United States Patent [19]

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[54] IN-LINE FLUID MIXER

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[52] **U.S. Cl.** **259/4**, 138/44

[51] **Int. Cl.** **B01f 5/00**

[58] **Field of Search** ..... 259/4, DIG. 30; 138/40, 42, 43, 44, 45; 251/126; 181/66, 67

[56] **References Cited**

UNITED STATES PATENTS

3,664,638	5/1972	Grout et al.	259/4
2,216,846	10/1940	Lewis	138/40 X
3,297,305	1/1967	Walden	259/4
2,426,833	9/1947	Lloyd	138/40
3,286,992	11/1966	Armeniades et al.	138/42 X
2,886,297	5/1959	Crandall	259/4

FOREIGN PATENTS OR APPLICATIONS

735,033	8/1932	France	259/4

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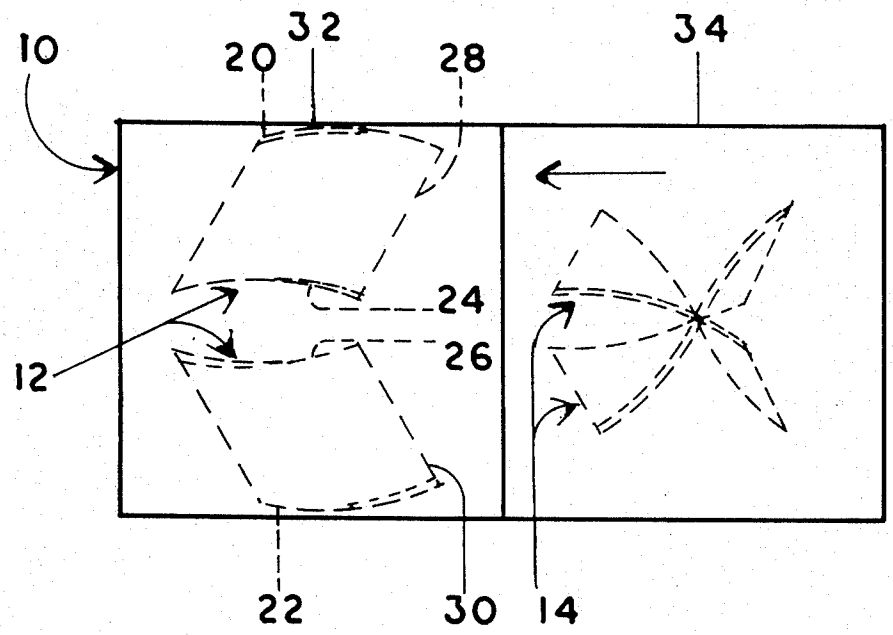
[57] **ABSTRACT**

An in-line spiral mixer characterized by successive left and right hand spaced spiral vanes disposed within a cylindrical tube. Each of the vanes comprises at least two separate parts with a central opening therebetween. The leading edge of each part is tapered from the outer to inner ends in the direction of fluid flow to minimize accumulation of material on the edge and cause self cleaning.

8 Claims, 2 Drawing Figures



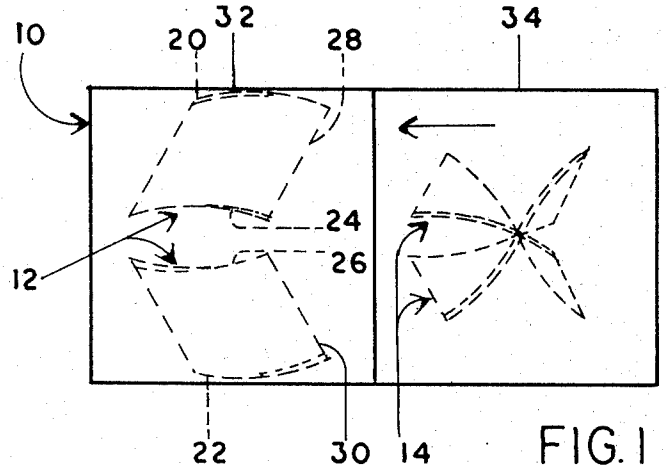


FIG. 1

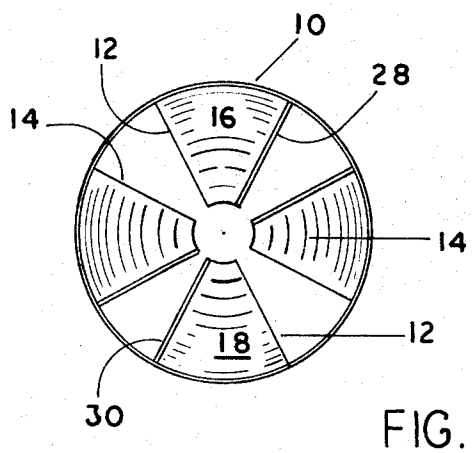


FIG. 2

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IN-LINE FLUID MIXER

BACKGROUND OF THE INVENTION

This invention relates to in-line spiral mixing devices and more particularly to improvements in the type of device employing successive or alternating right- and left-handed curvature spirals, such as that described in the Armeniades et al. U.S. Pat. No. 3,286,992.

The Armeniades et al. patent, incorporated herein by reference, illustrates a tubular in-line mixer having successive contiguous spirals of alternating curvature. Other mixers of this type are shown in the U.S. Pat. to Walden, No. 3,297,305, Crandall, No. 2,886,297, Sampel, No. 2,075,867 and Manka, No. 2,831,754. Spiral mixers of this type have heretofore been difficult to manufacture at a low cost. Also, a large number of vanes within a tube segment are required to assure adequate and thorough mixing. Another diffuculty is that the fluid stream tends to become isolated or compartmentalized within successive portions of the tube whereby mixing between adjacent portions of the stream is limited. If fibrous slurries are introduced into such mixers, an accumulation of fibers may occur on the leading edges of the mixing vanes, thereby decreasing the efficiency of the mixing process and more likely completely blocking the mixer and stopping fluid flow.

SUMMARY OF THE INVENTION

In mixing devices comprising successive oppositely curved vanes, I have discovered that a considerable improvement in both construction cost and mixing efficiency is realized by providing a space between adjacent oppositely curved vanes and by dividing each of the vanes into at least two separate parts secured to the interior wall of the flow chamber and having a central opening therebetween such that a central open core extends for the length of the mixing chamber. The central core promotes back mixing or mixing between spaced portions of the stream. The mixer of the present invention exhibits greatly improved mixing efficiency, thereby requiring fewer vanes for the same degree of mixing. An additional feature is the longitudinal tapering of the leading edges of each vane component, which minimizes the tendency of fibrous or similar materials to accumulate or hang up on such edges and renders the mixer self cleaning.

THE DRAWING

FIG. **1** is an elevational view of the novel mixing device; and

FIG. **2** is an inlet end view of the mixing device shown in FIG. **1**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIGS. **1** and **2**, the mixer comprises a flow chamber or tube **10** through which fluid may pass in the direction indicated by the arrow. The fluid materials will ordinarily be in liquid form but may also be in gas form; if in liquid form, the material may comprise multiple components or mixtures, one or more of which is a solid or a gas. For example, the material to be mixed may be an aqueous fiberous slurry employed in the manufacture of paper, or may comprise a mixture of reactive materials, such as a two component resin system. The flow chamber **10** is preferably in the shape of a straight cylinder having inlet and outlet ends, although irregular or curved chambers may be employed.

A plurality of spiral vanes, such as **12** and **14** are arranged in series in a longitudinally spaced relationship within the pipe and are secured to the inner wall of the tube **10.** Each of the vanes **12** and **14** comprise two or more separate and opposed spirally curved sheet members, such as **16** and **18,** each of which is secured along one edge, such as along the respective edges **20** and **22,** to the inner wall of the tube **10.** The respective opposite edges, such as **24** and **26,** extend inward toward one another but terminate radially from the central axis of the tube to define an open central core through the tube. Thus, each vane **12** and **14** comprises a pair or more of opposed curved sheets of approximately the same surface area, with each of the sheets being curved in the same rotational direction. The net effect of the cooperating sheets is a spiral vane having an open central core therein. The core provides additional fluid communication between the ends of the tube over that found in conventional spiral mixers, and enables efficient back flow mixing of contents passing through the tube.

From FIG. **1,** it will also be noted that longitudinally adjacent vanes are curved in opposite spiral direction. Thus, the vane **12** is arranged in a left-hand spiral configuration and the vane **14** is curved in a right-hand spiral configuration. As mentioned, each of the vanes resemble a portion of a flight of screw conveyor. In addition, the leading edge of each of the sheet members, such as the edges **28** and **30** are inclined from the outer to the inner end thereof in the direction of fluid flow to minimize adherence or hang-up of solid materials, especially fibers, on said edges. From FIG. **2,** it will be noted that the leading edge of the downstream vane **12** is longitudinally substantially perpendicular to the trailing edge of the adjacent upstream vane **14.**

Construction of the mixer is facilitated because the tube **10** comprises a plurality of abutting segments, such as **32** and **34,** each of which contains a single respective vane **12** and **14.** Thus, the vanes may be first separately secured or welded in the respective tube segments, and the segments may be then secured together, as by butt welding. Construction of each segment is further simplified because of the configuration of each vane. Since each vane is composed of two separate sheets, the entire vane may be constructed by simply bending each sheet in a particular manner, which would not be possible if the vane were composed of a single sheet. If desired, more than two, such as three or more, sheets may be employ-d in the manufacture of each vane, as long as the sheets remain separate and capable of being independently formed.

Although sufficient mixing for many applications may be achieved by utilizing two tube sections, it will be understood that the tube may comprise any number of a plurality of sections, with longitudinally adjacent vanes being curved in opposite spiral directions. As an example of this invention, efficient mixing has been achieved by employing tube sections having a length equal to the outer diameter of the tube. The vane sheets may be half the length of the section and are disposed longitudinally centrally within the tube along a pitch of about 45° relative to the tube axis.

Although a preferred embodiment of the invention has been described, it will be obvious to those skilled in the art that many modifications and changes in de-

sign of the presently described embodiment may be made without departing from the scope and the spirit of the appended claims.

I claim:

1. An in-line mixer comprising a longitudinal flow chamber, a plurality of vanes secured within said chamber in longitudinal series, said vanes being spaced from one another with adjacent vanes being curved in opposite spiral directions, each of said vanes comprising a plurality of curved sheet members terminating radially from the center of the chamber with their inner edges spaced from one another to define a longitudinal core within said chamber.

2. The mixer of claim **1** wherein the leading edge of each of said sheet members is inclined from the outer to inner end thereof in the direction of fluid flow to prevent accumulation of solid material thereon.

3. The mixer of claim **1** wherein the flow chamber comprises a tube comprising a plurality of abutting tube sections, each of said tube sections having a single vane disposed therein.

4. An in-line fluid mixer for mixing fibers dispersed in a liquid, comprising a longitudinal flow chamber, a plurality of spiral vanes secured within said chamber in longitudinal series, said vanes being spaced from one another and adjacent vanes being curved in opposite spiral directions, each of said vanes comprising a plurality of curved sheets each having a leading edge with respect to fluid flow, each of said edges being inclined from its outer to inner end thereof in the direction of fluid flow to minimize fiber hang-up thereon.

5. An in-line fluid mixer comprising a tube made up of a plurality of abutting sections, and a spiral mixing vane in each of said sections, adjacent mixing vanes being spirally curved in opposite directions and being spaced from one another, each of said vanes comprising a plurality of sheet-like members, each of said members being secured along one edge to the inner surface of the tube and terminating radially from the center of its respective tube section to define an open central core through said tube.

6. The mixer of claim **5** wherein the sheet-like members have leading edges with respect to fluid flow and wherein said edges are inclined in the direction of fluid flow from the outer to the inner ends thereof.

7. An in-line mixer for fluids conveyed through pipes, especially fluids containing fibrous matter, comprising a section of pipe and a plurality of curved sheet-like vanes secured in series longitudinally to the inner wall of the pipe, the vanes terminating radially from the center of the pipe to define an open central core through the pipe, each of said vanes having a leading edge inclined from the outer to the inner ends thereof to accommodate self-cleaning into said central core of fibrous matter temporarily hung-up on the leading edges of the vanes.

8. The mixer of claim **7** wherein alternating vanes are of opposite hand and are spaced from one another.

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