



US007975991B2

(12) **United States Patent**  
**Kojima**

(10) **Patent No.:** **US 7,975,991 B2**  
(45) **Date of Patent:** **Jul. 12, 2011**

(54) **GAS-LIQUID CONTACT SYSTEM**

6,431,528 B1 \* 8/2002 Kojima ..... 261/79.2  
7,056,367 B2 \* 6/2006 Trivett ..... 95/226  
7,510,172 B2 \* 3/2009 Kojima ..... 261/79.2

(75) Inventor: **Hisao Kojima, Yokohama (JP)**

(73) Assignee: **Anemos Company Ltd., Toyko (JP)**

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 844 days.

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JP 2000-202234 7/2000  
JP 2001-62269 3/2001  
JP 2004-181437 7/2004  
JP 2005-219036 8/2005  
JP 1304540 6/2007

(21) Appl. No.: **12/013,199**

(22) Filed: **Jan. 11, 2008**

(65) **Prior Publication Data**

US 2008/0169576 A1 Jul. 17, 2008

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Japanese Office Action for corresponding JP Application No. 2007-005883, Jan. 25, 2011.

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(30) **Foreign Application Priority Data**

Jan. 15, 2007 (JP) ..... 2007-005883

*Primary Examiner* — Frank M Lawrence

(74) *Attorney, Agent, or Firm* — Dittavong Mori & Steiner, P.C.

(51) **Int. Cl.**

**B01D 47/00** (2006.01)  
**B01F 3/04** (2006.01)

(57) **ABSTRACT**

(52) **U.S. Cl.** ..... **261/79.2; 261/113; 261/116; 261/117; 261/96; 96/296; 366/339**

(58) **Field of Classification Search** ..... 261/79.2, 261/94, 96, 113, 115-117; 96/234, 274, 96/277, 290, 296, 326; 95/149; 55/443, 55/456; 366/338-340

See application file for complete search history.

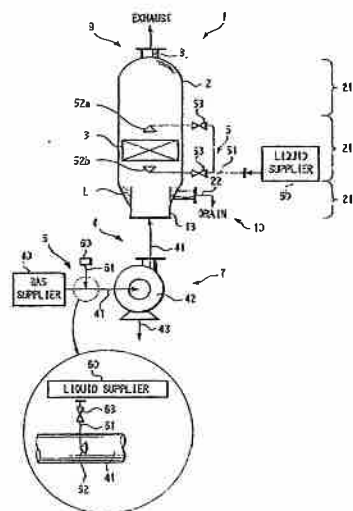
Disclosed is a gas-liquid contact system. The system includes a vessel arranged approximately perpendicular to the ground in a longitudinal direction, a static fluid mixer in the vessel having a passage tube and a spiral blade provided in the passage tube, a gas supplier supplying gas having foreign substances to the static fluid mixer from a lower end of the vessel, a gas discharger discharging the gas passed through the static fluid mixer from an upper end of the vessel, a first liquid supplier supplying liquid to the static fluid mixer, and a liquid discharger discharging the liquid supplied from the first liquid supplier outside of the vessel. In the system, the gas supplier includes a gas generator generating gas, a pipe connecting the gas generator with the vessel, a blowing device provided in the pipe, and a second liquid supplier supplying liquid to the pipe between the gas generator and the blowing device.

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**14 Claims, 8 Drawing Sheets**





US00D608411S

(12) **United States Design Patent**  
**Kojima**

(10) Patent No.: **US D608,411 S**  
(45) Date of Patent: **\*\* Jan. 19, 2010**

(54) **STIRRER**  
(75) Inventor: **Hisao Kojima, Yokohama (JP)**  
(73) Assignee: **Anemos Company Ltd., Tokyo (JP)**  
(\*\*) Term: **14 Years**  
(21) Appl. No.: **29/300,137**  
(22) Filed: **Feb. 25, 2008**

7,137,731 B2 \* 11/2006 Carlson ..... 366/337

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JP 2001-62269 A 3/2001  
JP 2003-181256 A 7/2003  
JP 2005-219036 A 8/2005  
WO WO-00/24502 A1 5/2000

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*Primary Examiner*—Robin V Webster

(74) *Attorney, Agent, or Firm*—Dithavong Mori & Steiner, P.C.

(30) **Foreign Application Priority Data**  
Aug. 31, 2007 (JP) ..... D2007-026831

(51) **LOC (9) Cl.** ..... **23-01**  
(52) **U.S. Cl.** ..... **D23/200**  
(58) **Field of Classification Search** ..... **D23/200, D23/207, 266, 263; 138/37, 39, 42; 366/336-340**  
See application file for complete search history.

(57) **CLAIM**

The ornamental design for a stirrer, as shown and described.

(56) **References Cited**

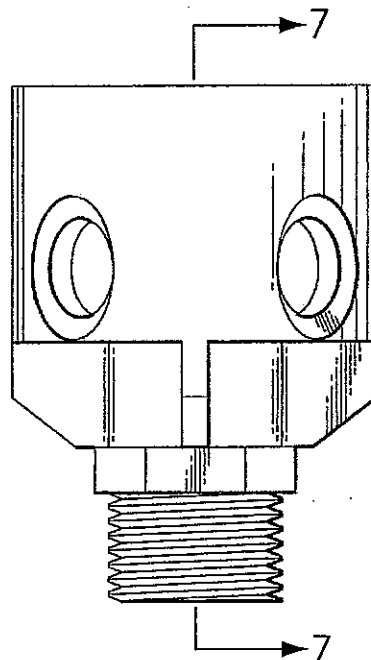
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D436,647 S \* 1/2001 Etschel et al. .... D23/200

**DESCRIPTION**

FIG. 1 is a front elevational view of a stirrer showing my new design;  
FIG. 2 is a rear elevational view thereof;  
FIG. 3 is a right side elevational view thereof;  
FIG. 4 is a left side elevational view thereof;  
FIG. 5 is a top plan view thereof;  
FIG. 6 is a bottom plan view thereof; and,  
FIG. 7 is a perspective cross sectional view taken along line 7-7 of FIG. 1.

**1 Claim, 6 Drawing Sheets**





US00D607535S

(12) **United States Design Patent**  
**Kojima**

(10) **Patent No.:** **US D607,535 S**  
(45) **Date of Patent:** **\*\* Jan. 5, 2010**

- (54) **MOTIONLESS FLUID MIXER**
- (75) **Inventor:** Hisao Kojima, Yokohama (JP)
- (73) **Assignee:** Anemos Company Ltd., Tokyo (JP)
- (\*\*) **Term:** 14 Years
- (21) **Appl. No.:** 29/300,136
- (22) **Filed:** Feb. 25, 2008
- (30) **Foreign Application Priority Data**  
Aug. 31, 2007 (JP) ..... D2007-026833
- (51) **LOC (9) Cl.** ..... 23-01
- (52) **U.S. Cl.** ..... D23/200
- (58) **Field of Classification Search** ..... D23/200,  
D23/207, 266, 263; 138/37, 39, 42; 366/336-340  
See application file for complete search history.

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*Primary Examiner*—Robin V Webster  
(74) *Attorney, Agent, or Firm*—Ditthavong Mori & Steiner, P.C.

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5,758,967 A *	6/1998	King	366/337
6,109,781 A *	8/2000	Ogasawara et al.	366/336
D436,647 S *	1/2001	Etschel et al.	D23/200
7,137,731 B2 *	11/2006	Carlson	366/337

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JP 10-85721 A 4/1998

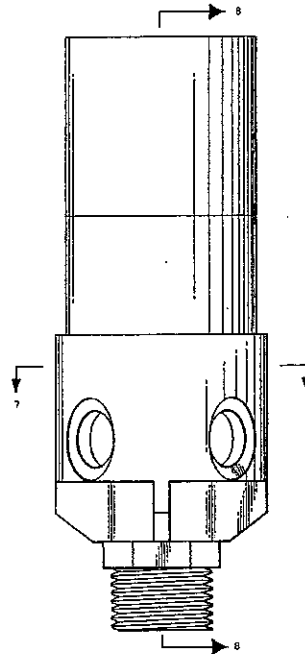
(57) **CLAIM**

The ornamental design for a motionless fluid mixer, as shown and described.

**DESCRIPTION**

- FIG. 1 is a front elevational view of a motionless fluid mixer showing my new design;
- FIG. 2 is a rear elevational view thereof;
- FIG. 3 is a right side elevational view thereof;
- FIG. 4 is a left side elevational view thereof;
- FIG. 5 is a top plan view thereof thereof;
- FIG. 6 is a bottom plan view thereof;
- FIG. 7 is a cross sectional view thereof, taken along a line 7—7 of FIG. 1; and,
- FIG. 8 is a perspective cross sectional view taken along line 8—8 of FIG. 1.

**1 Claim, 7 Drawing Sheets**





US007510172B2

(12) **United States Patent**  
**Kojima**

(10) **Patent No.:** **US 7,510,172 B2**  
(45) **Date of Patent:** **Mar. 31, 2009**

(54) **MIXING ELEMENT AND STATIC FLUID MIXER USING SAME**

5,104,233 A 4/1992 Kojima  
5,605,400 A 2/1997 Kojima  
5,945,039 A 8/1999 Kojima

(75) Inventor: **Hisao Kojima**, Kanagawa (JP)

(73) Assignee: **Anemos Company Ltd.**, Tokyo (JP)

(Continued)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 568 days.

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(21) Appl. No.: **11/276,340**

(Continued)

(22) Filed: **Feb. 24, 2006**

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(65) **Prior Publication Data**  
US 2007/0205523 A1 Sep. 6, 2007

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(Continued)

**Related U.S. Application Data**

*Primary Examiner*—Scott Bushey

(63) Continuation-in-part of application No. PCT/JP2004/001631, filed on Feb. 16, 2004.

(74) *Attorney, Agent, or Firm*—Sonnenschein Nath & Rosenthal LLP

(51) **Int. Cl.**  
**B01F 3/04** (2006.01)

(57) **ABSTRACT**

(52) **U.S. Cl.** ..... **261/79.2**; 261/113; 96/296; 96/326; 366/339; 366/340

A mixing element, which is produced at low cost, has high mixture agitation effectiveness, and is easily made large, and a static fluid mixer using the mixing element are provided. Further, a gas-liquid treatment apparatus with high treatment ability is provided. A mixing element **1** includes: a cylindrical passage tube **2** through which fluid flows; a plurality of spiral rightward rotation type first blades **3** formed of a perforated object, which are provided in the passage tube **2**; a first inner cylindrical tube **5** shaped like a cylinder and disposed inside the blades **3**; a plurality of spiral rightward rotation type blades **6** provided in the inner cylindrical tube **5**; and an opening **9** formed in the axial center portion of the blades **6**. A static fluid mixer is formed by using at least one mixing element **1** mentioned above.

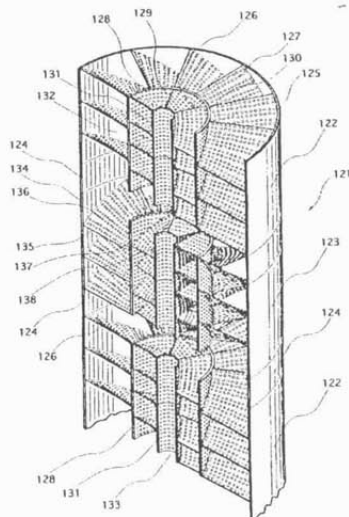
(58) **Field of Classification Search** ..... 261/79.1, 261/79.2, 94, 113; 96/296, 314, 320, 324, 96/326; 366/338, 339, 340, 341  
See application file for complete search history.

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**24 Claims, 27 Drawing Sheets**





US007264231B2

(12) **United States Patent**  
**Kojima**

(10) **Patent No.:** **US 7,264,231 B2**  
(45) **Date of Patent:** **Sep. 4, 2007**

- (54) **DIFFUSED GAS AERATION APPARATUS**
- (75) **Inventor:** Hisao Kojima, Kanagawa (JP)
- (73) **Assignee:** Anemos Company Ltd., Tokyo (JP)
- (\* ) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 62 days.
- (21) **Appl. No.:** 11/075,138
- (22) **Filed:** Mar. 8, 2005

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JP	10-085721	4/1998
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JP	2001-269692	10/2001
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(65) **Prior Publication Data**  
US 2005/0263914 A1 Dec. 1, 2005

**Related U.S. Application Data**  
(63) Continuation-in-part of application No. PCT/JP03/13844, filed on Oct. 29, 2003.

(51) **Int. Cl.**  
**B01F 3/04** (2006.01)

(52) **U.S. Cl.** ..... **261/79.2; 261/121.1; 261/123**

(58) **Field of Classification Search** ..... **261/79.2, 261/121.1, 123, 126, DIG. 70**  
See application file for complete search history.

- (56) **References Cited**
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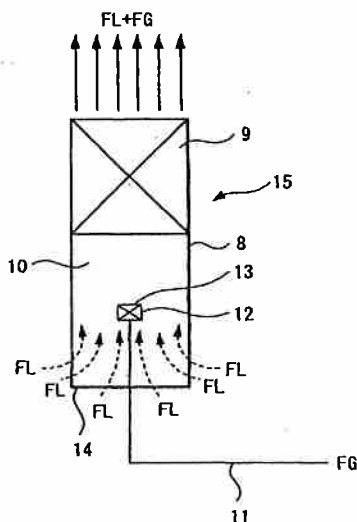
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*Primary Examiner*—Scott Bushey  
(74) *Attorney, Agent, or Firm*—Sonnenschein Nath & Rosenthal LLP

(57) **ABSTRACT**

An aeration apparatus including a cylindrical passage tube, a static mixer positioned in the passage tube adjacent an upper end of the tube and including a plurality of perforated blades and an opening between the blades along a central axis of the tube, a pneumatic line extending to the passage tube and connectable to a gas source, a gas blowoff portion positioned adjacent a lower end of the passage tube and connected to the pneumatic line for supplying gas from the gas source to the passage tube, and a liquid-introducing portion adjacent the lower end of the passage tube.

**18 Claims, 19 Drawing Sheets**





US006431528B1

(12) **United States Patent**  
**Kojima**

(10) **Patent No.:** **US 6,431,528 B1**  
(45) **Date of Patent:** **Aug. 13, 2002**

(54) **APPARATUS FOR REMOVING IMPURITIES  
IN LIQUID**

5,945,039 A 8/1999 Kojima

(76) **Inventor:** **Hisao Kojima**, 3-53-21, Shioiri-cho,  
Tsurumi-ku, Yokohama-shi,  
Kanagawa-ken (JP)

(\* ) **Notice:** Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 0 days.

(21) **Appl. No.:** **09/680,269**

(22) **Filed:** **Oct. 6, 2000**

(30) **Foreign Application Priority Data**

Oct. 7, 1999 (JP) ..... 11-287101

(51) **Int. Cl.<sup>7</sup>** ..... **B01F 3/04**

(52) **U.S. Cl.** ..... **261/79.2; 261/113; 96/296;**  
**96/326; 366/339; 366/340**

(58) **Field of Search** ..... **261/79.2, 94, 113;**  
**96/296, 314, 320, 324, 326; 366/338, 339,**  
**340, 341**

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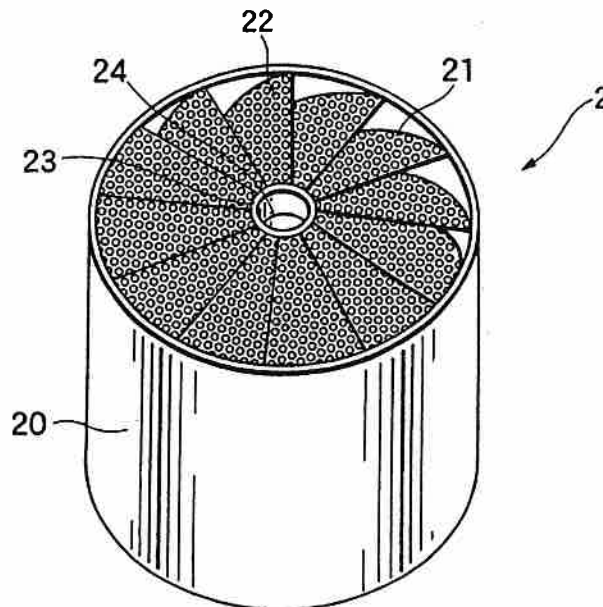
*Primary Examiner*—C. Scott Bushey

(74) *Attorney, Agent, or Firm*—Oblon, Spivak, McClelland,  
Maier & Neustadt, P.C.

(57) **ABSTRACT**

Static mixers are arranged so that its longitudinal direction  
is substantially vertical. A liquid supply mechanism supplies  
the liquid containing impurities from the upper end of the  
static mixer into the static mixer. A gas supply mechanism  
supplies gas from the lower end of the static mixer into the  
static mixer. The static mixer is fabricated so that one or  
more mixing elements comprising a passage tube through  
which fluid can pass and one or more spiral blades arranged  
inside the passage tube are, continuously or through one or  
more spacers, arranged in the longitudinal direction thereof.  
The liquid drops down inside the static mixer and the gas  
rises up inside the static mixer, so that the two are subjected  
to gas-liquid contact inside the static mixer.

**7 Claims, 7 Drawing Sheets**





US005605400A

# United States Patent [19]

[11] **Patent Number:** 5,605,400

**Kojima**

[45] **Date of Patent:** Feb. 25, 1997

[54] **MIXING ELEMENT AND METHOD OF PRODUCING THE SAME**

4,747,697	5/1988	Kojima .	
4,878,925	11/1989	Kojima .	
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5,104,233	4/1992	Kojima .	

[76] **Inventor:** Hisao Kojima, 3-53-21, Shioiri-cho, Tsurumi-ku, Yokohama-shi, Kanagawa-ken, Japan

*Primary Examiner*—Robert W. Jenkins  
*Attorney, Agent, or Firm*—Oblon, Spivak, McClelland, Maier & Neustadt, P.C.

[21] **Appl. No.:** 425,036

[22] **Filed:** Apr. 18, 1995

[30] **Foreign Application Priority Data**

Apr. 19, 1994 [JP] Japan ..... 6-115817

[51] **Int. Cl.<sup>6</sup>** ..... B01F 5/06

[52] **U.S. CL.** ..... 366/339; 366/341

[58] **Field of Search** ..... 366/336-340, 366/341

[56] **References Cited**

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[57] **ABSTRACT**

A mixing element comprises a cylindrical passage pipe through which a liquid flows, and a plurality of blade bodies disposed inside the passage pipe. The blade bodies forms inside the passage pipe a plurality of fluid passages extending spirally and in a longitudinal direction of the passage pipe. And, a gap between the blade bodies forms an opening for communicating the fluid passages to each other. These spiral blade bodies are produced independently to the passage pipe, after that, they are joined to an inner face of the passage pipe. Thus produced fluid mixer has an extremely high mixing-agitating effect.

**3 Claims, 17 Drawing Sheets**

