on one side of the associated piston having an internal passageway communicating in all positions of rotative movement with the other side of the associated piston, said passageway being rotatable with said valve member to communicate selectively with said inlet and outlet, and a port in said valve member communicating in all positions of rotative movement with said one side of the associated piston and rotative with said valve member to communicate with the outlet when said passageway communicates with the inlet and to communicate with the inlet when said passageway communicates with the outlet, said operating means comprising a shaft extending from each rotary member, and crank means positively connecting said shafts for simultaneous rotation of said rotary members, said actuating means comprising a first group of series connected switches associated with respective pistons at one limiting position thereof, and a second group of series connected switches associated with respective pistons at the opposite limiting position thereof, said groups being connected in parallel with each other for alternate actuation of said valve operating means upon repeated reciprocation of said pistons.

3. A fluid proportioning system comprising a plurality of cylinders, a plurality of fluid inlets each opening into a respective cylinder and adapted for connection in fluid communication with a respective fluid source, a piston in each cylinder and reciprocable therein between opposite limiting positions, a plurality of fluid outlets each opening from a respective cylinder for communication with a common vessel, valve means in each cylinder selectively positionable to communicate the associated inlet to a selected side of the associated piston and communicate the associated outlet to the other piston side, operating means interconnecting said valve means for simultaneous shifting thereof between selected positions, and actuating means for actuating said operating means only upon completion of the strokes of all of said pistons, whereby the frequency of reciprocation of all the pistons is equal, said actuating means comprising a first group of series connected switches associated with respective pistons at one limiting position thereof, and a second group of series connected switches associated with the respective pistons at the opposite limiting position thereof, said groups being connected in parallel with each other for alternate actuation of said valve operating means upon repeated reciprocation of said pistons.

4. A fluid proportioning system according to claim **3**, said valve means each comprising a rotary valve member located on one side of the associated piston having an internal passageway communicating in all positions of rotative movement with the other side of the associated piston, said passageway being rotatable with said valve member to communicate selectively with the inlet and outlet, and a port in said valve member communicating in all positions of rotative movement with said one side of the associated piston and rotative with said valve member to communicate with the outlet when said passageway communicates with the inlet and to communicate with the inlet when said passageway communicates with the outlet.

5. A fluid proportioning system according to claim **4**, said operating means comprising a shaft extending from each ro-

tary member, and crank means positively connecting said shafts for simultaneous rotation of said rotary members.

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