United States Patent [19]

Hori

[11] **3,865,910**

[45] **Feb. 11, 1975**

[54] **APPARATUS AND METHOD FOR CAUSING CONTACT BETWEEN GAS AND LIQUID**

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[22] Filed: **May 17, 1972**

[21] Appl. No.: **253,970**

[30] **Foreign Application Priority Data**

May 20, 1971 Japan 46-33591

[52] **U.S. Cl.** ..... **261/93,** 261/121 R

[51] **Int. Cl.** **B01f 3/04**

[58] **Field of Search** ..... 261/93, 91, 87, 114 A, 261/121 R; 259/8, 23, 43; 23/283, 285, 286

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[57] **ABSTRACT**

This invention relates to an apparatus for causing contact between gas and liquid by atomizing an abundant quantity of gas into fine bubbles. This invention comprises a revolving body mounting a plurality of hollow concentric coaxial cylinders of different diameters mounted vertically and integrally and securing canopies to the cylindrical wall portions of the cylinders open at the lower ends and closed at the upper ends, a vertically mounted drive shaft for causing rapid revolution of said revolving body in the liquid, and gas inlet pipes for supplying gas into spaces between said wall portions and said canopies. The gas supplied to said spaces is made to encircle the outer walls of the respective spaces in the form of thin films due to the speed of revolution and the gas film is then atomized into fine bubbles by means of the splitting force, so that the gas can be brought into contact with the liquid.

5 Claims, 4 Drawing Figures

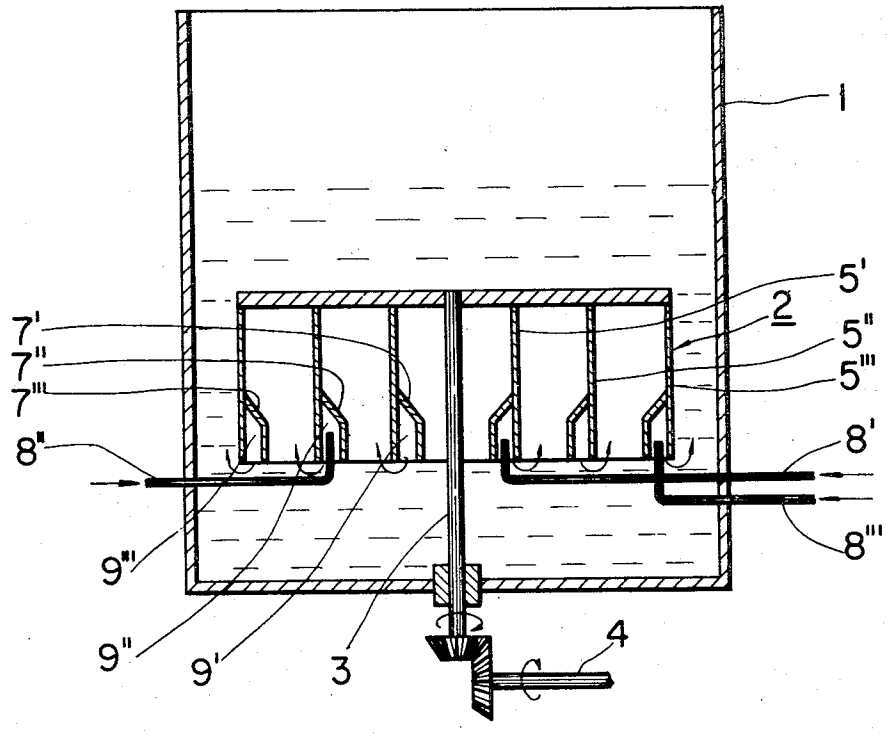


FIG. 1

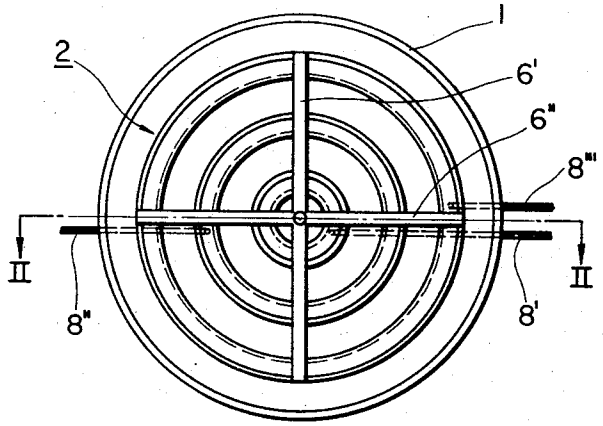


FIG. 2

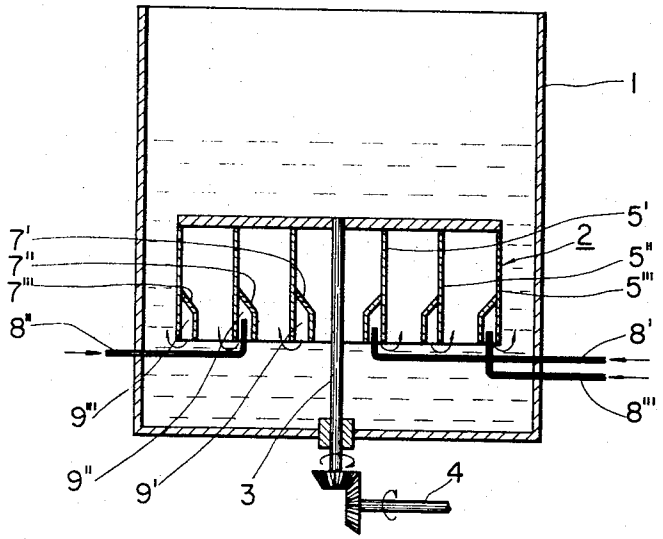


FIG.3

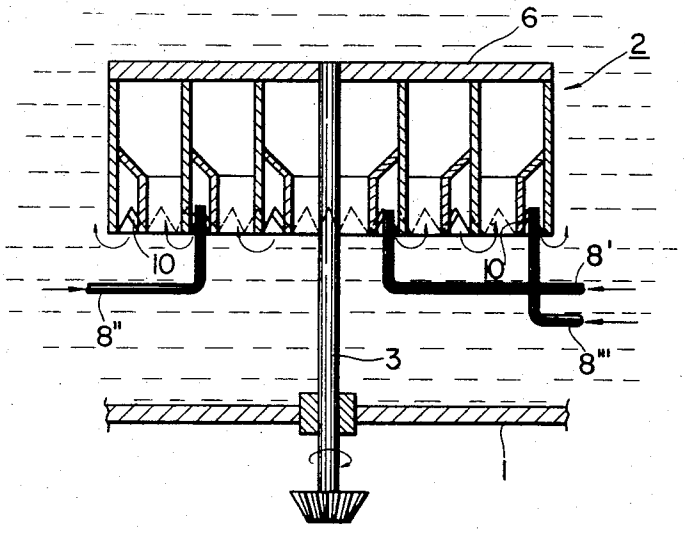
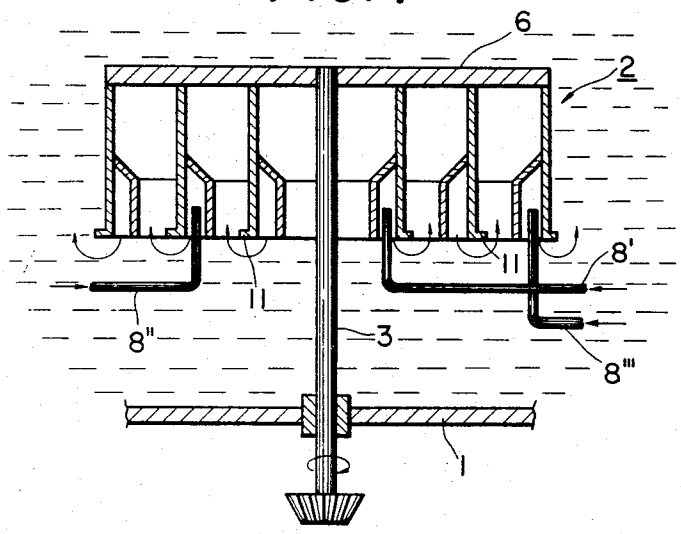


FIG.4



APPARATUS AND METHOD FOR CAUSING CONTACT BETWEEN GAS AND LIQUID

This invention relates to an apparatus for causing contact between gas and liquid by atomizing the gas into fine bubbles, and more particularly to an apparatus for causing contact between gas and liquid by atomizing the gas in an abundant quantity into the liquid.

An object of this invention is to provide an apparatus for atomizing gas in the liquid into fine bubbles to bring it into contact with the liquid.

Another object of this invention is to provide an apparatus for atomizing an abundant quantity of gas into fine bubbles in a given period of time.

Other objects of this invention will become clear by the following detailed description thereof.

The present inventor devised an apparatus for causing contact between gas and liquid comprising a hollow revolving cylinder having an opening at the lower end and being closed at the upper end, the arrangement being such that the gas supplied into the inner space of the cylinder through the open end thereof is made to encircle the outer periphery of the cylinder in the form of a thin film by the revolution of the cylinder and the film is then atomized into fine bubbles of uniform size by the splitting force caused by the revolution of the cylinder (U.S. Pat. Ser. No. 761,093 filed Sept. 20, 1968, now abandoned). In order that an abundant quantity of gas can be atomized into fine bubbles by this prior apparatus in a given period of time, not only the diameter of the cylinder must be considerably enhanced, but a larger motive power is required to keep the cylinder in revolution.

The present invention resides in the improvement of the above apparatus whereby an abundant quantity of gas is atomized into bubbles in a given period.

The present invention provides an apparatus for causing contact between gas and liquid which is relatively small in size but capable of atomizing gas in an abundant quantity. The present invention resides in an apparatus for causing contact between gas and liquid comprising a body capable of revolution mounted vertically and integrally having a plurality of hollow concentric coaxial cylinders of different diameters securing canopies to the cylindrical wall portions of the cylinders open at the lower ends and closed at the upper ends, a vertically mounted drive shaft for causing rapid revolution of said body in the liquid, and gas inlet pipes for supplying gas into spaces between said wall portions and said canopies, the arrangement being such that the gas supplied into said spaces is made to encircle the outer walls of the respective spaces in the form of thin films due to the speed of revolution and the gas film is then atomized into fine bubbles by means of the splitting force, so that the gas can be brought into contact with the liquid.

Next, reference is had to the accompanying drawings by way of explanation of the present invention.

FIG. 1 is a plan view showing an embodiment of the present invention,

FIG. 2 is a sectional view taken on the line II — II of FIG. 1 and

FIGS. 3 and 4 are the sectional views showing two examples of the revolving bodies shown only partially.

Referring now to FIGS. 1 and 2, a revolving body 2 is placed horizontally near the bottom of liquid tank 1. The vertical drive shaft 3 mounted centrally to the revolving body 2 revolves rapidly, driven by a motive power shaft 4. The revolving body 2 comprises a plurality of hollow cylinders of different diameters 5', 5'' and 5''' arranged concentrically about the drive shaft 3, support rods 6' and 6'' supporting these cylinders so that the peripheral wall portions thereof are kept in the vertical positions, and canopies 7', 7'' and 7''' having openings at the lower ends and being closed at the upper ends. These canopies 7', 7'' and 7''' are secured to the cylindrical wall portions of the cylinders and spaced a predetermined distance from said wall portions. In the present embodiment, there are provided three cylinders 5', 5'' and 5''' and two support rods 6' and 6'', but the present invention is not limited thereto. Furthermore, the heights of the hollow cylinders may be the same or different from each other. Since the canopies 7', 7'' and 7''' fixedly mounted to the peripheral wall portions of these cylinders provide for formation of the spaces for blowing gas between said wall portions and canopies, the space formed between the wall portions and the canopies may be cylindrical, conical or of any other desired shape. Canopies 7', 7'' and 7''' may be mounted to the inner or the outer peripheral wall portions of the hollow cylinders. The lower ends of the hollow cylinders 5', 5'' and 5''' may be at the same height as those of the canopies 7', 7'' and 7'''. Preferably the lower ends of the canopies are located below the lower ends of the cylindrical wall portions of the cylinders when the canopies are mounted on the inner wall portions of the cylinders, while the lower ends of the canopies are located above the lower ends of the wall portions of the cylinders, when the canopies are mounted to the outer wall portions of these cylinders.

When the lower end of the hollow cylinders 5', 5'' and 5''' is at the same height and smooth, as shown in FIG. 2, nonuniformity may be caused in gas dispersion from the revolving body 2 and the fine bubbles produced may not be of the same size. In this case, preferably the revolving body 2 as shown in FIGS. 3 and 4 may be used. In FIG. 3, the lower end of the hollow cylinder 5', 5'' and 5''' from which gas dispersion takes place is jagged in the form of saw teeth 10, while in FIG. 4, the lower end of the hollow cylinder 5', 5'' and 5''' from which gas dispersion occurs is reinforced with the rim 11.

The device in FIG. 3 aims at ensuring uniformity in gas dispersion as it is atomized into numerous fine bubbles, even when the gas flow rate varies, while the device in FIG. 4 aims at facilitating formation of gas film and subsequent formation of fine bubbles.

Gas is supplied from inlet pipes 8', 8'' and 8''' into the spaces 9', 9'' and 9''' formed between the peripheral wall portions of the cylinders 5', 5'' and 5''' and the canopies 7', 7'' and 7'''. Preferably the foremost parts of the gas inlet pipes are located as deep within said spaces as possible.

The gas supplied into said spaces finds its way through the open lower ends respectively and encircles the peripheral wall portions of the cylinders or canopies of the revolving body 2 in the form of a film which is then atomized into numerous fine bubbles to disperse all over the inside of the tank by the splitting force due to the speed of revolution and allowed to contact with the liquid. Three gas inlet pipes are provided independently in the present embodiment, but a single gas inlet pipe may be branched into three sections in the liquid phase. Since the average size of the fine bubbles varies

as a function of the linear speed of the outer lateral surface of the cylinder or canopies, the number of revolutions of the revolving body cannot be fixed unconditionally. For instance, when a hollow cylinder 60 mm in diameter and 230 mm in height which is closed at the top is revolved at an rpm of 3,350, the size of the bubbles generated is about equal to that of the bubble passed through the pore of 20 μ.

According to the present invention, since the respective spaces contained in the revolving body will revolve simultaneously and with the same speed, the outer spaces will have the larger linear speeds. Hence, in order that the fine bubbles of the same size may be generated from the respective spaces, it is necessary to regulate the gas quantity blown into the respective spaces as a function of their distance from the drive shaft **3**.

In the apparatus according to the present invention for causing contact between gas and liquid, since the respective spaces in the revolving body correspond to the space inside the hollow cylinder of the contact apparatus disclosed in our above-mentioned prior application, a larger quantity of gas can be blown into the revolving body per unit time. Moreover, since the gas can contact with liquid in the form of fine bubbles, there is a more intimate contact between gas and liquid.

I claim:

1. An apparatus for causing contact between gas and liquid including a vessel for containing the liquid which comprises a body vertically mounted for revolution comprising a plurality of integral hollow, concentric, coaxial cylinders of different diameters, having canopies secured to the cylindrical wall portions of the cylinders and spaced a predetermined distance therefrom, open at the lower ends and closed at the upper ends, a vertically mounted driving shaft for causing rapid revolution of said body in the liquid, and gas inlet pipes for supplying gas into spaces between said wall portions and said canopies, wherein the gas supplied to said spaces is made to encircle the outer walls of the respective spaces in the form of thin films due to the speed of revolution of said body and the gas film is then atomized into fine bubbles by means of the splitting force, so that the gas can be brought into contact with the liquid and wherein said liquid is maintained at a level which at least contacts the upper edge of the body capable of revolution.

2. An apparatus as claimed in claim **1**, in which the lower ends of the outer edge of said cylinders are in the form of saw teeth.

3. An apparatus as claimed in claim **1**, in which the lower ends of the outer edge of said cylinders are reinforced with a radially extending rim.

4. An apparatus as claimed in claim **1**, in which said body mounted for revolution is located near the bottom of the vessel.

5. A method of causing a gas to contact a liquid comprising supplying gas to canopies within a body mounted for revolution immersed in a vessel containing liquid, wherein said body comprises a plurality of hollow concentric coaxial cylinders of different diameters, having said canopies secured to the cylindrical wall portions of the cylinders and spaced a predetermined distance therefrom, open at the lower ends and closed at the upper ends, and wherein said body is revolved at a high rate of speed sufficient to form a thin film of gas around the outer walls of said cylinders with subsequent atomization and dispersion of said thin film of gas into said liquid and wherein said liquid is maintained at a level which at least contacts the upper edge of said body of revolution.

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