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(54) **An agitator blade**

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(73) Proprietor:
KANSAI CHEMICAL ENGINEERING CO. LTD
Amagasaki-shi Hyogo 660 (JP)

(72) Inventors:
• **Noda, Yasuo**
Amagasaki-shi, Hyogo 661 (JP)
• **Noda, Hideo**
Amagasaki-shi, Hyogo 661 (JP)
• **Inoue, Takaya**
Takatsuki-shi, Osaka 569 (JP)

(74) Representative:
Blumbach, Kramer & Partner GbR
Radeckestrasse 43
81245 München (DE)

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- **SOVIET INVENTIONS ILLUSTRATED Section Ch, Week 8730, Derwent Publications Ltd., London, GB; Class J02, AN 87-212402 & SU-A-1 278 010 (DNEPR CHEM)**
- **SOVIET INVENTIONS ILLUSTRATED Section Ch, Week 8404, 7 March 1984 Derwent Publications Ltd., London, GB; Class A18, AN 84-022646 & SU-A-1 005 870 (DZERZHINSK)**
- **SOVIET INVENTIONS ILLUSTRATED Section Ch, Week 8502, 20 February 1985 Derwent Publications Ltd., London, GB; Class J02, AN 85-011118 & SU-A-1 095 973 (BUGAI)**

Remarks:

The file contains technical information submitted after the application was filed and not included in this specification

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Description

[0001] The present invention relates to an agitator blade and more particularly to an agitator blade which is capable of mixing fluids efficiently and reliably.

[0002] Among widely used agitator blades are turbine blades, oar blades, marine blades and ribbon blades. When these conventional agitator blades are used for agitating and mixing within small equipment or tanks, a high degree of mixing close to 1 can be reached in a relatively short time without trouble with a single agitator blade.

[0003] When such agitator blades are used in large-scale tanks in plants, however, the use of only one agitator blade may result in an unexpected dead space being formed in the tanks, taking a protracted length of time to mix fluids at a sufficiently high degree of mixing. Even after many hours of mixing operation, it is often not possible to achieve a high degree of mixing that is easily realized for small-scale equipment and tanks.

[0004] One possible way to cope with such a situation is to increase the number of agitator blades. There is, however, a limit on the number of agitator blades that can be used in the tank. Even if the number of agitator blades is increased to as many as is allowable in the tank, the degree of mixing does not increase in proportion to an increase in the number of agitator blades. The additional agitator blades on the other hand require additional driving power, significantly increasing the operation cost.

[0005] After having conducted research on ways to eliminate aforementioned drawbacks experienced with the conventional agitator blades, the inventors of this invention have developed an agitator blade which is simple in construction and can achieve a high degree of mixing easily and reliably and with a minimum amount of driving power, and which comprises a plurality of local agitators for simultaneous agitation at multiple locations.

[0006] DE-U-85 28 381 discloses an agitator blade being mounted on a rotatable agitator shaft. The agitator blade comprises a mounting frame on which radially oriented hollow cylinders are mounted. The hollow cylinders have upwardly inclined inner edges. The outer axial ends of the cylinders lie in a plane which is oriented perpendicularly to the central axis of the cylinders.

[0007] "Perry's Chemical Engineers' Handbook", 6th Edition, pages 19-5, 19-6, discloses several types of radial-flow impellers having marine-type mixing propellers or being provided in the form of turbines with pitched, curved or flat plates.

[0008] SU-A-1 278 010 discloses an industrial mixer which comprises a vertical rotating shaft carrying a set of tubes each having a bent top.

[0009] GB-A-749 327 discloses an agitator plate being mounted on a rotating shaft. The agitator plate comprises a disk-like mounting frame on which tangentially

oriented hollow pipes are mounted.

[0010] SU-A-1 005 870 is directed to a mixer having a conical ring on a radial agitator arm. Differently oriented mixing plates are provided on the inner peripheral surface of the ring.

[0011] The present invention provides an agitator plate in accordance with claim 1.

[0012] Some specific details are defined in dependent claims 2 and 3.

[0013] The present invention concerns an agitator blade in which local agitators are mounted to a mounting frame secured to an agitator shaft, and which achieves a high degree of mixing. The local agitators themselves are not directly driven and require no driving power. The only member that is driven is the agitator shaft. There are no structural limitations except for the following requirement. That is, as the agitator shaft is driven, the mounting frame on which the local agitators are mounted is rotated about the agitator shaft to let fluid to be mixed pass through the local agitators, locally agitating the fluid in the tank. Such local agitators may be used as a flow mixer.

[0014] The flow mixer, as explained in "Kagaku Kogaku Binran (or Chemical Engineering Handbook)" compiled by Kagaku Kogaku Kyokai (Chemical Engineers Association) and published by Maruzen Kabushiki Kaisha in 1988, page 567, is a device that makes use of a kinetic energy of fluid flow in mixing the fluid and which is installed in a flow passage of the fluid being transported.

[0015] According to the representative aspects of this invention, examples of the local agitator include a cylinder incorporating one or more plates.

[0016] The plate may be twisted either in a positive or forward direction (i.e. clockwise as seen from the front end of the twisted plate) or in a reverse direction (i.e. counterclockwise as seen from the front end of the twisted plate). The twist angle of the plate (an angle between one end and the other end of the twisted plate) may be set anywhere in the range of 90 to 180 degrees. When a plurality of plates are employed, they are arranged in series end-to-end, with their axes substantially aligned along the axis of the cylinder (the cylinder axis passing through the opposite openings of the cylinder).

[0017] The plate may be formed by bending a square or rectangular plate at least once along a distinct bending line at or near the center, or by curving the plate at least once by bringing the opposite peripheral sides toward each other to cause the central portion of the plate between the opposing peripheral sides to form a vertex.

[0018] A plurality of bent plates, which may be disposed in an alternately inverted relationship with one another so that the facing bent peripheral sides of the adjacent bent plates cross each other, may be installed in a rectangular parallelepiped- or a cube-shaped cylinder that circumscribes them. The plurality of bent plates

are arranged side by side in the cylinder with their axes (virtually perpendicular to the bending lines or vertices) extending substantially parallel to the axis of the cylinder. As a result, the bending lines or vertices of the bent plates are placed in contact with the upper and lower internal surfaces, alternately, of the cylinder that circumscribes the bent plates.

[0019] The bent plates may have their facing peripheral sides in contact or spaced from each other.

[0020] The plates incorporated in the cylinder may include, for example, plates curved with a small curvature and corrugated plates with small pitches in addition to flat plates. Normally, the flat plates are virtually square or rectangular.

[0021] The plurality of flat plates may be so disposed that their facing peripheral sides cross each other. The flat plates may be installed inside a cylinder that inscribes them.

[0022] The flat plates may be placed in contact with each other at their facing peripheral sides or spaced from each other.

[0023] The inner surface of the cylinders of the local agitators and the surface of the plates, may be either smooth or rough, or may be formed with small depressions and projections in such patterns as waves, dots or small circles.

[0024] The cylinder of the local agitator may take an arbitrary shape as long as it ensures that fluids to be mixed can pass through the cylinder. For example, the transverse cross section of the cylinder (a cross section perpendicular to the axis of the cylinder that normally corresponds to the shape of the opening) may take a polygonal shape such as a triangle, quadrangle, pentagon and hexagon, or a circular shape such as a circle, oval and ellipse, depending on the shape, number and arrangement of the plates, installed in the cylinder. The transverse cross section of the cylinder is preferably a circle when accommodating twisted plates. In accommodating bent plates and flat plates, a square or rectangular transverse cross section is preferred. The cylinder of the local agitator may be formed either as a straight pipe or a curved pipe with a small curvature.

[0025] The mounting frame may be formed as a flat plate member, a curved plate member, a square rod member, a round rod member, a shape steel member, and a structure using these members.

[0026] The size and number of the local agitators to be mounted on the mounting frame are determined according to the kind and property of fluids to be mixed, the size and shape of the tank, and the target degree of mixing.

[0027] A single mounting frame may be mounted with a plurality of local agitators.

[0028] The plurality of local agitators mounted on one or more mounting frames may employ the same construction or differing constructions.

[0029] A plurality of local agitators may be mounted on a single plate-like mounting frame. The size of the

mounting frame itself is determined according to the number of local agitators to be mounted.

[0030] The local agitators are installed on the mounting frame in such a way as to allow the fluid to pass therethrough from one opening to the other during the operation.

[0031] The local agitators, which may accommodate a plurality of bent plates or flat plates in the cylinder, are mounted on the mounting frame in such a way that the boundary plane on which the facing peripheral sides of the adjacent bent plates or flat plates lie and cross each other can be oriented at any angle, from parallel to perpendicular, with respect to the rotating plane of the agitator blade.

[0032] The direction of the local agitator (i.e. the direction of axis passing through the opposing openings of the cylinder) on its rotating plane is set in the radial direction of a circle whose radius is the distance from the center of the rotating plane to the local agitator, according to the viscosity of the fluid to be mixed and the agitation speed, so as to obtain as high a degree of fluid mixing as possible. The angle between the axis of the local agitator and its rotating plane is also determined arbitrarily.

[0033] Rear side of a leading end of a local agitator against rotating direction is be cut off in order to have the leading end inclined. A plurality of local agitators may be arranged in parallel, which are slightly apart or connected.

[0034] The local agitator is preferably constructed such that its direction on a plane perpendicular to the rotating plane (vertical direction) can be changed freely. This may be realized, for example, by rotatably mounting the local agitator to the mounting frame with a screw or other means.

[0035] It is also possible to automatically control the direction of the local agitator according to the viscosity of the fluid to be mixed and the agitation speed to realize a high mixing degree, as by detecting the fluid resistance to which the local agitator or the mounting frame is subjected.

[0036] Although its excellent function can be utilized to its fullest extent when applied to the agitation of fluids in a large-scale tank, the agitator blade of this invention can also be used for agitation in small tanks.

[0037] Normally one or more agitator blades of this invention are installed in the tank. A plurality of agitator blades may be secured either to the same agitator shaft or separate shafts.

[0038] A gas supplied into the tank forms bubbles, which are broken into smaller bubbles increasing the contact surface area with the fluid.

[0039] The agitator blade of this invention is suitably applied for the mixing between different liquids, between liquid and solid, between liquid and gas, between different gases, between liquid, solid and gas.

Figures 1 and 2 are a side view and a vertical cross

section, respectively, of a local agitator which incorporates two twisted plates that are twisted in a positive or forward direction at a twist angle of 90 degrees;

Figures 3 and 4 are a side view and a vertical cross section, respectively, of a local agitator incorporating two twisted plates that are twisted in opposite directions at a twist angle of 180 degrees, the vertical cross section showing only the cylinder in vertical cross section with the two twisted plates shown in side view;

Figures 5 through 7 show one embodiment of the agitator blade, Figure 5 a horizontal cross section of the local agitator used in the agitator blade, Figure 6 a front view of the local agitator with a side wall of the cylinder body removed, and Figure 7 a perspective view of bent plates built into the local agitator; Figure 8 is a perspective view of the bent plates incorporated in the local agitator which are curved; Figures 9 and 10 illustrate a local agitator incorporating three bent plates that are each bent five times, Figure 9 representing a horizontal cross section of the local agitator and Figure 10 representing a front view of the local agitator with a side wall of the square cylinder removed;

Figures 11 through 13 show an agitator blade equipped with a local agitator incorporating two flat plates, Figure 11 a vertical cross section of the local agitator, Figure 12 a plan view of the local agitator with the upper surface of the square cylinder removed, and Figure 13 a partly cutaway perspective view of the agitator blade having a vertically rotatable local agitator; and

Figures 14 and 15 show a plan view and a slant view, respectively, of a plurality of local agitators and outer leading ends are cut in order to have leading end inclined.

[0040] The present invention will be described in detail in conjunction with embodiments shown in the accompanying drawings. It is noted, however, that the invention is not limited to these embodiments alone.

[0041] A local agitator 3 shown in Figure 1 and Figure 2 has two twisted plates 32, 33 installed inside a cylinder body 31 with their peripheries in contact with the inner circumferential surface of the cylinder body 31.

[0042] The twisted plate 32 is made by twisting a rectangular plate--whose shorter peripheral side and longer peripheral side are substantially equal to the inner diameter and one-half the length, respectively, of the cylinder body 31--in a positive or forward direction so that the short peripheral side 321 at one end and the short peripheral side 322 at the other end are nearly at right angles. The twisted plate 33 is also formed in the similar way. These twisted plates 32, 33 are installed inside the cylinder body 31 with the facing short peripheral sides 322, 331 set approximately 90 degrees from each other, with the axes of the two twisted plates virtu-

ally aligned, and with the two twisted plates arranged in series, end-to-end, in the direction of axis of the local agitator's cylinder body 31 and inscribed in the inner circumferential surface of the cylinder body 31. These twisted plates 32, 33 form a complex flow path in the cylinder body 31 of the local agitator 3.

[0043] As the agitator shaft is rotated to drive the local agitators, the fluids to be mixed are drawn from one opening of the cylinder body 31 (for example, left-side opening in Figure 2) into the cylinder body 31, in which they are forced to pass through a complex flow path before being discharged from the other opening.

[0044] A local agitator 6 shown in Figure 3 and Figure 4 has twisted plates 62, 63 inscribed in the cylinder body 61. These twisted plates are arranged in series along the axis of the cylinder body 61 and in contact, end-to-end, with each other, with the facing short peripheral sides 622, 631 set at approximately 90 degrees from each other. The two twisted plates 62, 63 are essentially similar to those used in the local agitator 3 of Figure 1 except that they are twisted in opposite directions at the twist angle of 180 degrees.

[0045] An agitator blade 7 shown in Figures 5 through 7 has four local agitators 72 mounted one on each of four support rods 71, which are spaced 90 degrees apart and secured to the agitator shaft 12.

[0046] The local agitator 72 has two bent plates 722, 723 installed in a rectangular cylinder 721 whose opening is rectangular. The bent plates 722, 723 are formed by bending rectangular flat plates along bending lines 7221, 7231. These two bent plates 722, 723 have their facing peripheral sides 7222, 7232 in contact with each other and are disposed in an inverted relationship with each other. They are installed in the rectangular cylinder 721 so that the cylinder 721 circumscribes them. The two bent plates 722, 723 are placed side by side with their axes virtually parallel to the axis of the rectangular cylinder 721.

[0047] As a result, when these bent plates are installed inside the rectangular cylinder, the bending line 7221 of one bending plate 722 and the bending line 7231 of the other bending plate 723 come into contact with the inner surfaces of the bottom wall and the top wall of the rectangular cylinder 721.

[0048] These bent plates 722, 723 form a complex flow passage inside the rectangular cylinder 721 of the local agitator.

[0049] The local agitator 72 is mounted on the support rod 71 in such a manner that a boundary plane 724 containing the facing peripheral sides 7222, 7232 of the adjacent two bent plates 722, 723 installed inside the local agitator is perpendicular to the rotating plane of the agitator blade 7, to which the local agitator 72 is mounted.

[0050] A bolt secured vertically to the top outer surface of the rectangular cylinder 721 is passed through a hole in the support rod 71 (bolt and hole are not shown) and fastened with a butterfly nut so that the local agita-

tor 72 is rotatable with respect to the support rod 71.

[0051] As shown in Figures 5 through 7, the local agitator 72 are radially arranged to face the agitator shaft 12.

[0052] As the local agitators 72 are driven by rotating the agitator shaft 12, the fluids to be mixed are forced into the rectangular cylinder 721 from one opening, flow through a complicated passage formed in the cylinder 721 and then are forced out from the other opening of the cylinder 721.

[0053] A bent plate 81 shown in Figure 8 is curved to cause the opposite short peripheral sides 811, 812 of a rectangular plate to come near each other with the central portion raised as a vertex 813. Another bent plate 82 is also curved in the similar manner. These two bent plates 81 and 82 are disposed side by side in an inverted relationship so that their vertices 813 and 823 project in opposite directions. These bent plates are placed inside the rectangular cylinder with their facing long peripheral sides 814 and 824 in contact.

[0054] A bent plate 91 shown in Figure 9 and Figure 10 are formed of a rectangular plate bent along bending lines 911, 912, 913, 914, 915. A second bent plate 92 is also a rectangular plate bent along bending lines 921, 922, 923, 924, 925. The third bent plate 93 is also a rectangular plate, which is likewise bent along bending lines 931, 932, 933, 934 and 935. In other respects, these three bent plates are essentially the same as those shown in Figures 5 through 7.

[0055] A local agitator 101 shown in Figures 11 through 13 contain two rectangular plates 1011 and 1012. The rectangular plates are stacked on their long peripheral sides so that they cross each other at an angle with their long peripheral sides 10111, 10121 in contact at the central portion. They are installed in a rectangular cylinder 1013 so that the cylinder circumscribes them. A boundary plane 1014 containing the long peripheral sides 10111, 10121 is parallel to the rotating plane of the local agitator. In other respects, this local agitator 101 is essentially similar to that shown in Figures 5 through 7.

[0056] In a local agitator shown in Figure 13, a support rod 103 is secured to the side of the rectangular cylinder 1013 with a thumbscrew, about which the local agitator can be rotated in a vertical plane.

[0057] In Figures 14 and 15, four pairs each of two local agitators 132, 133 are secured in a radial direction with 90° angle each around a central hole 1311 at the periphery of and on the both sides of a support plate 131 of a disk shape. A pair of local agitators 132, 133 is connected each other in parallel against rotation direction.

[0058] The local agitators 132, 133 are made of square cylinders 1323, 1333 wherein a pair of two bent plates 1321, 1322 and a pair of bent plates 1331, 1332, reversely directed each other, are put in. Rear side of a leading end of the local agitator against rotating direction is cut off in order to have the leading end inclined

and to have outer opening swept back. 134 is a boss mounted around the hole 1311 for an agitator shaft.

[0059] The agitator blade of this invention offers the following advantages. That is, when applied for agitation and mixing processes, the agitator blade of this invention can realize a high degree of mixing easily and reliably in a short period of time and with a small driving power. Further, the construction of this agitator blade is simple.

Claims

1. An agitator blade comprising:

a mounting frame having opposing sides and being secured to a rotatable agitator shaft, at least one local agitator having cylinders mounted on said mounting frame, said at least one local agitator being arranged radially in relation to said agitator shaft, and having first and second axial ends, the first and second ends both being open with respect to said mounting frame and spaced from said agitator shaft, the first axial end being disposed closer to the agitator shaft and the second axial end being disposed more remote from the agitator shaft, each of the first and second axial ends having a leading edge and a trailing edge in relation to the direction of rotation, and the radial distance from said leading edge of the second axial end to said agitator shaft being greater than the radial distance from said trailing edge of the second axial end to the agitator shaft.

2. An agitator blade as claimed in claim 1, wherein said cylinders are square cylinders.

3. An agitator blade as claimed in claim 1 or 2, wherein each local agitator internally contains at least one plate.

Patentansprüche

1. Rührwerksschaufel, die aufweist:

einen Montagerahmen, der gegenüberliegende Seiten aufweist und an einer drehbaren Rührwerkswelle gesichert ist, mindestens einen lokalen Rührer, der Zylinder aufweist, die auf dem Montagerahmen montiert sind, wobei der mindestens eine lokale Rührer radial bezüglich der Rührwerkswelle angeordnet ist und ein erstes und ein zweites axiales Ende aufweist, wobei das erste und das zweite Ende beide bezüglich des Montagerahmens offen

und von der Rührwerkswelle getrennt sind, das erste axiale Ende näher an der Rührwerkswelle angeordnet ist und das zweite axiale Ende entfernter von der Rührwerkswelle angeordnet ist,

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wobei das erste und das zweite axiale Ende jeweils einen vorderen Rand und einen hinteren Rand bezüglich der Drehungsrichtung aufweisen, und

wobei der radiale Abstand von dem vorderen Rand des zweiten axialen Endes zu der Rührwerkswelle größer als der radiale Abstand von dem hinteren Rand des zweiten axialen Endes zu der Rührwerkswelle ist.

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2. Rührwerksschaufel nach Anspruch 1, bei der die Zylinder quadratische Zylinder sind.

3. Rührwerksschaufel nach Anspruch 1 oder 2, bei der jeder lokale Rührer intern mindestens eine Platte enthält.

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Revendications

1. Pale d'agitateur comportant :

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un châssis de montage ayant des côtés opposés et étant fixé à un arbre d'agitateur pouvant tourner,

au moins un agitateur local ayant des cylindres montés sur le châssis de montage,

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ledit au moins un agitateur local étant disposé radialement par rapport à l'arbre d'agitateur, et ayant des première et seconde extrémités axiales, les première et seconde extrémités

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étant toutes les deux ouvertes par rapport au châssis de montage et à distance de l'arbre d'agitateur, la première extrémité axiale étant disposée plus proche de l'arbre d'agitateur et la seconde extrémité axiale étant disposée Plus

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éloignée de l'arbre d'agitateur, chacune des première et seconde extrémités axiales ayant un bord d'attaque et un bord de queue par rapport à la direction de rotation, et la distance radiale du bord d'attaque de la

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seconde extrémité axiale à l'arbre d'agitateur étant plus grande que la distance radiale du bord de queue de la seconde extrémité axiale à l'arbre d'agitateur.

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2. Pale d'agitateur suivant la revendication 1, dans lequel les cylindres sont des cylindres de section carrée.

3. Pale d'agitateur suivant l'une des revendications 1 ou 2, dans lequel chaque agitateur local contient intérieurement au moins une plaque.

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FIG. 1

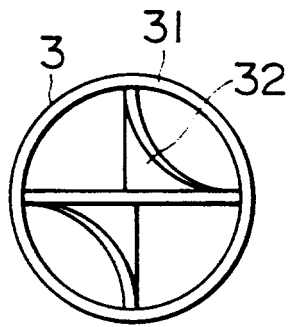


FIG. 2

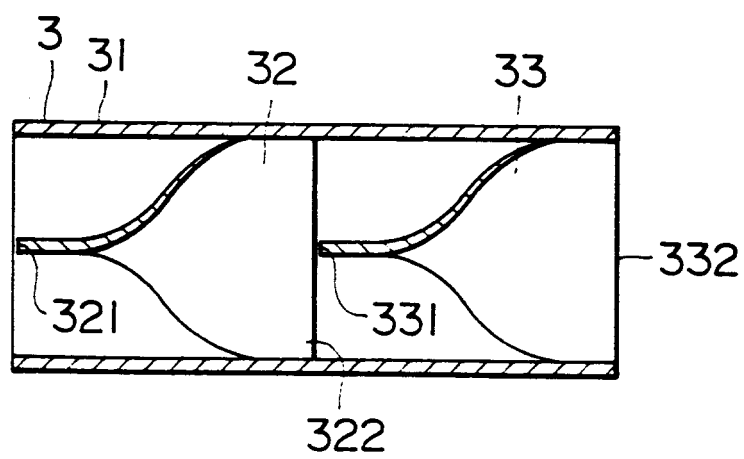


FIG. 3

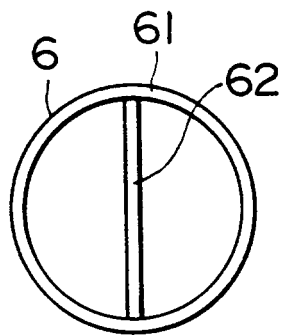


FIG. 4

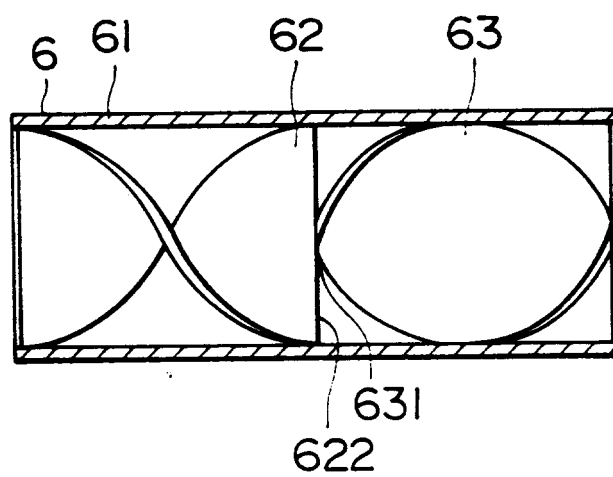


FIG. 5

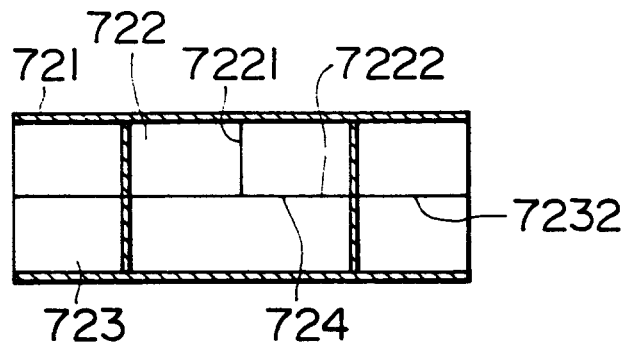


FIG. 6

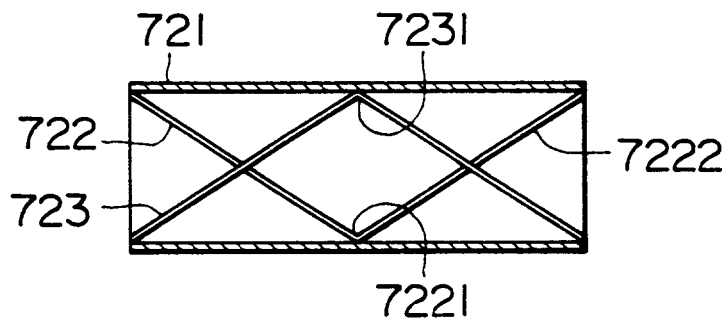


FIG. 7

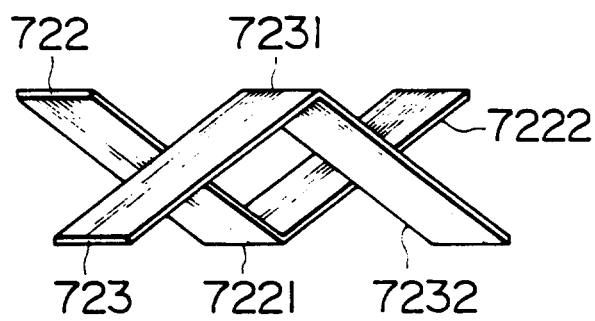


FIG. 8

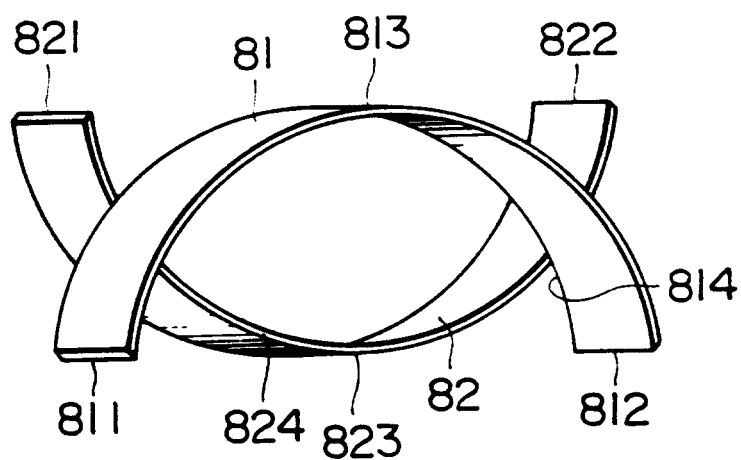


FIG. 9

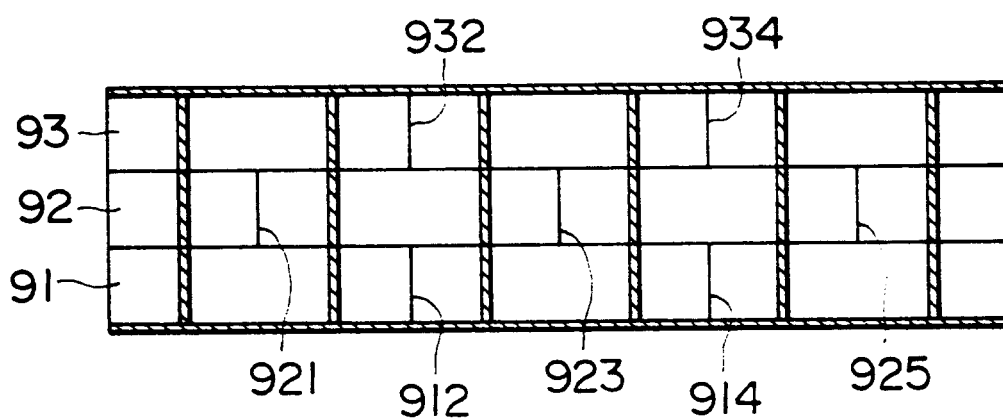


FIG. 10

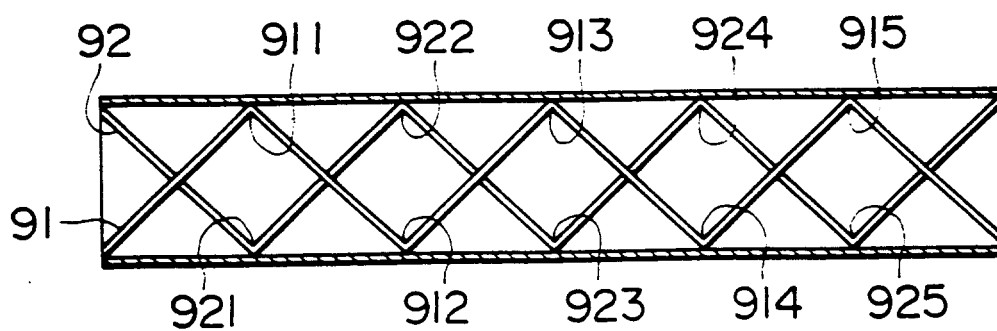


FIG. 11

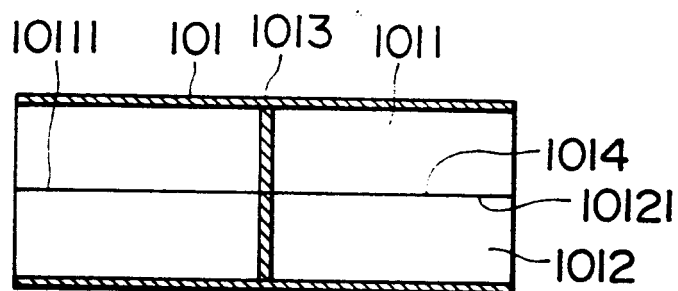


FIG. 12

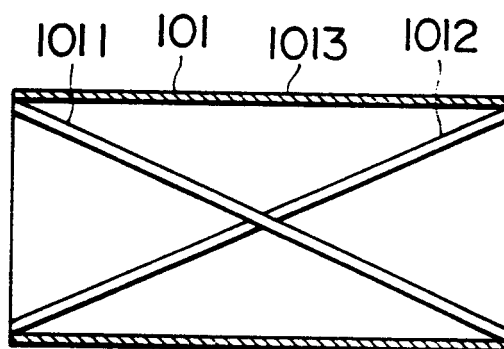


FIG. 13

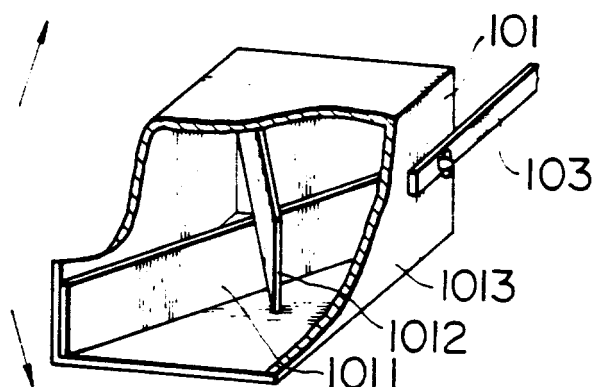


FIG. 14

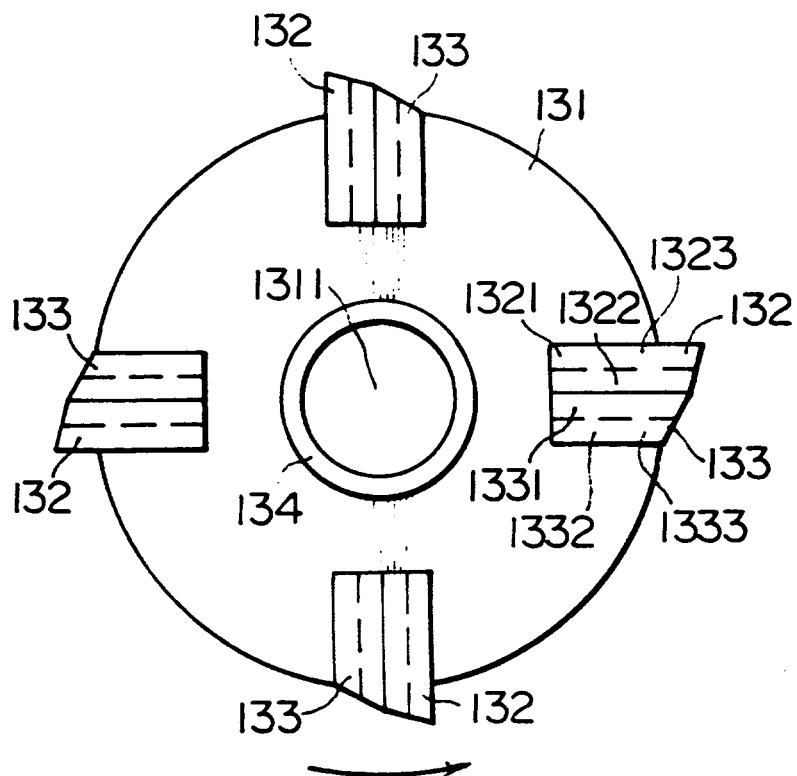


FIG. 15

