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M. A. LAMB

3,206,178

DIFFUSER TUBE

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Fig. 4

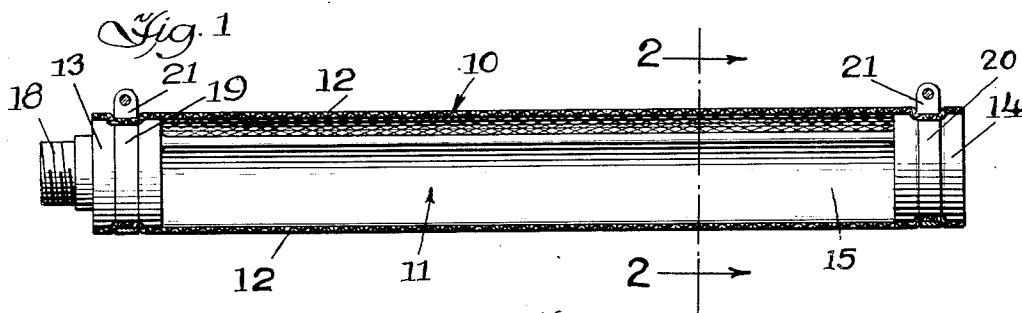
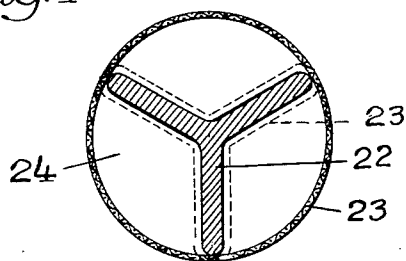


Fig. 2

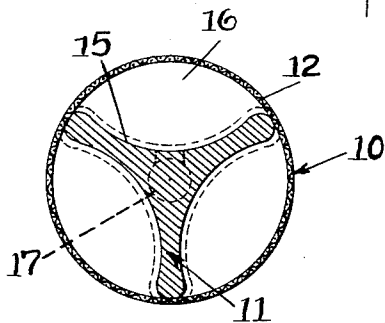
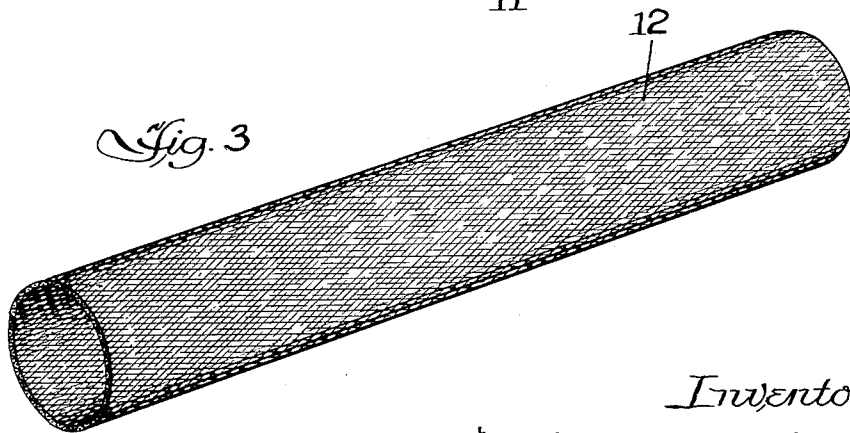


Fig. 3



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3,206,178

DIFFUSER TUBE

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4 Claims. (Cl. 261-122)

This application is a continuation-in-part of my co-pending application Serial No. 479,522, filed January 3, 1955, and now abandoned, which was a continuation-in-part of my prior application Serial No. 415,000, filed March 9, 1954, and now abandoned.

This invention relates to a diffuser tube used for the aeration of liquids or for the dispersion of gases or vapors therein, and more particularly to diffuser tubes having an outer member of collapsible, foraminated fabric secured to an inner member having a solid surface against which the fabric strikes, when the tube is rapidly deflated, to break away the solid foreign matter that accumulates on the porous surface of the fabric.

Diffusers of the type with which the present invention is concerned are employed in the activated sludge process of treating sewage, or flotation processes, treatment of industrial wastes, various fermentation processes, and other chemical processes where gas-liquid contact is essential. In the past such diffusers have in the main been made of porous carbon and ceramic material, or by wrapping a cord about a hollow foraminated core so that air was permitted to pass through openings provided between adjacent convolutions of the cord. These diffusers were costly. In addition they became clogged more or less readily and had to be taken off the air main to be cleaned. Frequently they could not be cleaned and had to be replaced. This made maintenance costly.

Another type of known diffuser comprises a hose having attached thereto a fabric bag porous enough to permit air to flow through the bag into the surrounding liquid. In diffusers of this type it is impossible to control the flow of air through the bag to provide uniform aeration of the liquid in which the bag is held because the bag is free to swing around in the liquid and cause the air bubbles escaping from the bag to coalesce into larger bubbles of varying size.

The diffuser tube of the present invention comprises a rigid nonporous inner member, and a flexible, porous outer member substantially coextensive in length with the inner member and secured thereto in any suitable manner. The length of this tube is substantially greater than the width or height thereof. The inner member is solid and is preferably cylindrical at its ends although it may have any desired configuration. An inlet opening extends through one of said cylindrical ends of the inner member. Preferably the inlet opening in the end of the inner member is threaded so that a nipple may be easily threaded therein. The nipple constitutes the means by which the diffuser tube is connected to an air supply pipe. Air or gas (aeriform body) is passed through the inlet into the interior of an air chamber which is enclosed within the outer member. The aeriform body then passes through the porous outer member to the surrounding medium.

Hereinafter, in the description of the invention, reference will be made only to "air," but with the understanding that by this term applicant contemplates gas or other aeriform body.

The porous member may be made of flexible, porous, woven fabric, suitably of a plastic material. Thus it may be made from a synthetic linear polyamide such as nylon, from a copolymer of vinyl chloride and vinylidene chloride of the type known commercially as "Saran," from "Orlon" or other synthetic plastic material, from canvas

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or other suitable textile material, or from porous metal fabric or other suitable fabric strong enough to withstand the action of sewage and the pressure of the liquid in which it is immersed, and yet be flexible enough to be collapsed quickly when the air or gas supply is shut off. The interstices of the fabric through which the air or gas flows may be varied as desired, but preferably are small enough to cause the air or gas to pass through in fine bubbles to provide more efficient aeration or gasification.

The inner, nonporous member may be made of wood, metal, glass, or any other suitable solid, rigid material. It may also be made of plastic such as phenol-formaldehyde, urea-formaldehyde or other thermosetting type of resin, or of woven or unwoven glass or other fabric impregnated with a synthetic resin, preferably of the thermosetting type. The outer member is pulled over the inner member, and the ends are secured to the ends of the inner member in any suitable manner. However, the outer member is not pulled taut when it is placed on the inner member, since a slight looseness is necessary throughout the length of the intermediate portion of the outer member so that it may strike vigorously against the surface of the inner member, when it is rapidly deflated, to dislodge solid foreign matter accumulated on its surface and in its pores.

The diameter of the intermediate portion of the inner member is reduced to provide an air chamber communicating with the inlet opening. The air chamber is preferably formed in three sections, each of which is provided with a shallow curved bottom to provide a concave surface against which the portion of the porous outer member coextensive therewith strikes when the diffuser tube is rapidly deflated. The "coextensive" portions of the inner and outer members are those portions that are defined by coinciding boundary lines. The arc defining the bottom surface of each section of the air chamber is shallower than the arc of the outer member when the outer member is inflated. Thus, the surface area of the concave surface of the inner member is slightly less than the surface area of the portion of the outer member coextensive therewith. The bottom surfaces of the air chamber may be flat, if desired.

The inner member is substantially parallel to the outer member, and the surfaces of the bottom of the air chamber are positioned close enough to the outer member to insure striking contact of the outer member throughout substantially its entire length with the concave bottom surfaces of the air chamber when the air supply is suddenly cut off and the outer member is forced inwardly by the pressure of the liquid or other medium in which it is immersed. The difference between the surface area of each concave surface comprising the bottom of a section of the air chamber and the surface area of the portion of said outer member coextensive therewith is insufficient to permit any portion of the outer member to fold over upon itself when said outer member engages said concave surface. The absence of folds in the portions of the outer member striking the bottom surface of the air chamber insures that each portion of the outer member through the interstices of which air is diffused strikes against the solid inner member when the outer member is rapidly deflated. If folds are present in the portion of the outer member striking against the bottom surface of the air chamber, the solids trapped within the folds may not be dislodged by said striking action.

The diffuser tube of the present invention may be used individually or a plurality of such tubes may be ganged together. It is preferred to connect a plurality of such tubes to an air supply pipe with the tubes arranged in parallel relationship and positioned adjacent one wall of the tank. The tubes are made relatively long so as to

emit a long stream of bubbles, and by ganging the tubes in parallel relationship to a supply pipe, a wide band of bubbles is obtained. The bubbles follow a circulatory path through the liquid in the tank to provide uniform aeration throughout the liquid.

The tube of the present invention is extremely efficient in that it provides a band of uniform sized bubbles throughout its entire length. The bubbles are very small and will not coalesce. The tube of the present invention provides a more uniform band of finely divided bubbles than has heretofore been known in the prior art.

In use, it is preferred that the diffuser tubes of the present invention be connected to an air supply through a line which includes a quick acting valve. When the quick acting valve is open, the air supply is instantaneously cut off from the tubes, and the air line between the valve and the diffuser tubes is open to the atmosphere, thereby causing a quick and complete collapse of the outer member of each of the tubes. When the outer member collapses, it strikes the nonporous inner member, causing solid foreign matter to be broken away from the surface of the porous outer member of the tube. When the quick acting valve is closed, the tube is quickly inflated.

The sudden inflation of the outer member of the tube serves to break away solid foreign matter that is not broken away when the outer member strikes the inner member of the tube. Solid foreign matter that is not broken away is sufficiently loosened in the pores of the tube so that it will be blown out by the pressure of the air when the tube is inflated. The deflation is so rapid as to prevent infiltration of the surrounding liquid. The diffuser tubes are kept quite clean at all times by merely turning the valve controlling the air in order to deflate and then re-inflate the tubes, with the result that the maintenance expense of the present system is relatively low. If a more thorough cleaning is necessary, or if any repairs are required, the diffuser tubes may be readily removed.

The structure of the present invention, by means of which the above and other advantages are attained, will be described in detail in the following specification, taken in conjunction with the accompanying drawings, showing a preferred illustrative embodiment of the invention, in which:

FIG. 1 is a longitudinal view, partly in section and partly in elevation, showing a preferred embodiment of the diffuser tube;

FIG. 2 is a cross sectional view, taken along the line 2—2 of FIG. 1;

FIG. 3 is a fragmentary perspective view of the outer porous member of the diffuser tube; and

FIG. 4 is a cross sectional view, similar to FIG. 2, showing a slightly different form of inner member.

Referring to the drawings, a diffuser tube 10 comprises a rigid nonporous inner member 11 and a flexible, collapsible, porous outer tubular member 12 that are substantially coextensive in length. Inner member 11 preferably has cylindrical ends 13 and 14. The ends may be of any desired cross sectional configuration and may be dissimilar, if desired. The diameter of the intermediate portion of said inner member is reduced throughout substantially its entire length to provide a reduced cross sectional area along three circumferentially spaced longitudinally extending lines to provide a plurality of concave surfaces 15. Each surface 15 forms the bottom of one section of an air chamber 16.

An inlet opening 17 extends longitudinally from the cylindrical end 13 to the air chamber 16. Preferably inlet 17 is threaded, and a nipple 18 is threaded into the inlet. The threaded nipple provides a convenient fitting for connection, through a quick acting valve (not shown), to a source of air under pressure. A single air inlet provides air for each section of the air chamber. The flexibility of the outer member causes its intermediate portion

to move outwardly from the intermediate portion of the inner member to a sufficient extent, under the pressure of the air flowing into one section of the air chamber, to permit the air to flow from one section to the others.

Each cylindrical end 13 and 14 of the inner member is provided with a circumferential groove 19 and 20, respectively, for the reception of split clamps 21, adapted to secure opposite ends of a tubular porous outer member 12 to the ends of the inner member. The tubular outer member may have one end closed, but preferably is open at both ends. The ends of the tubular outer member may be secured to the ends of the inner member in any suitable manner. The outer member is substantially coextensive in length with the inner member and completely encloses the intermediate portion of the inner member between the ends 13 and 14. The securing member, such as clamp 21, for example, is tightened sufficiently to prevent the outer member from being pulled off the inner member under normal conditions. Another clamp 21 is provided to secure the opposite end of the outer member to the inner member, but the outer member is not stretched taut between the clamps. The outer member must not be restrained against the movement necessary to permit it to strike against the inner member when it is rapidly deflated.

When air is forced through inlet 17 it passes directly into the air chamber 16 to inflate outer member 12. The air pressure causes the air to be dispersed through the interstices of the portions of the outer member 12 that are coextensive with the air chamber. The interstices of the fabric are small enough to cause the air to be dispersed in fine bubbles which aerate the sewage, or other liquid in which the tubes are immersed, in a very efficient manner. Although the tendency of the air passing through the fabric of the outer member is to keep the pores of said fabric clean by blowing away the solid foreign matter contained in the sewage, some solid foreign matter does accumulate on the fabric of the outer member 12. In time, such solid foreign matter would clog the pores of the fabric.

This possibility of clogging the pores of the fabric of the outer member 12 is obviated by merely opening and then quickly closing the valve (not shown) without any appreciable interruption of the aerating process. When the valve is opened to the atmosphere the air supply is instantaneously cut off from tube 10, and the air line (not shown) between the valve and the diffuser tubes is open to the atmosphere, whereby the pressure of the liquid in which tube 10 is immersed causes quick and complete collapse of the outer tubular member 12. The collapse of member 12 causes the fabric to strike the solid inner member with such force that substantially all of the solid foreign matter accumulated on the surface of member 12 is broken away.

It is essential that the entire portion of the outer member through the interstices of which air is dispersed, which is the portion spaced from the surface of the inner member when the outer member is inflated, be unrestrained as to movement relative to the inner member. This lack of restraint permits the entire portion of the outer member through which air is dispersed to strike against the portion of the inner member coextensive therewith when the outer member is rapidly deflated. If any portion of the outer member were restrained from striking against the inner member, such portion would become clogged with solid foreign matter and reduce the effective length of the diffuser tube, and thereby impair the efficiency of the aerating process.

Surface 15 of the inner member 11 forming the bottom of each section of the air chamber 16 is slightly curved, but it will be understood that this surface may be substantially flat, if desired. Surface 15 is positioned fairly close to outer member 12. The portion of the outer member that is coextensive with the bottom of the air chamber strikes against the bottom surface of said

air chamber throughout substantially the entire length of the outer member with sufficient force to dislodge solid foreign matter from the outer member when it is rapidly deflated. As shown in FIG. 2, the arc of each surface 15 is slightly shallower than the arc of the portion of the outer member extending between the ends of said surface.

The slight difference between the surface area of the bottom of the air chamber and the surface area of the portion of the outer member coextensive therewith is not sufficient to permit the fabric of the outer member to fold upon itself when it is collapsed by rapid deflation of the tube. Therefore every portion of the outer member through the interstices of which air is diffused strikes against the solid inner member when the outer member is rapidly deflated, to thereby dislodge all the solid foreign matter from the surface of the outer member. If any solid foreign matter is left on the surface of member 12 after its collapse, the sudden inflation that follows the closing of the valve serves to break away the rest of the solid foreign matter or at least to loosen it sufficiently so that it is blown out by the pressure of the air when the outer member 12 is inflated.

The embodiment of FIG. 4 is substantially the same as that previously described, the only difference being that the cross sectional shape of inner member 22 is designed to save material in making the inner member without losing the advantage of the slapping contact between the inner surface of outer member 23 and a solid surface of the inner member when the tube is deflated. The inner member 22 has its intermediate portion provided with a reduced cross section of approximately Y-shape. An air chamber 24 is similar to air chamber 16 except that the bottom surface of each section comprises two substantially flat surfaces inclined at an obtuse angle to each other. The total surface area of the bottom of each section is slightly smaller than the surface area of the portion of the outer member coextensive with said section. Substantially the entire outer member strikes against the inner member as in the embodiment of FIG. 1. At least one of the ends of the inner member 22 corresponding to end member 13 of the embodiment shown in FIG. 1 is of cylindrical configuration so that a nipple can be threaded therein as described in connection with the embodiment of FIG. 1.

Although I have described two preferred embodiments of the invention in considerable detail, it will be understood that the description thereof is intended to be illustrative, rather than restrictive, as many details of the structure may be modified or changed without departing from the spirit or scope of the invention. Accordingly, I do not desire to be restricted to the exact construction described.

I claim:

1. A diffuser tube comprising a rigid inner member and a flexible, collapsible, porous, outer tubular member, said inner member having ends of approximately the same perimeter, means securing one end of said outer member to said inner member adjacent one end thereof, means providing a closure for the other end of said outer member, said outer member completely enclosing the portion of said inner member between said ends, and an inlet for an aeriform body extending through one end of said inner member whereby said outer member may be inflated, the cross sectional area of the portion of said inner member between said ends being reduced along substantially its entire length, relative to the cross sectional area at its ends, to form an air chamber between said inner and outer members, said air chamber communicating with said inlet, said outer member having a substantially uniform cross section throughout its length when inflated, whereby a portion of said inflated outer member is spaced from the surface of the inner member along substantially its entire length, the cross sectional area of said outer member when inflated being sub-

stantially equal to the cross sectional area of the end of said inner member adjacent said inlet, the entire portion of the outer member spaced from the surface of said inner member being unrestrained as to movement toward said inner member, the outer surface of the inner member throughout the area of reduced cross section being located within the range of movement of said outer member, the portion of said outer member spaced from the surface of said inner member having a surface area slightly larger than the surface area of the portion of the inner member coextensive therewith, the difference between the surface areas of coextensive portions of said outer and inner members being such that the entire portion of the outer member coextensive with the surface area of the bottom of the air chamber will strike against the surface of said inner member in a condition wherein no portion of the material of the outer member is folded over upon itself when the outer member is deflated rapidly, to dislodge solid foreign matter accumulated on its outer surface.

2. A diffuser tube comprising a rigid inner member and a flexible, collapsible porous outer tubular member substantially coextensive in length, said inner member having ends of approximately the same perimeter, said outer member completely enclosing the portion of said inner member between said ends, means securing said outer member to said inner member adjacent one end thereof, means providing a closure for the other end of said outer member, and an inlet for an aeriform body extending through one end of said inner member whereby said outer member may be inflated, the cross sectional area of the intermediate portion of said inner member being reduced along three circumferentially spaced longitudinally extending lines, the portions of reduced cross sectional area being shaped to provide a plurality of concave surfaces, said outer member having a substantially uniform cross section throughout its length when inflated, the cross sectional area of said outer member when inflated being substantially equal to the cross sectional area of the end of said inner member adjacent said inlet, whereby portions of said inflated outer member are spaced from the concave surfaces of said inner member, said portions of the outer member being unrestrained as to movement toward the intermediate portion of said inner member, each of said concave surfaces being located within the range of movement of one of said portions of said outer member, each of said portions of said outer member having a surface area slightly larger than the surface area of the portion of the inner member coextensive therewith, the difference between the surface area of coextensive portions of said outer and inner members being such that the entire portion of the outer member coextensive with the surface area of any of said concave surfaces will strike against said concave surface of said inner member in a condition wherein no portion of the material of the outer member is folded over upon itself when said outer member is deflated rapidly, to dislodge solid foreign matter accumulated on the outer surface of said portion of the outer member.

3. A diffuser tube comprising a solid inner member and a flexible, collapsible, porous outer tubular member substantially coextensive in length, said inner member having ends of approximately the same perimeter, said tubular member completely enclosing the portion of said inner member between said ends, one end of said inner member projecting beyond one end of the outer member, a clamp encircling said outer member adjacent said end and holding said end tightly against said inner member, means providing a closure for the other end of said outer member, and an inlet for an aeriform body extending longitudinally through said projecting end of the inner member whereby said outer member may be inflated, said inner member being reduced in cross sectional area along the portion of its length between said ends, the portion of said inner member of reduced cross sectional area

having a plurality of longitudinally extending concave surfaces, said outer member having a substantially uniform cross section throughout its length when inflated, whereby portions of said inflated outer member are spaced from the concave surfaces of said inner member, the cross sectional area of said outer member when inflated being substantially equal to the cross sectional area of the end of said inner member adjacent said inlet, substantially all of said portions of said outer member being unrestrained as to movement toward the concave surfaces of said inner member, each of said concave surfaces being located within the range of movement of the coextensive portion of said outer member, each of said portions of said outer member having a surface area slightly larger than the surface area of the concave portion of the inner member coextensive therewith, the difference between the surface areas of coextensive portions of said inner and outer members being such that the entire portion of the outer member spaced from the inner member strikes against the concave surface of the inner member in a condition wherein no portion of the material of the outer member is folded over upon itself when said outer member is deflated rapidly to dislodge solid foreign matter accumulated on the outer surface of said outer member.

4. A diffuser tube comprising a rigid inner member having cylindrical end portions and a reduced intermediate portion having a cross section in approximately the form of a Y, a flexible, collapsible, porous outer tubular member completely enclosing the intermediate portion of said inner member between said end portions, clamping means securing said outer member to each of said cylindrical end portions, and an inlet for an aeriform body extending through one of said cylindrical end portions whereby said outer member may be inflated, said outer

member, when inflated, having a cross section substantially equal to the cross section of said cylindrical end portions throughout its length, whereby a portion of said inflated outer member is spaced from the concave surface of the inner member defining the inside portion of the Y, said spaced portion of the outer member being unrestrained as to movement toward said inner member, said concave surface being located within the range of movement of said outer member, the portion of said outer member spaced from the concave surface of the inner member having a surface area slightly larger than the surface area of the concave portion of the inner member coextensive therewith, the difference between the surface areas of coextensive portions being such that the entire portion of the outer member coextensive with said concave surface will strike against said concave surface in a condition wherein no portion of the material of the outer member is folded over upon itself when the outer member is deflated rapidly, to dislodge solid matter accumulated on its outer surface.

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