Dec. 24, 1946. A. F. McFARLAND 2,413,029

CHEMICAL FEEDING APPARATUS

Filed Nov. 8, 1941 3 Sheets-Sheet 1

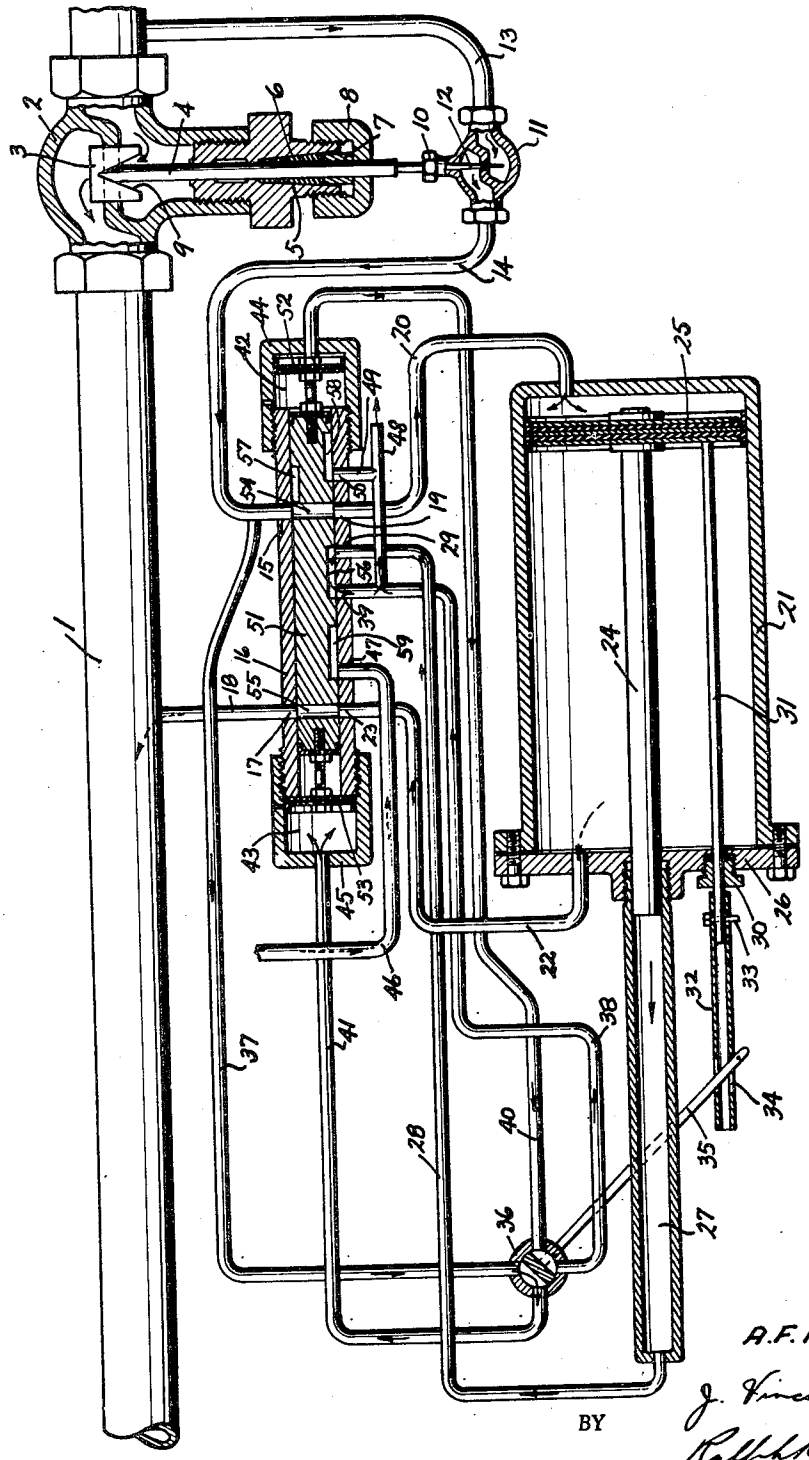


Fig. 1.

A. F. Mc. FARLAND.
INVENTOR.
BY J. Vincent Martin
and Ralph R. Browning.
ATTORNEYS.

Dec. 24, 1946. A. F. McFARLAND 2,413,029

CHEMICAL FEEDING APPARATUS

Filed Nov. 8, 1941 3 Sheets-Sheet 2

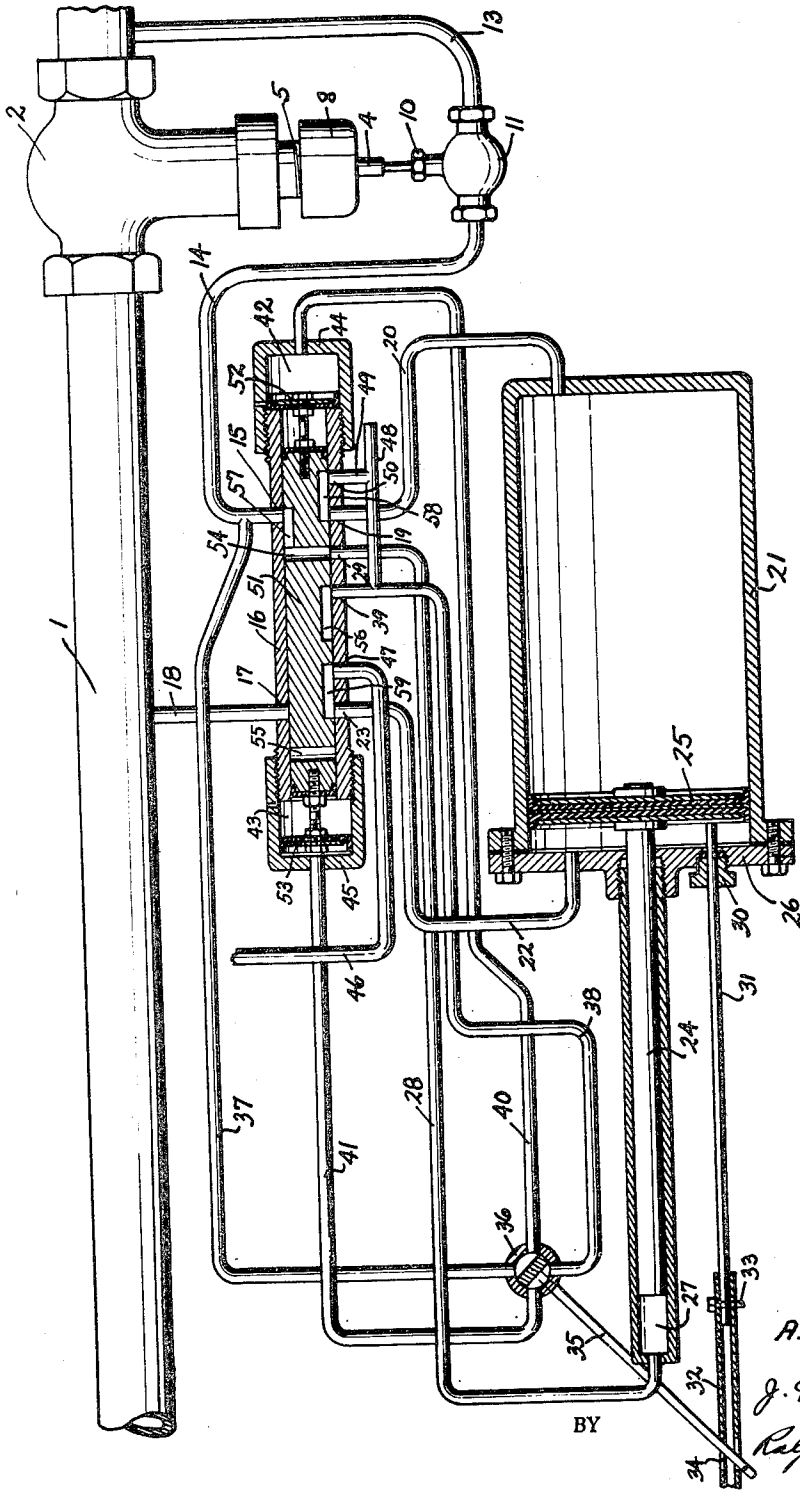


Fig. 2.

A. F. Mc. FARLAND
INVENTOR.
J. Vincent Martin
and
Ralph R. Browning.
ATTORNEYS.

BY

Dec. 24, 1946. A. F. McFARLAND 2,413,029

CHEMICAL FEEDING APPARATUS

Filed Nov. 8, 1941 3 Sheets-Sheet 3

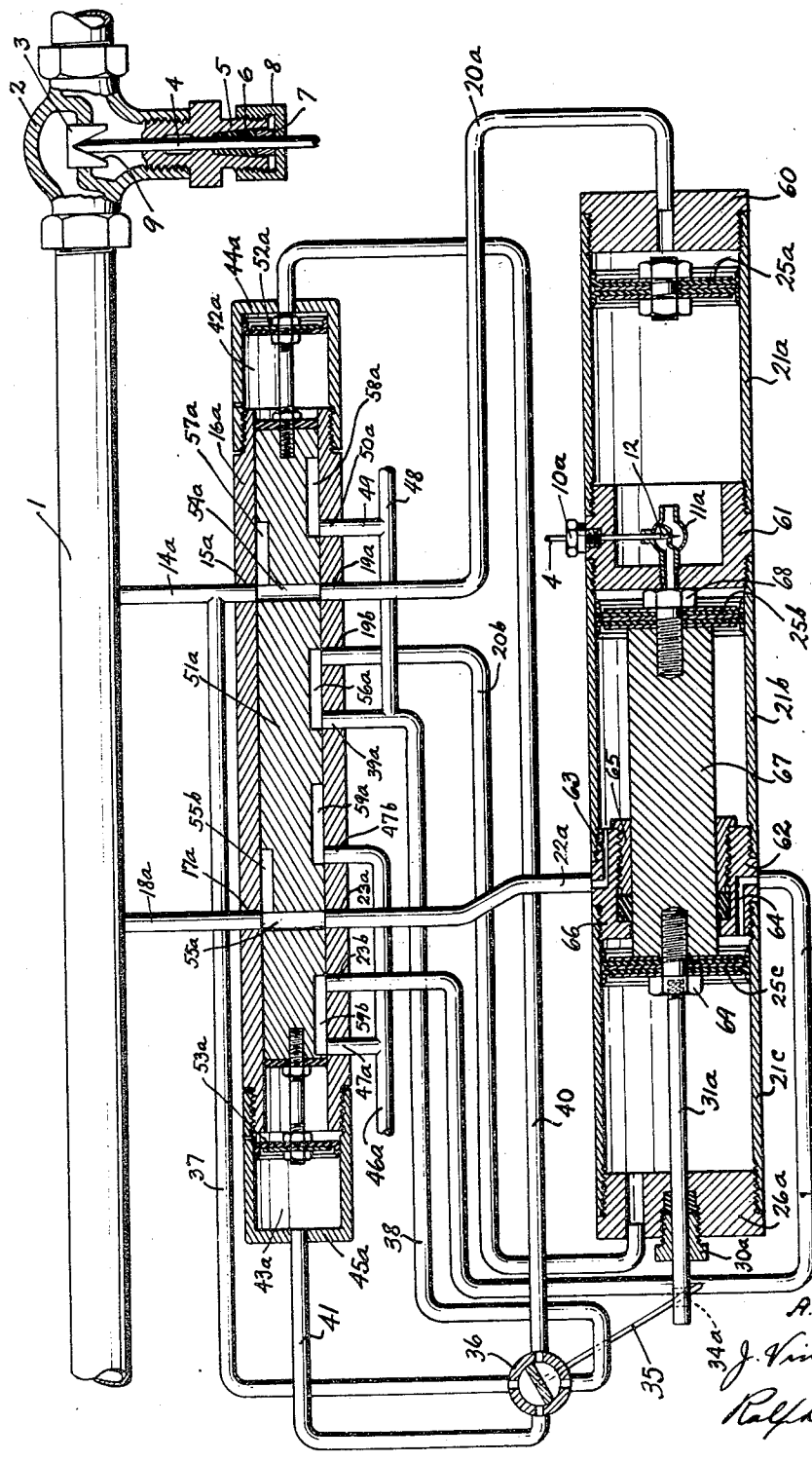


Fig. 3.

A. F. Mc. FARLAND.
INVENTOR.
J. Vincent Martin
and
Ralph R. Browning
ATTORNEYS.

Patented Dec. 24, 1946 2,413,029

UNITED STATES PATENT OFFICE

2,413,029

CHEMICAL FEEDING APPARATUS

Artie F. McFarland, Houston, Tex., assignor, by d'rect and mesne assignments, to McFarland Manufacturing Corporation, Houston, Tex., a corporation of Texas

Application November 8, 1941, Serial No. 418,338

18 Claims. (Cl. 103—50)

1

This invention relates to a chemical feeding apparatus and particularly to that type of apparatus which may be employed for feeding a chemical or some other liquid substance into a flowing stream of gas or liquid. It has for its general object the provision of a device of the character referred to which will feed the chemical or gas or liquid substance into the flowing stream in a substantially fixed proportion to the substance of said flowing stream. In other words, it will produce a mixture of the substance of the flowing stream with the chemical, which mixture will be substantially constant in its proportion.

It is not intended that this invention shall be limited to the feeding of any specific liquid into any other specific gas or liquid, but that it shall be applicable to all cases where it is desired to mix with a flowing stream of either gas or liquid a substantially fixed proportion of another liquid.

Another object of this invention is to provide such a device which will be automatic in its operation and will not cease to function and have to be refilled at intervals.

Another object of this invention is to provide a device of the character referred to in which there is a feeding chamber which will be automatically refilled each time it becomes empty so that there will be no substantial period during which the mixing of chemical or other liquid will not take place.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings wherein are set forth by way of illustration two embodiments of this invention.

In the drawings:

Fig. 1 is a diagrammatic view with parts broken away and shown in longitudinal cross section illustrating one embodiment of this invention with the parts in the position which they occupy during the feeding of liquid into the flowing stream just after the liquid reservoir of the device has been filled.

Fig. 2 is a view similar to Fig. 1 but illustrating the parts in the position which they occupy just after the reservoir for the liquid has been emptied and at the beginning of the operation of refilling the reservoir.

Fig. 3 is a view similar to Fig. 1 but showing a modified form.

Referring now more particularly to the form illustrated in Figs. 1 and 2 of the drawings, the numeral 1 illustrates a conduit through which a fluid flow is adapted to take place and with which

2

fluid it is desired to cause the mixture of a definite proportion of liquid the injection of which is accomplished by this invention. Inserted in this flow line or conduit 1 is a control valve 2 which is made very much like the ordinary cutoff valve but which is so arranged as to be controlled by the flow of fluid through the conduit 1 instead of to control the flow of fluid through this conduit.

The valve 2 instead of having the usual closure member which seats upon a seat to shut off the flow of fluid, has a plunger member 3 carried on stem 4 which is mounted for reciprocation through a stuffing box 5 having packing 6 therein held in place by a gland 7 and a nut 8. The plunger 3 is generally speaking of cylindrical form slidable longitudinally through the opening in the valve housing in which it provides a substantially close fit. This element 3 however is provided with a V-shaped notch 9 which is so disposed that as the element 3 is moved through the opening in which it is fitted, by the pressure of fluid in the conduit 1, the flow of such fluid will be permitted in increasing quantities through the notch 9. In other words, it will be seen that the element 3 will be moved through the opening in which it is mounted by a sufficient distance to accommodate the quantity of flow that is passing through the conduit 1, and when it has moved such a distance its movement will thereafter cease. The element 3 and stem 4 may be made of such weight that when flow of fluid through the conduit 1 is reduced or stopped the element 3 and stem 4 will drop to a position such that they will entirely close the opening through the valve 2, or if found desirable some other means may be provided for returning these elements to their closed position. In any event the pressure of fluid in the line 1 will tend to close this valve and will do so if this pressure is substantially above atmospheric.

The lower or external end of the stem 4 is of reduced diameter and extends through a stuffing box 10 into a valve housing 11 and has a valve element 12 formed thereon, this element being in the illustration in the form of a needle valve so as to regulate the flow of fluid through the housing 11. This valve housing 11 is connected by means of a conduit 13 to the conduit 1 on the upstream side of the valve 2, and is connected by means of a conduit 14 to a port 15 in a slide valve housing 16. Another port 17 of this slide valve housing is connected by a conduit 18 to the conduit 1 on the downstream side of the valve 2.

Directly opposite the port 15, the slide valve

housing 16 is provided with a port 19 and this port is connected by the means of a conduit 20 to one end of a feed cylinder or reservoir 21. The opposite end of this feed cylinder or reservoir is connected by a conduit 22 to a port 23 in the slide valve housing, the port 23 being substantially directly opposite the port 17.

The cylinder or reservoir 21 is adapted to contain the chemical or other liquid which is to be fed into and mixed with the stream of fluid flowing through the conduit 1. Slidably mounted in this cylinder on the piston rod 24 is a piston 25, the same being provided with suitable packing for the purpose of forming a seal with the inner surfaces of the walls of the cylinder 21.

The piston rod 24 extends through the head 26 of the cylinder 21 and into a chamber 27 which is secured to the head 26 and extends a substantial distance therefrom. This chamber is connected by means of a conduit 28 to a port 29 in the slide valve housing 16.

Also extending from the piston 25 in a direction substantially parallel to the piston rod 24 and through a stuffing box 30 in the head 26 is a control rod 31. The outer end of this control rod is provided with an extension 32 adjustably secured thereto by means such as a pin 33 and having an opening 34 therethrough for the purpose of forming a receptacle for the lever 35 which controls the operation of the four-way valve 36.

One of the connections to this four-way valve is by way of conduit 37 to the conduit 14 leading from the valve 11. A second connection is by means of a conduit 38 leading to a port 39 in the slide valve housing 16, this port being adjacent to the port 29 with which the conduit 28 is connected. The third and fourth connections to the four-way valve 36 are by way of the conduits 40 and 41 respectively to the opposite ends of the slide valve housing, and provide communication with the interiors of the cylinders 42 and 43 respectively at the ends of said housing. These cylinders are provided by means of the caps 44 and 45 which are respectively threaded on to the opposite ends of the slide valve housing 16.

The conduit 46 leading from a source of chemical supply is connected to a port 47 in the slide valve housing adjacent to the port 23. The conduit 38 is also vented through a pipe 48 which pipe connects by means of a branch 49 with a port 50 in the slide valve housing adjacent to the port 19.

The slide valve 51 which is slidable endwise within the housing 16 has pistons 52 and 53 mounted respectively in the cylinders or chambers 42 and 43 on the opposite ends of the slide valve housing. These pistons are appropriately formed to provide sliding seals against the walls of the chambers 42 and 43 and to be moved by pressure within said respective chambers in order to shift the slide valve 51 from one position to another.

The slide valve 51 is also provided with openings 54 and 55 extending transversely thereof, the opening 54 being adapted to connect the ports 15 and 19 when the slide valve is in one position and the opening 55 being adapted to connect the ports 17 and 23 when the slide valve is in the same position. When in this same position the slide valve has a passage 56 at an appropriate position on its surface to provide a connection between the conduit 28 and the conduit 38.

When in its opposite position the slide valve has a passage 57 in one surface communicating with one end of the opening 54 so that this passage

57 and the opening 54 will provide communication between the port 15 and the port 29. Also, the slide valve has a passage 58 which in this last mentioned position provides communication between the ports 50 and 19. One other passage 59 is adapted under these circumstances to provide communication between the ports 47 and 23.

The operation of the form just described is as follows:

With the various parts in the position in which they are illustrated in Fig. 1 it will be understood that the cylinder 21 to the left of the piston 25 will be filled with the chemical which it is desired to have mixed with the stream of fluid flowing through the conduit 1. With respect to this stream of fluid it will be understood that pressure from the main 1 will act through the conduit 13, the valve 11, the conduit 14, the passageway 54 in the slide valve, the conduit 20 and the space to the right of the piston 25 within the cylinder 21, tending to move the piston to the left. The chemical to the left of the piston will be under much the same pressure so that the unit pressures on the two sides of the piston will be equal. However, the area of cross section of the piston rod 24 will not be acted upon by the chemical under pressure, thus unbalancing the total pressures on the piston and causing it to move to the left. The chemical within the cylinder 21 to the left of the piston 25 will thus be caused to flow out through the conduit 22, the passage 55 and the conduit 18 into the conduit 1. This flow will be controlled by the position of the needle valve 12, and this needle valve position will in turn be controlled by the amount of fluid flowing through the conduit 1 and past the valve element 3. Thus, the valve element 3 will rise as the velocity of fluid in the conduit 1 increases. When the valve element 3 rises the valve element 12 will likewise rise and permit a greater flow through the conduit 13 and the other connected passageways. This increased flow will naturally cause a faster travel of the piston 25 and an increased amount of chemical forced from the cylinder 21 into the flowing stream of fluid in the conduit 1.

During this travel of the piston 25 to the left any substance within the space 27 will be forced out by the piston rod 24 and through the conduit 28, the passageway 56, and the conduit 48 to be vented to the atmosphere.

When the piston 25 reaches the extent of its movement to the left, the engagement of the valve handle 35 with the slot 34 will cause a shifting of this valve to the position illustrated in Fig. 2. Prior to this shifting it will be noted that pressure from the conduit 14 will have been conducted through the conduit 37, the valve 36 and the conduit 41 to the space 43 at the left-hand end of the slide valve housing thereby forcing and holding the slide valve in the position illustrated in Fig. 1. At the same time, the space at the right-hand end of the slide valve housing will have been vented through the conduit 40, the valve 36 and the conduit 38 which communicates with the conduit 48.

After the valve 36 has been shifted as above described by the movement of the piston 25 to the left, pressure fluid from the conduit 14 will be lead through the conduit 37 and the conduit 40 to the space within the right-hand end of the slide valve housing so as to act upon the piston 52 and tend to move the slide valve to the left. At the same time, the space at the left end of the slide valve housing will have been vented through the conduit 41, the valve 36 and the

conduits 38 and 48. The slide valve will, therefore, be immediately shifted to its extreme left-hand position as is illustrated in Fig. 2.

Referring now more particularly to Fig. 2, it will be seen that with the slide valve in the position illustrated the conduit 14 will be connected through the passageways 57 and 54 and the conduit 26 to the chamber 27. Pressure fluid from the conduit 14 will thereby be caused to act upon the left-hand end of the piston rod 24 and to tend to move the piston rod 24 and the piston 25 together with their associated parts back to the position illustrated in Fig. 1. The shifting of the slide valve will also have connected to conduit 22 through the passageway 59 to the conduit 46 and thence to the source of chemical supply so that as the piston 25 is moved toward the right a supply of chemical will be drawn into the cylinder 21 in the space at the left-hand of the piston 25.

The shifting of the slide valve as above referred to will also have placed the conduit 20 and the space at the right-hand of the piston 25 within the cylinder 21 in communication with the atmosphere through the passageway 58 and the conduits 49 and 48. The piston 25 will thus be free to move to the right under the influence of the pressure admitted to the space 27. When the piston 25 has been moved to its extreme right-hand position the cylinder 21 to the left of the piston 25 will have again been filled with chemical, the valve 36 will have been shifted again to the position illustrated in Fig. 1, and the cycle will be repeated.

The form of the invention illustrated in Figs. 1 and 2 is such that a feeding of the chemical must necessarily be interrupted for a short space of time during the time that the cylinder 21 is being refilled after it has become empty. In Fig. 3 of the drawings, however, there is illustrated a form in which no such interval of time is necessary for the purpose of refilling the cylinder from which the chemical is fed.

Referring now more in detail to Fig. 3, the pipe line 1 is provided with a valve 2 which is similar in all respects to that previously described in connection with Figs. 1 and 2. The stem 4 of this valve has on its lower end a needle valve 12 which is likewise similar to that on the lower end of the stem 4 in Figs. 1 and 2. This stem extends through a stuffing box 10*a* for a purpose to be presently described.

The conduit 14*a* extends directly from pipe line 1 to the port 15*a* of the slide valve housing 16*a* instead of passing through the valve 11 as shown in Figs. 1 and 2. The conduit 18*a* connects the port 17*a* of the slide valve housing with the pipe line 1 at a position downstream from the connection between this pipe line and the conduit 14*a*.

Directly opposite the port 15*a* is a port 19*a* from which a conduit 20*a* extends to an opening through the cylinder head 60. The cylinder head 60 forms a closure for one end of a power cylinder 21*a*. Connected to the opposite end of the power cylinder 21*a* by means of a partition 61 is a feed cylinder 21*b*, and this feed cylinder 21*b* is connected to a second feed cylinder 21*c* by means of a partition 62. The second feed cylinder 21*c* is closed at its opposite end by means of a head 26*a*.

A conduit 22*a* extends from a port 23*a* in the slide valve housing directly opposite the port 17*a* to connect with a passage 63 in the partition 62, and this passage leads to the space within the feed cylinder 21*b*. Another conduit 22*b* leads from a port 23*b* in the slide valve housing adjacent to the port 23*a* but longitudinally spaced therefrom and connects with a passageway 64 in the partition 62, this passageway providing communication with the interior of the feed cylinder 21*c*.

Within the power cylinder 21*a* is a separating piston 25*a* which is not mechanically connected to any part of the mechanism but is intended merely to separate the power fluid from the pipe line 1 from a body of liquid which is placed within the power cylinder 21*a* to the left of the piston 25*a*. This liquid is made to fill the space within the cylinder 21*a* to the left of the piston 25*a*, and also to fill the space within the valve 11*a* and within the feed cylinder 21*b* to the right of the piston 25*b*. Passage of this body of liquid from the cylinder 21*a* to the cylinder 21*b* is controlled by means of the valve 11*a* and the movement of the needle valve 12. This valve serves in all respects the same function as the valve 11 in Figs. 1 and 2 with the exception that it serves to control the passage of liquid instead of the passage of the fluid from the pipe line 1 which in many instances would be gas, or which if a liquid might be corrosive so as to cause rapid deterioration of the needle valve 12. The liquid within the cylinder 21*a* may be of any desired characteristics but preferably one which is inert and is possessed of proper degree of viscosity so that it may be readily controlled by the needle valve 12. Also, in those cases where it is subjected to variations in temperature at frequent intervals it should be of such a nature that these variations in temperature will not seriously affect the rate at which it will flow through the needle valve 12.

The feed pistons 25*b* and 25*c* within the feed cylinders 21*b* and 21*c* respectively are mounted on the opposite ends of a connecting piston rod 67, this rod passing through the partition 62 and being sealed therein by means of a gland nut 65 bearing against a packing 66. A cap screw 68 is employed for securing the piston 25*b* to the right-hand end of the piston rod 67 and a second cap screw 69 is provided for securing the piston 25*c* to the opposite end of the piston rod 67. The cap screw 69 has its head tapped and threaded to receive the threaded inner end of a controlling rod 31*a* which extends through the head 26*a* and through the seal formed by the stuffing box 30*a* and has an opening 34*a* adjacent its outer end for the purpose of receiving the handle 35 of the valve 36. It will be seen that as the piston and piston rod assembly consisting of the pistons 25*b* and 25*c* and the piston rod 67 moves from right to left or vice versa it will shift the valve handle 35 and thus turn the valve 36 to one position or to the other.

The valve 36 is connected in exactly the same manner as in the previously described form of the invention, the conduit 37 connecting one port of this valve to the conduit 14*a* leading from the pipe line 1, the conduit 38 connecting an opposite port of this valve 36 to a port 39*a* in the slide valve housing which port is adjacent to the port 19*b*, and the conduit 38 is vented through a connecting conduit 48. The conduit 48 is also connected with a short conduit 49 which is in communication with the port 50*a* of the slide valve housing adjacent to the port 19*a* on the opposite side thereof from the port 39*a*.

One of the two remaining ports of the valve 36 is connected by a conduit 40 to the right-hand end of the slide valve housing where it communi-

cates with the interior of the chamber 42a formed by the cap 44a that is threadedly mounted on this end of the chamber. The opposite port of the valve 36 is connected by a conduit 41 to the chamber 43a at the left-hand end of the slide valve housing, this chamber being provided by the cap 45a which is threadedly connected at this end of the housing.

A conduit 46a leads from a source of chemical supply and is connected by branches to ports 47a adjacent one side of the port 23b and to a second port 47b adjacent the opposite side of the port 23a.

The slide valve 51a has a piston 52a mounted on one end thereof and a piston 53a mounted on the other end thereof, these pistons being disposed in the spaces 42a and 43a respectively. These pistons are so arranged that when acted upon by pressures of fluids injected through the conduits 40 or 41 as the case may be they will serve to shift the slide valve from one position to the other. The slide valve has a passageway 54a transversely thereof which when the valve is in its left-hand position as illustrated in Fig. 3 will serve to interconnect the ports 15a and 19a. A similar passageway 55a when the valve is in the same position serves to interconnect the ports 17a and 23a. When the valve is in this same position a passageway 56a in one surface thereof serves to interconnect the ports 19b and 39a and another similar passageway 59b serves to connect the ports 23b and 47a.

When the slide valve is in its opposite position or at its extreme left-hand position as illustrated in Fig. 3, a passageway 57a combines with the passageway 54a to interconnect the ports 15a and 19b. A passageway 58a at this position serves to connect ports 19a and 50a and a passage 59a serves to interconnect ports 47b and 23a.

In operation, when the parts of the device shown in Fig. 3 are in a position illustrated in that figure power fluid will tend to flow in through the conduit 14a and this power fluid exerting its pressure through the conduit 37, the valve 36 and the conduit 41 will act upon the piston 53a and force and hold the slide valve in the extreme right-hand position as illustrated. The power fluid will also be conducted through the passageway 54a, the conduit 20a and into the power cylinder 21a on the right-hand side of the piston 25a. This will tend to move this piston to the left, and the speed of its movement will depend upon the position of the needle valve 12, this position in turn depending upon the amount of flow which is taking place through the conduit 1. In this case also the unit pressures on the two sides of the piston 25b will be equal but due to the area of cross section of the rod 67 the total pressure on this piston will be unbalanced and the piston will move to the left.

As the liquid within the cylinder 21a is forced by the needle valve 12 into the cylinder 21b, it moves the piston assembly 25b and 25c on the rod 67 to the left. Prior to this movement the space within the cylinder 21b and to the left of the piston 25b will have been filled with a chemical which it is desired to feed into the pipe line 1. During this movement toward the left this chemical will be forced out through the passage 63, the conduit 22a, the passage 55a and into the pipe line 1. At the same time, the conduit 46a from the source of chemical supply will be connected through the port 47a, the passageway 59b, the port 23b and the conduit 22b and the passageway 64 to the interior of the cylinder 21c to

the right of the piston 25c. Therefore as this piston 25c moves to the left it will draw into this space to the right of the piston 25c a supply of chemical which is later to be fed into the pipe line 1. Fluid from the interior of the cylinder 21c to the left of the piston 25c will during this procedure be forced out through the conduit 20b, the port 19b, the passageway 56a, the port 39a and the conduit 48 to the atmosphere, this venting of the space within the cylinder 21c making possible the left-hand movement of the entire assembly.

When the assembly has reached the left-hand extremity of its movement, the connection between the rod 31a and the valve handle 35 will serve to shift the valve 36 to its opposite position, in which position the conduits 37 and 40 will be connected to each other and the conduits 38 and 41 will be connected to each other. When this shift takes place power fluid will be drawn through the conduit 37 from the conduit 14a and pass through the valve 36 into the conduit 40 and discharge into the space 42a at the right-hand end of the slide valve housing. The left-hand end of the slide valve housing will be vented through the conduit 41a, the valve 36, the conduit 38 and the conduit 48. The slide valve will thus be shifted immediately to its extreme left-hand position. With the slide valve in the last named position power fluid will be delivered from the conduit 14a through the port 15a, the passageway 57a and 54a, the port 19b and the conduit 20b into the cylinder 21c on the left-hand side of the piston 25c. This will tend to act directly upon the piston assembly including the piston 25b and 25c and the piston rod 67 and move this entire assembly toward the right. Again the unit pressures on the two sides of the piston 25c will be substantially equal, but due to the piston rod 67 the total pressures will be unbalanced and the piston will move to the right. This movement will be permitted by virtue of the venting of the space to the right of the piston 25a within the cylinder 21a, this venting taking place through the conduit 20a, the port 19a, the passageway 58a and the conduits 49 and 48. The speed of the movement again will depend upon the position of the needle valve 12 and this in turn will depend upon the amount of fluid flowing through the pipe line 1.

As the piston assembly moves toward the right in the manner just described the chemical supply which has been drawn into the right-hand portion of the cylinder 21c will be forced out through the passageway 64, the conduit 22b, the port 23b, the passageways 55a and 55b and the conduit 18a into the pipe line 1. Simultaneously a new supply of chemical will be drawn into the left-hand portion of the cylinder 21b through the passageway 63, the conduit 22a, the port 23a, the passageway 59a, the port 47b and the conduit 46a. When the piston assembly reaches its extreme right-hand position which is illustrated in Fig. 3 the valve 36 will again be shifted and the operation will be repeated.

It will be noted that in the apparatus last described there is in substance no interruption of the feeding of the chemical to the pipe line because when the feeding mechanism which consists of the piston assembly referred to reaches one extreme position its direction of movement is immediately reversed and on its reverse movement it again feeds chemical into the pipe line.

It is furthermore noted that whereas in the form shown in Figs. 1 and 2 the feeding move-

ment is controlled by the needle valve 12 acting upon a flow of the fluid which is flowing in the pipe line, that is a portion of that fluid which is separated out and conducted through the conduit 13, in Fig. 3 provision is made for the action of this valve upon an entirely separate substance the nature of which may be controlled. By this means the operating characteristics of the device may be much better regulated in the event that the fluid flowing in the pipe line 1 is not suitable for this regulating purpose.

From the above it will be apparent that means have been provided whereby all of the objects and advantages sought by this invention have been attained.

Having described my invention, I claim:

1. In a device of the character described, a single cylinder providing a feed reservoir, a single piston movable in said cylinder in one direction to feed a fluid from said cylinder and in another direction to refill said reservoir, means for applying fluid under pressure to the opposite side of said piston from the fluid to be fed to move said piston on its feeding stroke, a piston rod extending from said piston through the portion of said cylinder adapted to receive the fluid to be fed, means to apply fluid pressure directly and solely against the free end of said piston rod to move the piston in a direction to refill said cylinder with fluid to be fed, and means carried by said piston for changing the application of fluid pressure from said piston to said piston rod when the piston nears the end of its feeding stroke and from said piston rod to said piston when the piston nears the end of its refilling stroke whereby said piston will be moved first in one direction and then in the other.

2. In a device of the character described, having a feed reservoir, fluid actuated means movable in one direction to feed a fluid from said reservoir and in another direction to refill said reservoir, means actuated by said movable means as it nears the end of its movement in each direction to cause it to move in the other direction, and control means connected with said movable means for controlling the rate of movement thereof, the combination comprising a metering valve associated with said control means, and fluid flow responsive means disposed in the path of a stream of fluid and connected to said metering valve for controlling the opening thereof in proportion to the rate of flow in said stream of fluid, whereby the rate of movement of said movable feeding means will be controlled in proportion to the rate of flow in said stream of fluid.

3. In a device of the character described, a feed reservoir, means movable in one direction to feed a fluid from said reservoir and in another direction to refill said reservoir, a slide valve adapted in one position to subject said movable feeding means to the action of a fluid under pressure to cause the movement thereof in said first direction, and simultaneously to connect said reservoir to a discharge port, and adapted in another position to vent the pressure fluid previously applied to said movable feeding means, to connect said reservoir to a source of supply of fluid, and to apply fluid under pressure to said feeding means in the opposite direction whereby to refill said reservoir with fluid to be fed, and means connected with said movable feeding means for causing the shifting of said slide valve to its opposite position as said feeding means nears each of the respective ends of its stroke a conduit for supplying an actuating fluid under pressure through said slide valve to said feeding means, a valve in said conduit, and means in a flowing stream, responsive to the rate of flow of the stream, to vary the opening of the valve in said conduit.

4. In a device of the character described, a feed reservoir, means movable in one direction to feed a fluid from said reservoir and in another direction to refill said reservoir, a multiple valve adapted in one position to subject said movable feeding means to the action of a fluid under pressure to cause the movement thereof in said first direction, and simultaneously to connect said reservoir to a point of discharge, and adapted in another position to vent the pressure fluid previously applied to said movable feeding means, to connect said reservoir to a source of supply of fluid, and to apply fluid under pressure to said feeding means in the opposite direction whereby to refill said reservoir with fluid to be fed, and means connected with said movable feeding means for causing the shifting of said multiple valve to its opposite position as said feeding means nears each of the respective ends of its stroke a conduit for supplying an actuating fluid under pressure through said slide valve to said feeding means, a valve in said conduit, and means in a flowing stream, responsive to the rate of flow of the stream, to vary the opening of the valve in said conduit.

5. In an apparatus for feeding a fluid, a cylinder, a piston reciprocably mounted in the cylinder, a conduit communicating with the cylinder at one end for the intake and discharge of a fluid to be fed, a conduit communicating with the cylinder at its other end for supplying and discharging an actuating fluid to displace the piston and feed the fluid contained in the other end of the cylinder, fluid actuated means for returning the piston and drawing fluid to be fed into the cylinder, a conduit communicating with the fluid actuated means for supplying and discharging an actuating fluid, valve means shiftable for alternately placing one of the actuating fluid conduits in communication with an actuating fluid under pressure and with a reduced pressure while the other conduit is oppositely connected and for placing the conduit of the fluid to be fed alternately in communication with a source of fluid to be fed and a destination for fluid to be fed, fluid actuated means for shifting said valve means, and means actuated by the piston for controlling the supply and discharge of an actuating fluid to said actuating means for said valve means.

6. In an apparatus for feeding a fluid, a cylinder, a piston reciprocably mounted in the cylinder, a conduit communicating with the cylinder at one end for the intake and discharge of a fluid to be fed, a conduit communicating with the cylinder at its other end for supplying and discharging an actuating fluid to displace the piston and feed the fluid contained in the other end of the cylinder, fluid actuated means for returning the piston and drawing fluid to be fed into the cylinder, a conduit communicating with the fluid actuated means for supplying and discharging an actuating fluid, valve means shiftable for alternately placing one of the actuating fluid conduits in communication with a source actuating fluid under pressure and with a reduced pressure while the other conduit is oppositely connected and for placing the conduit of the fluid to be fed alternately in communication with a source of fluid to be fed and a destination for fluid to be fed, valve means for throttling the flow of actuating fluid to said cylinder, and fluid flow responsive

means for controlling the throttling valve means.

7. In an apparatus for feeding a fluid, a cylinder, a piston reciprocably mounted in the cylinder, a conduit communicating with the cylinder at one end for the intake and discharge of a fluid to be fed, a conduit communicating with the cylinder at its other end for supplying and discharging an actuating fluid to displace the piston and feed the fluid contained in the other end of the cylinder, fluid actuated means for returning the piston and drawing fluid to be fed into the cylinder, a conduit communicating with the fluid actuated means for supplying and discharging an actuating fluid, valve means shiftable for alternately placing one of the actuating fluid conduits in communication with an actuating fluid under pressure and with a reduced pressure while the other conduit is oppositely connected and for placing the conduit of the fluid to be fed alternately in communication with a source of fluid to be fed and a destination for fluid to be fed, valve means for throttling the flow of actuating fluid, and fluid flow responsive means for controlling the throttling valve means.

8. A feed device comprising a cylinder, a partition in the cylinder intermediate its ends dividing the cylinder into two portions, a piston rod extending through the partition, a piston carried by each end of said rod, a feed fluid conduit communicating with each portion of the cylinder adjacent the partition, an actuating fluid conduit communicating with each end of the cylinder, and a single valve member operable in one position to place the conduit at one end of the cylinder in communication with a fluid under pressure, the feed fluid conduit communicating with the corresponding portion of the cylinder in communication with a destination, the conduit at the other end in communication with atmospheric pressure, and the other feed fluid conduit in communication with a source of supply.

9. A feed device comprising a cylinder, a partition in the cylinder intermediate its ends dividing the cylinder into two portions, a piston rod extending through the partition, a piston carried by each end of said rod, a feed fluid conduit communicating with each portion of the cylinder adjacent the partition, an actuating fluid conduit communicating with each end of the cylinder, valve means operable in one position to place the conduit at one end of the cylinder in communication with a fluid under pressure, the feed fluid conduit communicating with the corresponding portion of the cylinder in communication with a destination, the conduit at the other end in communication with atmospheric pressure, and the other feed fluid conduit in communication with a source of supply, and a throttle valve in the conduit communicating with one end of the cylinder to control the rate of displacement of the pistons.

10. A fluid actuated motor comprising a cylinder having a port in each end, a piston reciprocable between the ends of said cylinder, valve means alternately placing one port in communication with a fluid under pressure and an exhaust while the other port is in communication with an exhaust and the fluid under pressure respectively, a throttle valve associated with one of said ports for controlling the flow of fluid therethrough into and out of the cylinder to regulate movement of said piston, a flow conduit, and means responsive to flow of fluid through said flow conduit to increase the opening of said throttle valve as the flow of fluid through the flow conduit increases and reduce the opening of the throttle valve as the flow of fluid decreases.

11. In a device of the character described, having a feed reservoir, means movable to feed a fluid from said reservoir, fluid actuated means for moving said means, a source of actuating fluid under pressure, means for connecting said actuating means to said source to actuate said feeding means in its feeding movement, an adjustable control valve interposed in the connecting means between the source of actuating fluid and said fluid actuated means, and means including a fluid flow velocity responsive device for varying the amount of opening of said control valve in proportion to the velocity of flow of a fluid.

12. In an apparatus for feeding a fluid, a cylinder, a piston reciprocably mounted in the cylinder, a conduit communicating with the cylinder at one end for the intake and discharge of a fluid to be fed, a conduit communicating with the cylinder at its other end for supplying and discharging an actuating fluid to displace the piston and feed the fluid contained in the other end of the cylinder, fluid actuated means for returning the piston and drawing fluid to be fed into the cylinder, a conduit communicating with the fluid actuated means for supplying and discharging an actuating fluid, valve means shiftable for alternately placing one of the actuating fluid conduits in communication with an actuating fluid under pressure and with a reduced pressure while the other conduit is oppositely connected and for placing the conduit of the fluid to be fed alternately in communication with a source of fluid to be fed and a destination for fluid to be fed, fluid actuated means for shifting said valve means, means actuated by the piston for controlling the supply and discharge of an actuating fluid to said actuating means for said valve means, valve means for throttling the flow of actuating fluid, and fluid flow responsive means for controlling the throttling valve means.

13. A feed device comprising a cylinder, a partition in the cylinder intermediate its ends dividing the cylinder into two portions, a piston rod extending through the partition, a piston carried by each end of said rod, a feed fluid conduit communicating with each portion of the cylinder adjacent the partition, an actuating fluid conduit communicating with each end of the cylinder, valve means operable in one position to place the conduit at one end of the cylinder in communication with a fluid under pressure, the feed fluid conduit communicating with the corresponding portion of the cylinder in communication with a destination, the conduit at the other end in communication with atmospheric pressure, and the other feed fluid conduit in communication with a source of supply, a throttle valve in the conduit communicating with one end of the cylinder to control the rate of displacement of the pistons, and fluid flow responsive means for adjusting the degree of opening of the throttle valve.

14. A feed device comprising a cylinder, a partition in the cylinder intermediate its ends dividing the cylinder into two portions, a piston rod extending through the partition, a piston carried by each end of said rod, a feed fluid conduit communicating with each portion of the cylinder adjacent the partition, an actuating fluid conduit communicating with each end of the cylinder, valve means operable in one position to place the conduit at one end of the cylinder in communication with a fluid under pressure, the feed fluid conduit communicating with the corresponding

portion of the cylinder in communication with a destination, the conduit at the other end in communication with atmospheric pressure, and the other feed fluid conduit in communication with a source of supply, fluid actuated means for shifting said valve means, and means actuated by the piston for controlling the supply and discharge of an actuating fluid to said actuating means for said valve means.

15. A feed device comprising a cylinder, a partition in the cylinder intermediate its ends dividing the cylinder into two portions, a piston rod extending through the partition, a piston carried by each end of said rod, a feed fluid conduit communicating with each portion of the cylinder adjacent the partition, an actuating fluid conduit communicating with each end of the cylinder, valve means operable in one position to place the conduit at one end of the cylinder in communication with a fluid under pressure, the feed fluid conduit communicating with the corresponding portion of the cylinder in communication with a destination, the conduit at the other end in communication with atmospheric pressure, and the other feed fluid conduit in communication with a source of supply, fluid actuated means for shifting said valve means, means actuated by the piston for controlling the supply and discharge of an actuating fluid to said actuating means for said valve means, and a throttle valve in the conduit communicating with one end of the cylinder to control the rate of displacement of the pistons.

16. A feed device comprising a cylinder, a partition in the cylinder intermediate its ends dividing the cylinder into two portions, a piston rod extending through the partition, a piston carried by each end of said rod, a feed fluid conduit communicating with each portion of the cylinder adjacent the partition, an actuating fluid conduit communicating with each end of the cylinder, valve means operable in one position to place the conduit at one end of the cylinder in communication with a fluid under pressure, the feed fluid conduit communicating with the corresponding portion of the cylinder in communication with a destination, the conduit at the other end in communication with atmospheric pressure, and the other feed fluid conduit in communication with a source of supply, fluid actuated means for shifting said valve means, means actuated by the piston for controlling the supply and discharge of an actuating fluid to said actuating means for said valve means, a throttle valve in the conduit communicating with one end of the cylinder to control the rate of displacement of the pistons, and fluid flow responsive means for adjusting the degree of opening of the throttle valve.

17. In an apparatus for feeding a fluid, a cylinder, a piston reciprocably mounted in the cylinder, a conduit communicating with the cylinder at one end for the intake and discharge of a fluid to be fed, a conduit communicating with the cylinder at its other end for supplying and discharging an actuating fluid to displace the piston to feed the fluid contained in the other end of the cylinder, fluid actuated means for returning the piston and drawing fluid to be fed into the cylinder, a conduit communicating with the fluid actuated means for supplying and discharging an actuating fluid, and a slide valve comprising a casing having a port in communication with an actuating fluid under pressure, a plurality of ports one for each of said conduits and communicating therewith, exhaust ports, a port for the discharge of the fluid to be fed, a port in communication with a supply of fluid to be fed, and a valve body slidable in said casing and having ducts therein operable when the slide valve is in one position to place the actuating fluid port in communication with the port of one of said actuating fluid conduits, to place the port of the other of said actuating fluid conduits in communication with one of said exhaust ports, to place said feed fluid conduit in communication with said feed fluid supply port and operable when in another position to oppositely connect said ports of the actuating fluid conduits and to connect the feed fluid conduit in communication with the feed fluid discharge port.

18. In an apparatus for feeding a fluid, a cylinder, a piston reciprocably mounted in the cylinder; a conduit communicating with the cylinder at one end for the intake and discharge of a fluid to be fed; a conduit communicating with the cylinder at its other end for supplying and discharging an actuating fluid to displace the piston to feed the fluid contained in the cylinder on the opposite side of the piston; fluid actuated means for returning the piston and drawing fluid to be fed into the cylinder; a conduit communicating with the fluid actuated means for supplying and discharging an actuating fluid; and a slide valve comprising a casing having separate ports communicating with an actuating pressure fluid, a supply of fluid to be fed, the conduits communicating with the ends of the cylinder, and the fluid actuated means, and having ports for exhausting spent actuating fluid and fluid to be fed; a valve body slidable in said casing; means for shifting said body to two positions; and ducts in said body operable in one position of the body within the casing to provide connections between the port for the actuating pressure fluid and the port connected to the cylinder on the power side of the piston, the actuating fluid discharge port and the piston returning means port, and the feed fluid exhaust port and the port connected to the cylinder on the feed side of the piston; said ducts operable in the other position of the body to effect communication between the actuating fluid port and the piston returning port, the feed fluid port and the port leading to the cylinder on the feed side of the piston, and the actuating fluid exhaust port and the port leading to the cylinder on the power side of the piston.

ARTIE F. McFARLAND.