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METHOD AND APPARATUS FOR TREATING LIQUIDS WITH GAS

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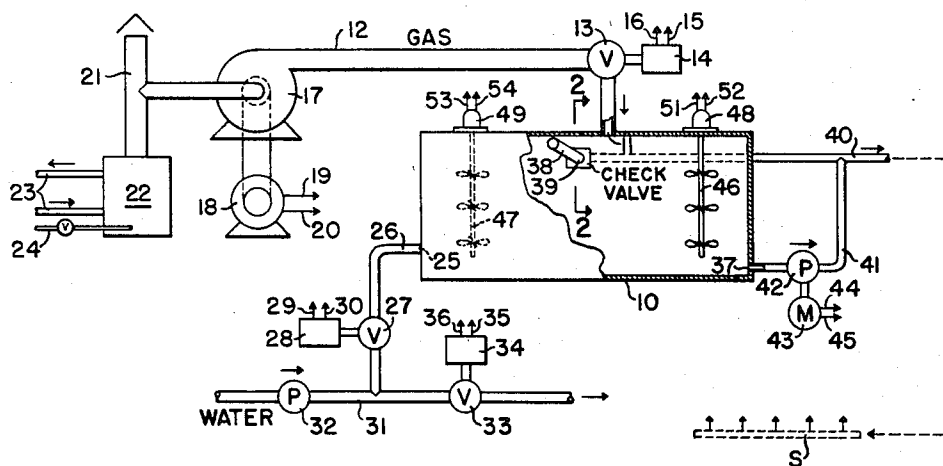


FIG. 1

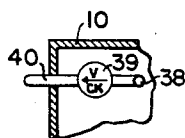


FIG. 2

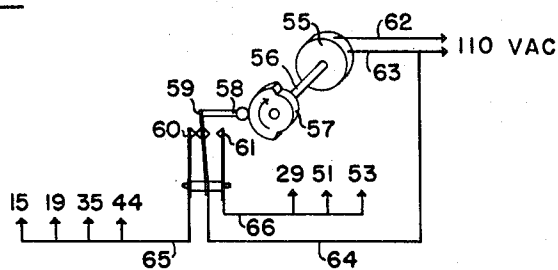


FIG. 3

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METHOD AND APPARATUS FOR TREATING LIQUIDS WITH GAS

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The invention relates to treating a liquid with gas and is, for example, suitable for inhibiting the growth of algae and the accumulation of slime in swimming pools, sewerage ducts and basins, and the like. The invention is particularly concerned with an apparatus and method of effecting contact between the treating gas and the liquid and, in the preferred embodiment, of producing a stream of treated liquid that contains dispersed therein a quantity of gas for contact with a body of liquid to which the said treated liquid is added.

It is known from U.S. Patent No. 3,072,134, issued Jan. 8, 1963, to treat water from swimming pools with combustion gas which contains carbon monoxide among other constituents, using a device that effects pulsating flow. Such a device is costly, and the pulsations cause noise and result in wear of the moving parts, leading to the need for servicing.

The present invention provides a treating device and method wherein the gas and the liquid are supplied alternately to a mixing chamber in repetitive cycles each of which extends through an appreciable time period, such as one to sixty minutes. Principally liquid and principally gas are alternately discharged from the chamber into a common discharge conduit, respectively during the supply of gas and the supply of liquid to the chamber. The cyclic operation is controlled by any suitable timing means, such as a continuously rotating, electrically driven cam acting on one or more switches that energize flow-control elements at appropriate times.

The mixing chamber preferably contains agitating means, such as one or more motor-driven stirrers, e.g., of the egg beater type that cause splashing, and the agitating means are placed into operation by the timing means during the part of each cycle that liquid enters the mixing chamber; the agitator means is, in the preferred embodiment, not operated during the part of the cycle in which the treating gas enters the chamber.

In most installations it is desirable to discharge the liquid from the mixing chamber under pressure, and for this purpose there is provided a pump that draws liquid from a liquid outlet in a lower part of the mixing chamber during the part of the cycle in which liquid is discharged and gas is admitted. This is advantageously a self-priming pump, capable of acting on gas as well as liquid. In one mode of operation this pump draws gas from the mixing chamber and forces it into the discharge conduit after the liquid level within the chamber has fallen to the level of the liquid outlet.

The gas (or additional gas, when some gas is moved by the pump as described immediately above), mixed with droplets of liquid when agitating means are provided, is discharged from the mixing chamber through a separate gas outlet near the top of the chamber through a non-return valve to a point of the discharge conduit downstream from the pump during the part of the cycle in which liquid enters the mixing chamber.

It is preferred not to discharge all of the liquid from the mixing chamber during the liquid-discharge part of the cycle, but to permit a small amount of liquid to remain therein. For example, a body of water from one-half to three inches in depth may be retained below the level of the liquid outlet. This prevents liquid entering the chamber from flowing directly to the liquid outlet and promotes

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settling of entrained solid materials carried by the untreated water, thereby obviating the need for a strainer.

The invention will be further described with reference to the accompanying drawing, wherein:

FIGURE 1 is an elevation of the mixing chamber and associated parts, portions of the chamber appearing in section;

FIGURE 2 is a fragmentary sectional view taken on the line 2—2 of FIGURE 1; and

FIGURE 3 is a partial circuit diagram of the control system, the timer appearing in isometric.

Referring to FIGURE 1, there is provided a mixing chamber 10 having at the top a gas inlet 11 fitted to a gas supply duct 12, and preferably having a valve 13 that is normally closed and is opened when electric power is supplied to a valve operator 14 by circuit 15, 16. The duct further has a blower 17, driven by an electric motor 18 when power is supplied by circuit 19, 20. The blower may be omitted when the gas source supplies gas under sufficient pressure, e.g., when the source is a pressure cylinder. In the embodiment shown the gas source is the flue 21 of a heater 22 which may, for example, be the heater used to heat water that is supplied to a swimming pool (either fresh water or water drawn from the pool.) The water being heated flows into and out of the heater through pipes 23, and the heater contains a burner and, usually, a pilot light (not shown) to which gaseous or liquid fuel is supplied through a duct or pipe 24.

The chamber 10 may be constructed in any suitable manner to permit access for cleaning or servicing of the internals to be described.

The mixing chamber has a liquid inlet 25 at one end, through which liquid for treatment is supplied through a pipe 26. This pipe has a valve 27 that is normally closed and is opened by a valve operator 28 when electric power is supplied by circuit 29, 30. Liquid is supplied under pressure from a supply pipe 31 which may have a pump 32. When the invention is applied to swimming pools, this pipe 31 may, for example, be used to feed liquid to the pool or to the heater pipes 23. Downstream from its connection to the pipe 26, the pipe 31 has a normally closed valve 33 that is opened by a valve operator 34 when electric power is supplied by circuit 35, 36.

The chamber further has dual outlet means: A liquid outlet 37 situated near the bottom and, preferably, slightly above the bottom, and gas outlet at a higher level including an intake pipe 38 and a swing check valve 39, which is further indicated schematically in FIGURE 2. The gas outlet is connected to a discharge conduit 40 which includes a branch 41 connected to the liquid outlet 37, preferably through a pump 42 which is driven by an electric motor 43. This motor operates only when electric power is supplied by circuit 44, 45. The pump 42 is self-priming and, in one embodiment, is able to pump gas.

The discharge conduit 40 is connected to any suitable receiver, such as a tank. As applied to swimming pools, it may be connected to a porous or multi-perforated duct, such as a soaker hose S, situated at the pool bottom to distribute the treated water and undissolved gas, which enter the body of water in the pool throughout its length. The rate of flow of undissolved gas is so low as to be scarcely perceptible; yet it is effective in treating water in the pool.

The mixing chamber further contains one or more agitators 46, 47, provided with electric motors 48, 49, which operate only when electric power is supplied through circuits 51, 52, and 53, 54, respectively. The agitators may be of any known or suitable design, e.g., having paddle blades as shown, preferably operable to cause violent agitation and splashing of liquid to form a spray, whereby there is effected intimate contact between the gas and the liquid.

The timer shown in FIGURE 3 includes an electric motor 55 that operates continuously and rotates a shaft 56 through suitable reduction gears (not shown) for one revolution during each cycle. The shaft carries a cam 57 having two sections each of constant radius and acting on a cam follower 58 which moves the armature 59 of a two-pole switch. When the follower is on the higher part of the cam the armature 59 engages a contact 60 on a leaf spring, and when the follower is on the low part of the cam the armature moves resiliently to a contact 61 on another leaf spring to make contact. The motor 55 is supplied continuously with electric power through circuit 62, 63, the latter circuit part being further connected to the armature 59 by a circuit 64. The contact 60 is connected by a circuit 65 to the circuits 15, 19, 35 and 44 of the flow-control elements shown in FIGURE 1, and the contact 61 is similarly connected by a circuit 66 to the circuits 29, 51 and 53. The circuit part 62 is at all times connected to the circuits 16, 20, 30, 36, 45, 52 and 54, either directly or through ground.

The speed of the shaft 56 determines the length of the cycle, which is chosen according to the size of the mixing chamber 10 and the flow rates of liquid and gas, usually between one and sixty minutes. By way of example, when the chamber has dimensions of 16" x 8" x 8", the length of the cycle may be three minutes. The relative lengths of the two parts of the cycle, i.e., the angular extents of the two cam portions, may also be selected to suit the flow rates and may be equal. Thus, in the example given, each part of the cycle is 1½ minutes in duration.

The operation will be described as applied to the treatment of swimming pool water to inhibit the growth of algae and slime-forming organisms. It is assumed that the chamber 10 is initially filled with water and that the cam follower 58 has just been raised by the cam to initiate the gas-accumulation part of the cycle.

(1) In the gas-accumulating period the circuits 15, 19, 35 and 44 are energized, causing water in the pipe 31 to flow through the valve 33 and by-pass the mixing chamber. Gas from the flue 21 is driven by the blower 17 through the open valve 13 into the chamber 10 and previously treated water is discharged by the pump 42 to the discharge conduit 40. The pumping rate of this pump is, in a preferred embodiment, such in relation to the size of the mixing chamber that all liquid above the level of the outlet 37 is discharged somewhat before the end of this period, e.g., ten to thirty seconds when the period lasts for 1½ minutes. After the liquid has been discharged the pump forces gas from the chamber into the conduit 40, so that the conduit will contain undissolved gas in addition to liquid. This gas escapes through the many opening of the soaker S and rises through the water in the pool.

(2) The liquid-accumulating period starts when the cam follower moves to the lower part of the cam 57. The valves 13 and 33 are thereby closed and the blower 17 and pump 42 are stopped. Instead, the circuits 29, 51 and 53 are energized, and water from the pipe 31 is diverted through the pipe 26 to fill the mixing chamber. The agitators 46, 47 being now in operation, the water is splashed about and mixed with the gas within the chamber. This causes solution of some gas, including carbon monoxide, in the water. The gas being but sparingly soluble in the water, most of it is displaced upwardly as the water level rises. When this gas attains a sufficient pressure it escapes through the check valve 39 in the gas outlet. This escaping gas is usually moist and contains water mist. In the event that the flow rate of the entering water is so great that the mixing chamber is filled before the end of this period water can also escape through the gas outlet.

The next cycle commences immediately upon the completion of the liquid-accumulating period just described.

It may be noted that the check valve 39 prevents liquid

or gas discharge by the pump 42 from flowing back into the mixing chamber.

The system can be operated also when the heater 22 is not in operation but the pilot flame is on. Pilot flames usually burn fuel inefficiently and produce a large carbon monoxide content. This can in certain instances be sufficient to provide effective treatment of swimming pool water. It will be understood that only small concentrations of carbon monoxide, insufficient to be a hazard to persons using the pool, are involved.

I claim as my invention:

1. A device for treating a liquid with a gas which comprises, in combination with a source of treating gas:

(a) a fully enclosed mixing chamber having gas inlet means connected to receive gas from said source, liquid inlet means, gas outlet means at an upper level of the chamber connected to discharge gas into a discharge conduit, and liquid outlet means at a lower level of the chamber connected to discharge liquid into said discharge conduit,

(b) a separate flow-control means for each of said gas inlet means, liquid inlet means, and liquid outlet means.

(c) actuating means for activating each of said flow-control means to effect flow through the activated flow-control means, and

(d) timer means for operating said actuating means repetitively in a series of cycles each of which cycles includes:

(1) a gas-accumulating period during which the actuating means of the gas inlet means and of the liquid outlet means are activated, whereby gas is admitted to and liquid is discharged from said chamber, and

(2) a liquid-accumulating period during which the actuating means of the liquid inlet means is activated, whereby liquid is admitted to and gas is discharged from said chamber.

2. In combination with the device defined in claim 1, check-valve means in said gas outlet means disposed to permit flow only from the mixing chamber to the said discharge conduit.

3. A device as defined in claim 2 wherein said flow-control means in the liquid outlet means is a pump.

4. In combination with the device defined in claim 1:

(a) agitator means within said chamber for admixing gas and liquid within said chamber, and

(b) power means for operating said agitator means,

(c) said timer means being further constructed to apply power to operate said power means during the liquid-accumulating period of each cycle.

5. A device as defined in claim 1 wherein said flow-control means in the gas inlet means includes a blower having power drive means, said timer means being constructed to apply power to said drive means when activating said flow-control means.

6. A device as defined in claim 5 wherein said flow-control means in the gas inlet means includes, additionally, a valve provided with an operator that constitutes the said actuating means therefor.

7. In combination with a device as defined in claim 1:

(a) a source of liquid including a principal conduit and a pump for inducing the flow of liquid therethrough,

(b) a branch conduit connected to said principal conduit downstream from said pump and connected to said liquid inlet means, said flow-control means of the liquid inlet means being in said branch conduit, and

(c) a valve in said principal conduit situated downstream from said branch conduit and having a valve operator constituting actuating means therefor,

(d) said timer means being further constructed to activate the valve operator recited in section (c) hereof to permit flow of liquid through the associated valve

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during the gas-accumulating period, when the actuating means in the liquid inlet means is not activated.

8. A device as defined in claim 1 wherein said timer means includes an electrically driven rotary device having an operating cycle of duration such that the mixing chamber is substantially emptied of liquid during the gas-accumulating period and the chamber is filled with liquid to at least three-fourths of its volume during the liquid-accumulating period.

9. A device as defined in claim 8 wherein the said gas-accumulating and liquid-accumulating periods have approximately equal durations.

10. A device as defined in claim 1 wherein the duration of each cycle is between about one and sixty minutes.

11. The method of treating a liquid with a gas which comprises the steps of:

- (a) supplying said gas to a closed mixing chamber which is initially substantially filled with said liquid while discharging said liquid from a lower part of the chamber to a discharge conduit,
- (b) thereafter supplying said liquid to said chamber

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while displacing the gas upwards within the chamber and discharging said gas from an upper part of the chamber to said discharge conduit, and

(c) repeating steps (a) and (b) in alternation.

12. In combination with the steps defined in claim 11, the step of agitating the liquid within the chamber and thereby effecting intimate contact with the gas during step (b).

13. The combination of steps defined in claim 12 wherein some gas is discharged from the lower part of the chamber into the discharge conduit during the terminal part of step (a).

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