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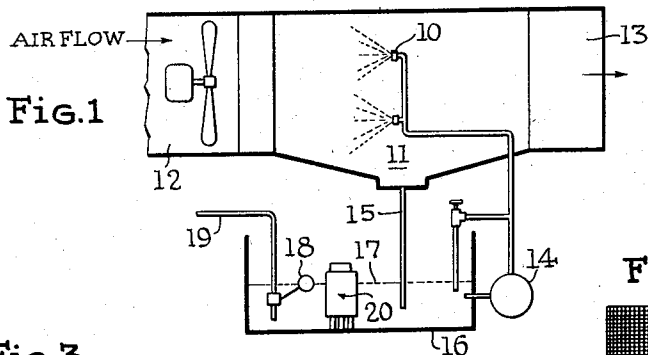


Fig. 1

Fig. 5

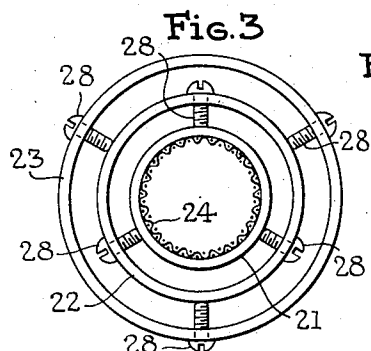


Fig. 3

Fig. 4

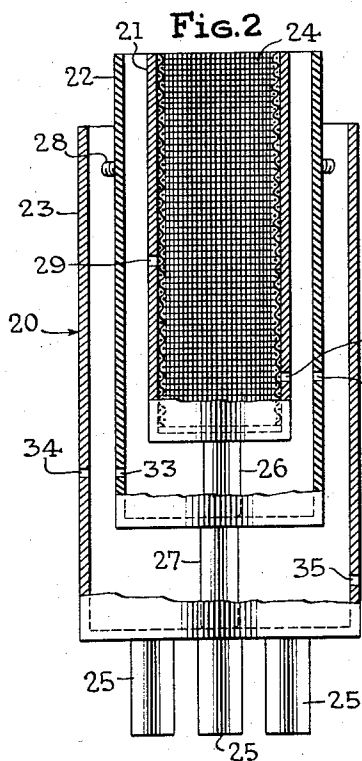
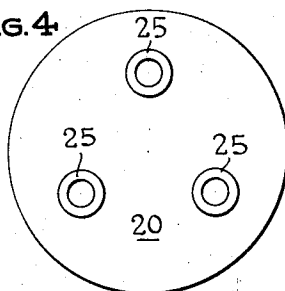


Fig. 2

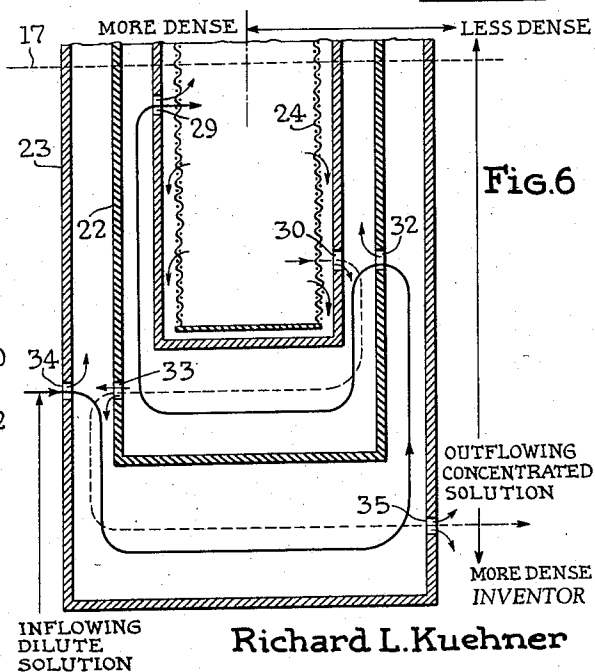


Fig. 6

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This invention relates to an improved method and apparatus for dispensing and dissolving chemicals. It is particularly applicable in the dispensing of chemical solutions used in a treating operation, wherein the dissolved chemical is progressively consumed during the course of the treatment. In applications of this type, where the treating solution is used in a concentration less than saturation concentration, the problem arises of continuously and automatically maintaining the concentration of the treating solution within a predetermined range less than the saturation concentration. The present invention provides an effective method and means for obtaining this result continuously and automatically.

Merely by way of illustration and not limitation, the present invention will be described with reference to its application in the deodorization and sterilization of the air circulated in air conditioning systems. As disclosed in applicant's prior Patent No. 2,683,074—issued July 6, 1954—an effective method of producing such sterilization and deodorization consists in spraying the circulated air with a circulating aqueous alkaline solution of potassium permanganate. Such a solution has been found to be highly effective in removing odors, molds and bacteria from the circulated air. As the deodorant and disinfectant effect is dependent upon a chemical reaction between the smoke, etc. in the air and the dissolved chemicals in the solution, the chemicals are gradually consumed in time and, hence, must be replaced. Moreover, in actual practice, it is found desirable to maintain the concentration of the solution at a strength less than saturation, which strength is established by the following considerations:

In order to economize in the use of chemicals, it is sought to use the most dilute treating solution effective to produce the desired deodorization and sterilization of the circulated air, especially in the case where there exists the possibility of an overflow of the washing solution into a drain. At the same time, the upper limit of the concentration actually used in practice must be kept below that strength at which there would exist a tendency of the chemicals to crystallize on the equipment and form deposits which lead to corrosion of the metallic surfaces, plugging of flow lines, etc.

It is, therefore, an important feature of the present invention to provide a dissolving dispenser for chemicals which will automatically feed the chemicals into a treating solution as the chemicals dissolved therein become consumed by the treatment, the chemicals being fed at such a rate as to maintain the concentration of the solution at an optimum predetermined value less than saturation, and the feeding of the chemicals becoming automatically inoperative when said optimum value, hereinafter referred to as the equilibrium point, has been reached.

The device basically is a dispenser because it supplies solute at a controlled rate. More accurately, it is a dissolving dispenser because the control is exercised through the dissolving action. An important advantage is that it has no moving parts.

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Other objects and advantages of this invention will become apparent from the following description, taken in connection with the accompanying drawing which illustrates a practical system in which the invention finds useful application. However, the invention is not limited to its use in any specific system.

In the drawings:

Fig. 1 is a diagrammatic view of the air washer using the dispenser of the present invention;

Fig. 2 is a vertical sectional view of the chemical dispenser of the present invention;

Fig. 3 is a top plan view of the dispenser;

Fig. 4 is a view of the bottom end of the dispenser;

Fig. 5 is an elevational view of a detail, while

Fig. 6 is a diagram illustrating the operation of the dispenser.

Referring to Fig. 1: The washer unit has the customary spray devices 10 for spraying the treating liquid, and these are interposed in the path of the air stream which enters the compartment 11 at one end 12 thereof and leaves through the other end 13. The liquid circulating means is indicated at 14 and the spray liquid accumulating in the bottom of the compartment 11 passes via the drain 15 to the reservoir 16 where it accumulates to the level indicated at 17. A float 18 automatically controls the inlet of water through a main 19 to maintain a predetermined level 17 in the reservoir.

The desired chemicals are added to the treating water in the reservoir 16, being introduced by means of the dispenser of the present invention—designated in its entirety by the reference numeral 20—to form a treating solution of the desired concentration. The dispenser 20, which rests on the bottom of the reservoir, is illustrated in greater detail in Figs. 2–5. In the particular embodiment shown, which is given merely by way of illustration, the dispenser comprises three concentrically arranged vertical cylinders 21, 22, 23, open at their upper ends, the innermost cylinder 21 containing a wire mesh basket 24—shown in Fig. 5—which receives the solid treating chemical; a 100 mesh basket is suitable for this purpose. The outermost cylinder 23 is provided with a plurality of leg members 25, by which the dispenser rests on the bottom of the reservoir 16; similarly, the two inner cylinders 21, 22 rest on the bottoms of the immediately adjacent cylinders by means of the leg members 26, 27 respectively. The several cylinders are supported in concentric relation by means of the adjusting screws 28.

Each cylinder is provided with two opposed apertures, which in the case of the innermost cylinder 21 are designated as 29, 30. The latter defines a fluid outlet and is positioned adjacent the bottom of the cylinder 21, while the aperture 29 defines a fluid inlet and is positioned at an intermediate level on the cylinder wall and 180° removed from outlet aperture 29. Similarly, cylinder 22 is provided with apertures 32, 33, and cylinder 23 with corresponding apertures 34, 35.

It is considered advantageous, but not indispensable so to dimension the leg members, relatively to the heights of the fluid outlets, that outlets such as 33 and 35 which lead through an encircling cylinder such as 22 and 23 are at heights intermediate the closed bottom of the encircled cylinder, such as 21 or 22 and the closed bottom of the next outer or encircling cylinder such as 22 or 23. This relationship is shown in Figs. 2 and 6.

The leg members 26, 27 of the inner cylinders are of such a length that the inlet of one cylinder will be adjacent to and on a level with the outlet of the next adjacent cylinder, starting with the outermost cylinder and proceeding inwardly as is clearly shown on the schematic diagram of the dispenser on Fig. 6. This

particular disposition of the apertures is for a purpose to be explained below.

The assemblage shown in Figs. 2 and 3 serves as a flow-directing and flow-controlling barrier which surrounds and is spaced from the foraminous container 24. The barrier affords a liquid-filled labyrinthine communication between that portion of the bath immediately adjacent the foraminous container 24 and that portion of the bath which surrounds said barrier.

In use, the desired chemical, e. g. alkalized potassium permanganate, is introduced within the mesh basket 24 in the innermost container of the dispenser, and the latter is then placed in the spray water reservoir 16; the water level maintained in the latter is such that the inlet aperture 29 is below the level of the water. Thereupon, water will gradually infiltrate through the apertures of the several cylinders and fill the cylinders up to the level of the water in the reservoir 16. A certain amount of the chemical will go into solution in the water in the innermost cylinder 21. It may be assumed that, once the system is in normal operation, the solution in the innermost cylinder is saturated, or approaches saturation with the particular chemical stored in the basket since a relatively small amount of fluid is in contact at all times with a large amount of the chemical. The dense solution thus formed in cylinder 21 will thereupon flow out through aperture 30 into cylinder 22. Replacement water will then naturally flow in through the upper aperture 29 and a fluid flow will thus be induced through cylinder 21. The same operation will be repeated in the successive cylinders until finally, the solution passes out through outlet 35 into the reservoir 16 and mixes with the water therein.

As mentioned above, the inlet 32 of the cylinder 22 is located adjacent the outlet opening 30 of cylinder 21; accordingly, the entering and outgoing fluid streams tend to mix and produce turbulence and better diffusion. Similar mixing will, of course, also take place in the region of the apertures 33, 34.

Inspection of the path of the fluids illustrated on Fig. 6 will show that the flow of the weaker solution from the reservoir 16 into the innermost cylinder 21, is generally countercurrent to that of that concentrated solution flowing outwardly from this cylinder and through cylinders 22, 23 into the reservoir. This produces effective contact and intimate mixing of the streams.

Since the level of the water in the reservoir and in the several cylinders is the same, it is apparent that the flow of fluid from the reservoir into the cylinders and from the cylinders into the reservoir is induced here by the increased hydraulic head resulting from the increased density of the solution inside the cylinders. The densest solution exists in the innermost cylinder, the density progressively decreasing in the successive cylinders. Further, in each cylinder the densest solution is found on the bottom thereof. This is indicated diagrammatically on Fig. 6.

This cycle of inflow of treating fluid from reservoir 16 through inlet 34 of the dispenser, and outflow of solution through aperture 35, will continue until an equilibrium point is reached, i. e. a point where the hydrostatic head of the solution in the reservoir will balance that in the cylinders.

As will be pointed out in greater detail below, the equilibrium point is dependent upon certain variables in the structure of the dispenser, i. e. the size of the apertures and the number of cylinders in the dispenser. Accordingly, in designing a dispenser for a particular load, these variables are so selected and coordinated that the dispenser will discharge sufficient chemical to obtain the desired "normality," i. e. percentage concentration by weight of chemical in the spray solution—within a practical range—to accomplish effective deodorization and disinfection of the circulated air, and

when the desired normality or equilibrium point has been reached, the dispenser will automatically stop discharging concentrated replenishing solution into the treating solution in the reservoir.

Applicant has determined by extensive experimentation that using a solution of alkalized potassium permanganate of 0.05 normal, which represents a concentration of 0.156% by weight, he is able to effectively absorb the smoke and odors in an occupied space. A spray solution of 0.5 normal leads to crystallization and scaling of the equipment and, of course, is to be avoided. On the other hand, the minimum normality of the spray liquid that will absorb tobacco smoke is 0.004 normal. According to the present invention, the dispenser is preferably so designed that it discharges chemicals at such a rate as to maintain the normality of the treating solution not in excess of 0.05, the discharge from the dispenser stopping automatically when this point is reached.

The several variables present in the design of the dispenser and their effect on the operation are:

(1) *Hole size.*—An increase in the hole size decreases the restrictive effect of the orifice and lessens thereby the total head against which the inner cylinder must work. This results in an increased flow rate and a higher normality of equilibrium.

(2) *Number of cylinders.*—An increase in the number of cylinders while retaining the same orifice size sets up additional heads against which the innermost head must work, primarily because of the increased number of orifices through which the solution must pass. Obviously, this creates an increase in the total resistance to flow, and thereby lowers the flow rate and the normality at which the system balances.

(3) *Number of orifices.*—An increase in the number of orifices in the cylinder (there must be an additional inlet orifice for each additional outlet orifice) increases the flow rate, but does not affect the equilibrium normality. The latter results from an equilibrium of heads across the wall of a tube and this is independent of the number of orifices, since the restrictive effect of each orifice must be considered individually. Therefore, an increase in the total number of orifices does not decrease the resistance to flow and, therefore, does not raise the equilibrium normality. However, the rate of discharge will be increased, since with unbalanced heads, rate of flow is a function of the head pressure differential times the available orifices through which the liquid can pass.

(4) *Cylinder diameters.*—An increase in the cylinder diameters will result in an increase in the flow rate but will not affect the balancing or equilibrium normality. Balancing normality will not be changed because there is no change in the heads against which the inner head must operate. However, the flow rate will be increased for the following reason: With larger diameter cylinders, a greater period of time is required for the solution within the cylinders to equalize due to the greater mass of water to be treated. However, once this has occurred, then, the rate of flow into the reservoir will be greater should unbalance occur, because a greater mass of solution is available for discharge.

(5) *Depth of submergence.*—No effect on normality or flow rate because the physical head in each cylinder is changed an equal amount.

(6) *Vertical distance between orifices.*—Has no effect on normality or flow since heads remain unchanged. The only limitation here is that inlet orifice must be located above outlet so that flow will be in one direction. Orifices must not overlap.

(7) *Vertical spacing of individual cylinders.*—Has no effect on discharge rate or holding normality. Only consideration is that separation between cylinders must be sufficiently great to prevent concentrated chemical (potassium permanganate) in the inner tube from passing

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directly without dilution through the discharge orifice, which would cause plugging of the latter.

From a considerations of the foregoing, it is apparent that there are several variables which affect the proper design of a dispenser to maintain a predetermined equilibrium normality, i. e. concentration in the treating solution for a particular load. As far as applicant has been able to determine, there is no readily expressed relationship between the several variables. However, in all instances, the construction and operation of the dispenser is fundamentally governed by the following broad principles:

(1) The operation of the dispenser is a function of the difference in the absolute concentrations of the solution in the innermost cylinder of the dispenser and that of the treating solution in the reservoir, and

(2) The limiting factor on the maximum value of the concentration of the treating solution at the equilibrium point, i. e. when the dispenser ceases to discharge, is constituted by the restrictive effect of the orifices on the flow of the concentrated substantially saturated solution from the innermost cylinder into the reservoir.

In keeping with the control principles stated above, in order that a dispenser maintain a desired maximum concentration of dissolved chemical in the treating solution in the reservoir, the variables of the dispenser, i. e. size of orifice, number of cylinders, should be so selected that the total resistance to flow from the container into the reservoir does not exceed the difference in hydrostatic head obtaining between a column of the saturated solution and an equal column of a solution of the desired concentration. Conversely, once the factors which primarily control the resistance to flow of the replenish-

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be open at the top or have a cover provided with an air vent, i. e. the device must be under atmospheric pressure in order to operate properly.

On the attached table, there is set out a résumé of data obtained as a result of tests with the dispenser of the present invention during a period over a year. Applicant's experiments have shown that there is required a discharge into the treating solution of about 1 gram of alkalized potassium permanganate per day per average smoker in order to adequately remove the resultant smoke from a room. An average smoker consumes 10 cigarettes per 9-hour day. As indicated on the table, applicant determined that a combination of these cylinders, and apertures of .0625" in the inner cylinder, .031" in one of the outer cylinders, and .0625" in the third cylinder, will give an equilibrium point of .05 normal and will discharge sufficient chemical to give the desired effect.

The tabulated data further shows that in the case of a dispenser having one cylinder, or even two cylinders, the equilibrium point is too high for practical purposes, the holding normality being 1.6, 1.4 respectively.

Further, in connection with the above tabulated data, it should be observed that the occupancy listed is smoker occupancy. If we consider that 60% of the people smoke, then, the actual occupancy capacity of the plant is greater than the given figures. With reference to the tabulated size of the refrigeration plant: it is not possible to accurately predict the size of the refrigeration plant required by the number of occupants alone. Therefore, applicant used the very rough rule of thumb of 1-4 people per ton of refrigeration in approximating the size of plant each dispenser would handle.

No. Tubes in Dispenser	Dispenser Diameter, inches	Orifice Sizes	Holding Normal- ity	Gms. Disch., 9 Hr. Day	Smoker Occu- pancy	Tons Plant
1-----	1 3/4	.0625	1.6	102	102	15-100
2-----	1 3/4-3 1/4	.0625, .0625	1.4	57	57	14-57
3-----	1 3/4, 3 1/4, 4 1/4	.0625, .0625, .0625	.8	25	25	6-25
3-----	1 3/4, 3 1/4, 4 1/4	.0625, .0625, .031	.04	12	12	3-12
3-----	1 3/4, 3 1/4, 4 1/4	.0625, .0625, .031	.05	12	12	3-12
3-----	1 3/4, 3 1/4, 4 1/4	.0625, .031, .0625	.05	2.5	3	1-3
3-----	1 3/4, 3 1/4, 4 1/4	.0625, .031, .031	.001	.64	1	1/4-3/4
3-----	1 3/4, 1 7/8, 2 1/4	.0625, .0625, .031	.04	3.7	4	1-4
3-----	1 3/4, 2 1/8, 2 3/8	.0625, .0625, .031	.05	3	3	3/4-3

ing solution into the reservoir have been selected, the maximum concentration of the solution in the reservoir at the equilibrium point becomes fixed. That is, the dispenser will function substantially to maintain the concentration of the treating solution at said maximum concentration, and the discharge of replenishing solution from the dispenser into the reservoir will automatically stop when said maximum has been reached.

Practical experience with the dispenser of the present invention using potassium permanganate has shown that it is advantageous to use preferred numerical values for some of the variables of the dispenser. Thus, it was established that to prevent plugging of the innermost cylinder of the dispenser, it should have a minimum hole size of .0625"; the other cylinders, which are not so liable to plugging, should nevertheless have a minimum hole size of .031" to prevent an erratic and unpredictable flow. Experience has also shown that in the case of a dispenser using potassium permanganate, at least two cylinders are needed. If a dispenser having but one cylinder and the smallest permissible orifice (the only variable) be used, then, the balancing normality or equilibrium point will be too high. It was further determined that 3/4" vertical space between cylinders is too little, while 1" is satisfactory.

In use, the water level must be above the uppermost aperture. When potassium permanganate is the chemical employed, the water level should be above the crystals, since the crystals will absorb moisture and cake if not covered. Also, when in operation, the device must either

I claim:

1. A device for maintaining at a substantially uniform strength, less than saturation, a bath of chemically active solution which is subject to continuous depletion of its dissolved content with attendant reduction of its gravity, comprising means for retaining the bath; a foraminous container for solute submerged in said bath; and an enclosing structure offering liquid-filled labyrinthine communication between the foraminous container and the main portion of the bath, and comprising a plurality of upright cup-like members open at their tops and each projecting above the level of the liquid bath and having closed bottoms, said members being graduated in size, the smallest encircling said container and each of the others encircling and spaced from the next smaller, said closed bottoms similarly being spaced apart, each of said members having in its side wall a restricted inlet opening and a restricted outlet opening offset vertically so that the outlet openings lead from lower levels as compared with the inlet openings, and lead from the spatial interval between the bottom of a cup-like member and the bottom of the cup-like member encircled by it.

2. A device for maintaining at a substantially uniform strength, less than saturation, a bath of chemically active solution which is subject to continual depletion of its dissolved content with attendant reduction of its gravity, said device comprising in combination means for retaining said bath; a foraminous container sustained within said bath so as to be immersed therein while confining solute undergoing dissolution; and a flow-directing and

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flow-controlling barrier surrounding and spaced from said foraminous container, said barrier offering liquid-filled labyrinthine communications between that portion of the bath adjacent the foraminous container and that portion of the bath which surrounds said barrier, said barrier comprising a series of spaced enclosing partitions each closed to the passage of liquid except that each of said partitions has restricted openings arranged at different levels, namely relatively deeply submerged openings for flow of high gravity solution toward the surrounding portion of the bath and less deeply submerged openings for return flow of low gravity depleted solution toward the surrounded portion of the bath.

3. The combination defined in claim 2 in which the spaced enclosing partitions are in the form of an assemblage of cup-like units having approximately cylindrical spaced walls arranged substantially coaxially in

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encircling relation each to another and said foraminous container.

4. The combination defined in claim 2 in which the spaced enclosing partitions are in the form of an assemblage of cup-like units having approximately cylindrical spaced walls arranged substantially coaxially in encircling relation each to another and said foraminous container, and said cup-like units are separable and include centering means, whereby assemblages differing in flow characteristics can be made.

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