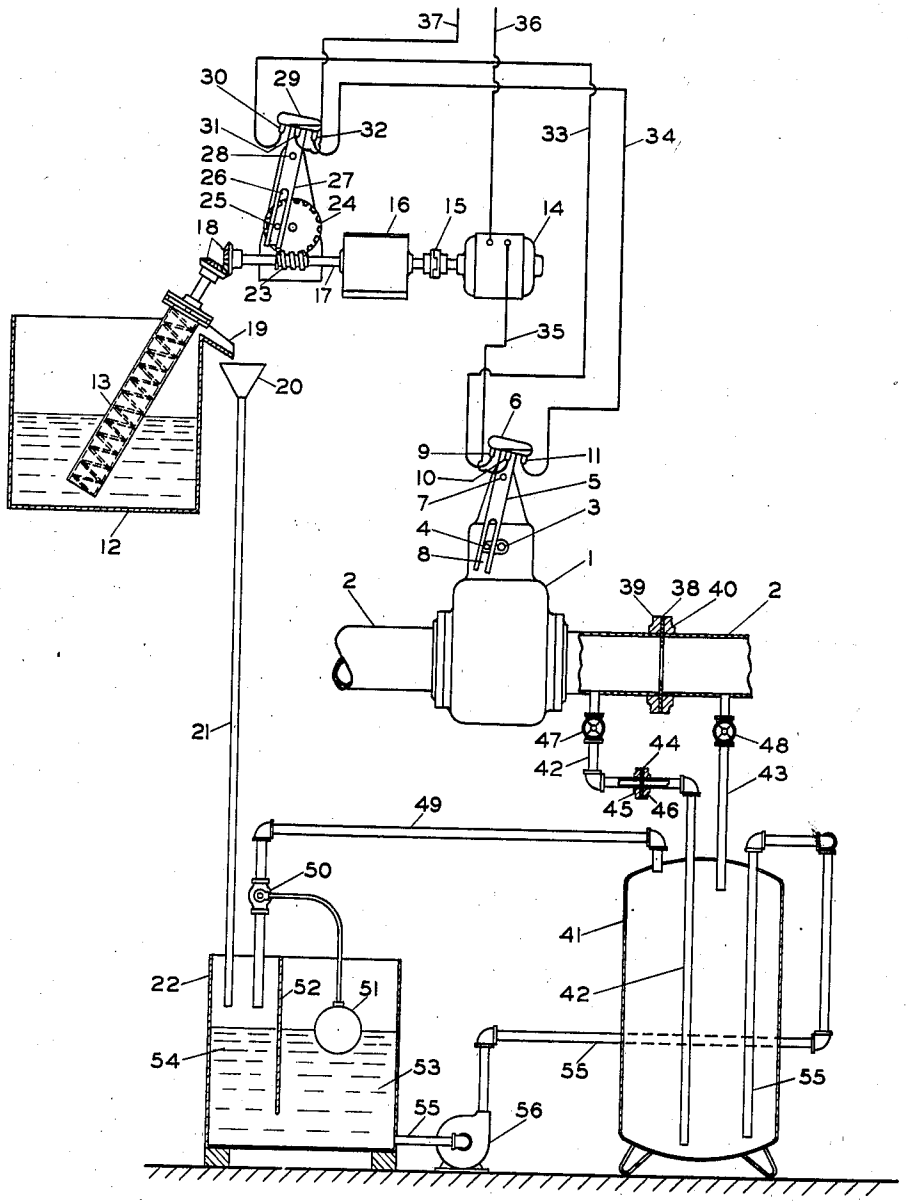
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APPARATUS FOR AND METHOD OF APPORTIONING CHEMICAL TO A FLOW OF WATER

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APPARATUS FOR AND METHOD OF APPORTIONING CHEMICAL TO A FLOW OF WATER

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8 Claims. (Cl. 210—31)

This invention relates to apparatus for and method of apportioning chemical to a flow of water and it comprises a pipe conveying a flow of water under pressure, a flow restricting element in said pipe, a closed mixing tank, a connection from said pipe on one side of said element to said tank, another connection from said tank to said pipe on the other side of said element, a flow restricting element in one of said connections, a dilution tank, means for feeding chemical and diluting fluid into said dilution tank, and a pump for conveying the mixture of chemical and dilution fluid from the dilution tank to the mixing tank, all as more fully hereinafter set forth and as claimed.

In the treatment of water by the addition of chemicals thereto, devices have come into general use where the chemical is added to the water intermittently. The flow of water to be treated is metered and the meter is arranged, every time a predetermined quantity of water has passed through it, to actuate a feeding device which then feeds a predetermined quantity of chemical. When water contains dissolved carbonates, for instance, it is often desirable to convert these carbonates into sulfates or chlorides by the addition of sulfuric or hydrochloric acid. The quantities of acid added are usually small and it has been found exceedingly difficult to add these small quantities of acid in a continuous proportionate stream to water, especially at varying flow rates. Consequently, intermittently operating batch type feeding devices have come into general use. While these devices apportion the acid to the water with great accuracy over long periods of time there are obviously short cycle irregularities which are objectionable. While the batch of acid is being fed, the water is over-treated and between feeding periods the water is under-treated or not treated at all. Thus, the water is alternately under-treated and over-treated, in the latter case containing free acid which makes it exceedingly corrosive.

It is the object of the present invention to provide an apparatus and a method whereby intermittently fed batches of chemical such as sulfuric acid are uniformly apportioned to a flow of water even at varying rates of flow.

The manner in which this object is achieved is illustrated in the accompanying drawing which shows, in more or less diagrammatic form, an elevation, partly in section, of an apparatus in accordance with my invention.

Referring now to the drawing, a meter 1 is mounted in the pipe 2 conveying the water to be treated. The meter has a shaft 3 provided with an eccentric pin 4. A bracket 5 carrying a three point mercury switch 6 is pivoted at 7 on the meter case. The bracket has a slot 8 in which pin 4 is adapted to slide. The mercury switch 6 has terminals 9, 10 and 11. Shaft 3 turns at a rate proportional to the rate of flow of water so that the pin 4 rocks bracket 5 back and forth, causing the mercury to establish alternately an electrical connection between terminals 9 and 10, and between terminals 10 and 11, every time a predetermined quantity of water has passed the meter.

A concentrated acid storage tank 12 is fitted with a measuring pump 13 of the type disclosed in Cawley Patents 1,678,766 and 1,720,999, dated July 31, 1928, and July 16, 1929, respectively. An electric motor 14, through coupling 15, speed reducer 16, shaft 17 and bevel gears 18, is adapted to rotate the measuring pump 13. Tank 12 has a spout 19 adapted to discharge the acid lifted from tank 12 by pump 13 through funnel 20 and pipe 21 into an open dilution tank 22.

A worm 23 on shaft 17 drives worm wheel 24 provided with an eccentric pin 25 which slides in slot 26 of a bracket 27 pivoted at 28. A three point mercury switch 29 with terminals 30, 31 and 32 is mounted on bracket 27. Upon rotation of worm wheel 24 the bracket 27 is tilted back and forth so that the electrical connection in switch 29 is alternately shifted between terminals 30, 31 and terminals 31, 32 every time the pump 13 has made a predetermined number of revolutions, in other words, has measured out and discharged a predetermined quantity of acid.

Terminals 9 and 30, and 11 and 32 are interconnected by wires 33 and 34, respectively. Terminal 10 is connected to motor 14 by wire 35. Motor 14 and terminal 31 are connected by the respective wires 36 and 37 to a source of electric energy (not shown).

In pipe 2 an orifice plate 38 is mounted between flanges 39 and 40, the flow through pipe 2 being in a direction from meter 1 toward orifice plate 38. A cylindrical closed mixing tank 41 has its lower portion connected by pipe 42 to pipe 2 on the upstream side of orifice plate 38, and its upper portion by pipe 43 to pipe 2 on the downstream side of the orifice plate 38. Pipe 42 has an orifice plate 44 mounted between flanges 45 and 46. Pipes 42 and 43 are fitted with shut-off valves 47 and 48, respectively, permitting the shutting off of tank 41 from pipe 2.

From the upper portion of tank 41 a pipe 49 leads to the open dilution tank 22 which is di-

vided by baffle 52 into chambers 53 and 54 communicating with each other near the bottom of tank 22. Pipe 49 as well as pipe 21 terminate in chamber 54. Pipe 49 is fitted with a valve 50 actuated by a float 51 located in chamber 53. A pipe 55 leads from dilution tank 22 through a pump 56 to the lower portion of the mixing tank 41.

In order to achieve the desired object in the operation of this apparatus it is necessary that the various elements are dimensioned, arranged and adjusted in accordance with certain definite requirements which are best explained in an example.

Let it be assumed that pipe 2 conveys water at varying flow rates, the maximum being 100 gallons per minute, and that the meter 1 is arranged to shift the electrical connections of switch 6 every time 100 gallons have passed, i. e. once every minute at the maximum rate of flow and at longer intervals when the rate is less, the interval between shifting of the switch being inversely proportional to the rate of flow.

In the position shown in the drawing, the mercury in switch 6 interconnects terminals 10 and 11, and the mercury in switch 29 interconnects terminals 31 and 32. A circuit is thus established through wire 37, terminals 31 and 32, wire 34, terminals 11 and 10, wire 35, motor 14 and wire 36. Motor 14 is thereby energized and operates, rotating simultaneously pump 13 and pin 25. After the pump has measured out and discharged a predetermined amount of, say, 100 cubic centimeters of acid the pin 25 has rotated and tilted the bracket 27 to such extent that the terminals 31 and 32 are electrically disconnected and terminals 30 and 31 are interconnected. The circuit is thus interrupted and motor 14 stops. When another quantity of 100 gallons has passed the meter connection between terminals 10 and 11 is broken, and terminals 9 and 10 are interconnected by the mercury in switch 6. Thereupon another circuit is established through wire 37, terminals 31 and 30, wire 33, terminals 9 and 10, wire 35, motor 14, and wire 36. Motor 14 is again energized and operates until the circuit is interrupted by a shifting of switch 29 when the pump 13 has measured out and discharged another quantity of 100 cubic centimeters of acid. This intermittent feeding is repeated every time 100 gallons of water have passed through the meter.

The acid discharged by pump 13 flows via spout 19, funnel 20 and pipe 21 into the dilution tank 22. Pump 56 runs continuously and withdraws diluted acid from tank 22 and discharges it through pipe 55 into the mixing tank 41 near its bottom. Diluting liquid flows through pipe 49 from the mixing tank 41 into the dilution tank 22, the liquid level in tank 22 being maintained constant by float 51 controlling valve 50 so as to close when the level rises and to open when the level falls.

In the present example the mixing tank 41 is so dimensioned that it has a cross sectional area of one square foot and a cubical content of 12 gallons. The orifices in plates 38 and 44 are of such size that with a flow of 100 gallons per minute through pipe 2 there is a bypass flow of 3 gallons per minute from pipe 2 through pipe 42 with orifice plate 44, tank 41 and pipe 43 back to pipe 2. Due to the arrangement of the two orifice plates the bypass flow is always a constant proportion of the main flow through pipe 2, in this case 3 per cent.

Since acid is being fed for every 100 gallons of main flow and since the bypass flow amounts to 3 gallons for every 100 gallons of main flow, four feeding cycles will take place while the total volume of liquid flowing through the bypass equals the cubical content of the mixing tank 41 (12 gallons). This is true regardless of what the rate of flow through pipe 2 may be. At the maximum rate of 100 gallons per minute, for instance, acid is being fed every minute; the bypass flow is 3 gallons per minute so that it takes 4 minutes or 4 feeding cycles to displace the 12 gallons in tank 41. At a flow rate of 50 gallons per minute through pipe 2 acid is being fed every 2 minutes; the bypass flow is 1½ gallons per minute so that it now takes 8 minutes to displace the contents of tank 41, again 4 feeding cycles.

It follows that the concentration of acid in tank 41 does not vary with varying rates of flow although there are cyclic variations in concentration during each feeding cycle. If each quantity of acid were fed into the tank 41 in an instant then 3 gallons of water of the bypass flow would mix with the 12 gallons of dilute acid in the tank before the next feeding occurs, in other words there would be a reduction in acid concentration of about 20 per cent from the maximum. Actually, however, this variation is less because of the delaying action of the dilution tank 22. Thus with the conditions given in the foregoing example, the concentration of dilute acid flowing through pipe 43 to treat the water in pipe 2 varies less than 10 per cent above and below the average, these variations following a sine-like curve in cycles equal in duration to the feeding cycles. This is sufficiently accurate for most practical purposes, but the variations in uniformity of treatment may, of course, be made as small as desired by increasing the detention period in tank 41 in terms of feeding cycles. This is accomplished by feeding less acid more frequently, by reducing the bypass flow, or by increasing the cubical content of tank 41.

The pump 56 is preferably of such size that it maintains an upward velocity in tank 41 of not less than two gallons per minute per square foot of cross sectional area of the tank in order to maintain a uniform dispersion of chemical throughout the tank. Acid as well as solutions of other chemicals used in water treatment have a specific gravity higher than that of water and tend to accumulate and concentrate in the lower portion of the tank unless sufficient agitation is maintained. I have found that acid has a tendency to accumulate in the lower portion of tank when the upward velocity in the tank is as low as 1½ gallons per minute per square foot. In the foregoing example the upward velocity in tank 41 is 5 gallons per square foot per minute at the maximum rate of flow through pipe 2, 2 gallons due to pump 56 and 3 gallons due to the bypass flow. Even if the flow through pipe 2, and consequently also the bypass flow, drops to a small fraction of the maximum the pump circulation still provides for uniform mixing in tank 41. Thus the pump serves a twofold purpose: It pumps the chemical into the pressure system and at the same time provides agitation and mixing at all rates of flow without any need for a separate agitator.

Orifice plate 44, shown in pipe 42, might equally well be located in pipe 43 so far as fulfilling its function is concerned but since pipe 42 conveys water and pipe 43 dilute acid the location in pipe 42 is preferable.

While the present invention has been described

with particular reference to the feeding of acid it is, of course, equall well adapted to uniformly apportion any other intermittently fed chemical solution used in water treatment. In the feeding of sulfuric acid all those elements coming in contact with acid in concentrated or dilute form must be made of suitable corrosion resistant material, such as lead, or lead lined steel or iron.

As shown in the drawing, the pipe 49 terminates uppermost in tank 41 so that it acts as an air relief. In this manner any air which might collect in the upper portion of the tank is vented to the atmosphere through pipe 49 and cannot pass into the main pipe 2.

The orifice plates 38 and 44 may be replaced by other flow restricting elements, such as nozzles, adjustable gates or the like. Other modifications of the elements shown in the drawing will occur to those skilled in the art without departing from the fundamental concept of my invention, and the appended claims are, therefore, relied upon for a definition of the scope of my invention.

What I claim is:

1. Apparatus for apportioning chemical to a flow of water under pressure comprising a pipe conveying a flow of water, a flow restricting element in said pipe, a closed mixing tank, a connection from said pipe on one side of said element to said tank, another connection from said tank to said pipe on the other side of said element, a flow restricting element in one of said connections, a dilution tank, means for feeding chemical into said dilution tank, means for operating said means for feeding chemical, a pipe for admitting diluting liquid into said dilution tank, a valve in said last named pipe, a float in said dilution tank adapted to actuate said valve, a connection from said dilution tank to said mixing tank, and a pump in said last named connection.

2. Apparatus for apportioning chemical to a flow of water comprising a pipe conveying a flow of water under pressure, a flow restricting element in said pipe, a closed mixing tank, a connection from said pipe on one side of said element to said tank, another connection from said tank to said pipe on the other side of said element, a flow restricting element in one of said connections, a dilution tank, a third connection from the mixing tank to the dilution tank, a valve in said third connection, a float in said dilution tank adapted to actuate said valve, a fourth connection from said dilution tank to said mixing tank, a pump in said fourth connection, and means for feeding chemical into said dilution tank.

3. The apparatus of claim 2, the third connection terminating in the mixing tank at an elevation higher than that at which any of the other connections terminate.

4. The apparatus of claim 2, the first and fourth connection terminating in the lower portion of the mixing tank, and the second and third connection terminating in the upper portion of the mixing tank.

5. Apparatus for apportioning chemical to a flow of water comprising a pipe conveying a flow of water under pressure, a chemical feeding device, chemical receiving means, power means for operating the chemical feeding device to feed into the receiving means a predetermined quantity of chemical upon each energization of the power means, a water meter adapted to integrate the flow of water through said pipe, switch means operated by said meter and adapted to energize the power means each time a predetermined quantity of water has been conveyed through said pipe, a flow restricting element in said pipe, a closed mixing tank, a connection from said pipe on one side of said element to said tank, a flow restricting element in said connection adapted to pass through said connection a quantity of water equal to not more than about one-fourth the contents of said mixing tank while said predetermined quantity of water is being conveyed through said pipe, means conveying the chemical fed by said feeding device from the receiving means into said tank, and a connection adapted to convey a mixture of water and chemical from the tank to said pipe on the other side of said first named flow restricting element.

6. Apparatus for apportioning chemical to a flow of water under pressure comprising a pipe conveying a flow of water, a flow restricting element in said pipe, a closed mixing tank having a given cross-sectional area, a connection from said pipe on one side of said element to said tank, another connection from said tank to said pipe on the other side of said element, a flow restricting element in one of said connections, a container for a solution of chemical, a pump conveying solution of chemical from said container into said tank near one end thereof and a pipe conveying liquid from the other end of said tank to said container, the pump being adapted to maintain a progressive velocity through the tank of at least one and one-half gallons per minute per square foot of the cross-sectional area of the tank.

7. A method of apportioning water treatment chemical to a main flow of water under pressure which comprises bypassing a predetermined proportion of said flow and flowing it through a closed chamber, mixing chemical intermittently with a stream of diluting liquid taken from the bypassing proportion of the flow, introducing the mixture of chemical and diluting liquid into the bypassing proportion of the flow flowing through the chamber, returning the bypassing proportion of the flow to the main flow, and maintaining in the chamber a progressive velocity of at least one and one-half gallons per minute per square foot of cross-sectional area of the chamber.

8. A method of apportioning water treatment chemical to a main flow of water under pressure which comprises bypassing a predetermined proportion of said flow and flowing it upwardly through a chamber, feeding chemical intermittently and mixing it with liquid withdrawn from the bypassing proportion of the flow, flowing the mixture of chemical and liquid upwardly through the chamber, returning the bypassing proportion of the flow to the main flow, and maintaining in the chamber an upward velocity of at least one and one-half gallons per minute per square foot of cross-sectional area of the chamber.

ERIC PICK.