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(54) Method and apparatus for blending solids or the like.

(57) Particulate materials are blended in a vessel (10) provided with a single vertically extending mixing tube (26) therein. The vessel comprises a downwardly converging frustoconically-shaped bottom wall (16) which defines the lower region of the vessel. The mixing tube is provided with one or more longitudinally extending divider plate (36) which divide the mixing tube into a plurality of longitudinally extending compartments. The mixing tube is provided with a plurality of openings (44) which provide direct fluid flow communication with the interior of the vessel and the longitudinally extending compartments. The lower ends of the mixing tube and the compartments therein extend through the bottom wall of the vessel. Methods of blending solids using the described apparatus and methods of constructing the described apparatus are also disclosed.

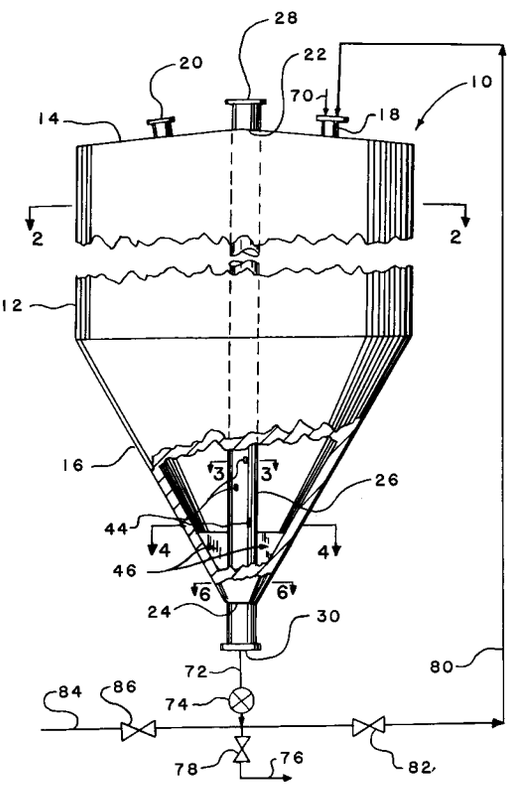

FIG. 1

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This invention relates to blending. In another aspect, the invention relates to a novel apparatus and method for blending of particulate materials.

It is often necessary to blend or homogenize truck-size, hopper car-size, or larger batches or quantities of particulate materials or solids in order to produce uniform mixtures. In the plastics industry, for example, slight variations in properties of polymers may occur in different production runs. Blending of the pellets made in such runs is important to insure products of uniform quality. Efficient blending of particulate materials can be accomplished by the use of apparatus which comprises a vessel having a plurality of vertically extending tubes therein. The solids to be blended are positioned within the vessel surrounding the tubes. The tubes are provided with openings through which the particles enter the tubes to flow by gravity downwardly through the tubes to a common collection zone.

While a blending apparatus of the general type disclosed above has been found to be quite effective, it has been found to be desirable to obtain an improved apparatus for sampling and blending of particulate materials or solids that can more easily be fabricated in the field.

In accordance with the present invention, an improved blender apparatus of the general type described above is provided. A preferred embodiment of the blender apparatus of the present invention employs a blender vessel having an outer storage chamber and a single inner mixing tube wherein the inner mixing tube comprises a tube extending generally parallel to the vertical axis of the vessel and wherein the tube is divided into a plurality of separate compartments by an inner divider means and wherein the tube is provided with a plurality of openings so that each compartment is in direct fluid flow communication with the outer storage chamber by way of at least one of the openings.

It is an object of the present invention to provide improved blender apparatus for blending particulate materials or solids.

It is another object of the invention to provide an improved method of blending particulate materials or solids.

It is another object of the invention to provide an improved blender apparatus that can be easily and economically fabricated in the field.

It is yet another object of the present invention to provide an improved blender apparatus that has no need for internal supports in order to prevent structural failure.

It is a further object of the present invention to provide an improved blender apparatus that can be easily cleaned and inspected for obstruction.

It is still another object of the present invention to provide an improved method and apparatus for blending particulate materials or solids which method and apparatus are reliable and economical in operation.

Other aspects, advantages, and objects of the present invention will become readily apparent to those skilled in the art upon further study of the instant specification, claims and drawings in which:

Figure 1 is a side elevation view of one embodiment of the present invention with portions thereof broken away to illustrate the lower portion of the blender in vertical cross-section;

Figure 2 is a horizontal cross-section view taken along line 2-2 of Figure 1;

Figure 3 is an enlarged horizontal cross-section view taken along line 3-3 of Figure 1;

Figure 4 is an enlarged horizontal cross-section view taken along line 4-4 of Figure 1.

Figure 5 is an enlarged partial horizontal cross-section view illustrating one of the four baffles of Figure 4.

Figure 6 is an enlarged horizontal cross-section view taken along line 6-6 of Figure 1.

Figure 7 is an enlarged side elevation view of the lower portion of the embodiment of Figure 1 with the front half of the vessel removed in order to clearly illustrate the baffle arrangement.

Referring now to the drawings, and to Figures 1 and 2 in particular, there is illustrated therein an upright, generally cylindrical vessel 10 comprising a generally cylindrical side-wall 12, a top closure 14, and a downwardly converging, generally frustoconically shaped bottom wall or closure 16. The length to diameter ratio of the cylindrical vessel 10 is generally in the range from about 1.5:1 to about 3.5:1. The top closure 14 is provided with a solids inlet or filling port 18 and a vent 20. The top closure 14 is provided with a first opening 22, and the bottom wall or closure 16 is provided with a second opening 24. A single mixing tube 26 having a first end 28 and a second end 30 is positioned with the first end 28 above the top closure 14 and the mixing tube 26 passing through the first opening 22 which opening 22 is suitably sealingly engaged with the outer surface of the mixing tube 26. The mixing tube 26 extends downwardly through the vessel 10 and through the second opening 24 in the bottom wall 16, which opening 24 is suitably sealingly engaged with the outer surface of the mixing tube 26. The second end 30 of the mixing tube 26 is positioned beneath the bottom wall or closure 16 of the vessel 10.

The interior of the mixing tube 26 is provided with a longitudinally extending divider means for dividing the mixing tube into a plurality of longitudinally extending compartments. Preferably, the divider means divides the mixing tube into from

about 4 to about 36 longitudinally extending compartments. More preferably, the divider means divides the mixing tube into from about 10 to about 30 longitudinally extending compartments. The mixing tube 26 is provided with a plurality of openings so as to provide direct fluid flow communication between the annular space between the interior of the vessel 10 and the exterior of the mixing tube 26 and the plurality of longitudinally extending compartments of the mixing tube 26. The ratio of the diameter of the cylindrical vessel 10 to the diameter of the mixing tube 26 is generally in the range of from about 5:1 to about 15:1.

A preferred embodiment of the mixing tube 26 is illustrated in Figure 3. In the preferred embodiment, the mixing tube 26 comprises an outer tube 32 and an inner tube 34. The inner tube 34 is concentrically positioned within the outer tube 32 to thereby form an annular space therebetween. A plurality of longitudinally extending divider plates 36 are positioned within the annular space between the inner tube 34 and the outer tube 32. Each divider plate 36 has a first edge 38 that is positioned in direct contact with the outer wall of the inner tube 34, and a second edge 40 that is positioned in direct contact with the inner wall of the outer tube 32. Each divider plate 36 extends at least substantially the full length of the inner tube 34, thereby dividing the annular space between the inner tube 34 and the outer tube 32 into a plurality, preferably from about 4 to about 36, of longitudinally extending compartments 42. Preferably, the longitudinally extending compartments 42 each have approximately the same cross-sectional area.

The outer tube 32 of the mixing tube 26 is provided with a plurality of openings 44. The openings 44 are positioned at varying elevations on the mixing tube 26 between the top closure 14 and the bottom wall or closure 16 of the vessel 10. The openings 44 are positioned around the circumference of the mixing tube 26 so that each longitudinally extending compartment 42 is in direct fluid flow communication with the annular space between the interior of the vessel 10 and the exterior of the outer tube 32 by means of at least one opening 44. The openings 44 can be of any suitable size and shape that will allow the free flow of particulate materials or solids from the interior of the vessel 10 into the longitudinally extending compartments 42. Preferably, the openings 44 have a sufficiently narrow dimension in the horizontal direction that each opening 44 provides direct fluid flow communication from the interior of the vessel 10 to only one of the longitudinally extending compartments 42. Preferably, the openings 44 are elongated so as to have a greater length in the vertical direction than the length in the horizontal direction so as to allow a maximum flow rate from the interior of the vessel 10 to the longitudinally extending compartments 42 without allowing flow from the interior of the vessel 10 to more than one longitudinally extending compartment 42 through any one opening 44.

In a preferred embodiment of the invention, for every opening 44 positioned at a particular elevation there exists a second opening 44 at approximately the same elevation positioned at the opposite side of the outer tube 32 as illustrated in Figure 3. The purpose of the second opening 44 is to eliminate the pressure buildup against the outer tube 32 that is created by the flow of material toward the first opening 44. It is not necessary for each opening 44 to have a diametrically opposed second opening 44 at approximately the same elevation; however, by positioning a plurality of diametrically opposed openings 44 at various elevations along the outer tube 32, the external pressure upon the outer tube 32 created by the flow of material will be balanced, thereby eliminating the need for external tube supports that may obstruct the flow of material inside the vessel 10.

At least one bottom opening 45 in the outer tube 32 is positioned in contact with the edge or line of intersection along which the mixing tube 26 contacts or intersects the inner surface of the bottom wall or closure 16 of the vessel 10. Preferably, a plurality of bottom openings 45 in the outer tube 32 are positioned in evenly circumferentially space relation around the outer tube 32 in contact with the edge or line of intersection along which the mixing tube 26 contacts or intersects the inner surface of the bottom wall or closure 16 of the vessel 10. In the preferred embodiment illustrated in Figure 6, four bottom openings 45 are positioned in evenly circumferentially space relation around the outer tube 32 in contact with the edge or line of intersection along which the mixing tube 26 contacts or intersects the inner surface of the bottom wall or closure 16 of the vessel 10.

At least one baffle 46 is positioned in contact with the bottom wall or closure 16 of the vessel 10 so as to direct particulate materials or solids toward the bottom openings 45 that exist in contact with the edge or line of intersection that exists between the mixing tube 26 and the inner surface of the bottom wall or closure 16 of the vessel 10.

The Figures 4 and 7 illustrate a vessel 10 which is provided with four separate baffles 46 in contact with the bottom wall or closure 16 of the vessel 10. The baffles 46 are equally circumferentially spaced around the mixing tube 26 so as to direct flow of particulate materials or solids to four equally spaced locations along the edge or line of intersection along which the mixing tube 26 intersects the inner surface of the bottom wall or closure 16 of the vessel 10.

As shown in Figures 5 and 7, each baffle 46 comprises a first side 48 and a second side 50. The first side 48 and the second side 50 have a common first edge 52 so that the first side 48 and second 50 form an acute angle. The first edge 52 has a first end 54 in contact with the outer tube 32 and a second end 56 in contact with the bottom wall or closure 16 of the vessel 10. The first side 48 of the baffle 46 has a second edge 58 which extends from the second end 56 of the first edge 52 along the bottom wall or closure 16 of the vessel 10 to a point at the junction of the bottom wall or closure 16 and the outer tube 32. The first side 48 of the baffle 46 has a third edge 60 that extends from the first end 54 of the first edge 52 along the outer tube 32 to the point at which the second edge 58 intersects the junction of the outer tube 32 and the bottom wall or closure 16 of the vessel 10.

The second side 50 of the baffle 46 has a second edge 62 which extends from the second end 56 of the first edge 52 along the bottom wall or closure 16 of the vessel 10 to a point at the junction of the bottom wall or closure 16 and the outer tube 32. The second side 50 of the baffle 46 has a third edge 64 that extends from the first end 54 of the first edge 52 along the outer tube 32 to the point at which the second edge 62 intersects the junction of the outer tube 32 and the bottom wall of closure 16 of the vessel 10.

As illustrated in Figure 1, the vessel 10 can be filled with particulate materials or solids to be blended by means of a conduit 70 which communicates with the solids inlet 18. A conduit 72, having control means such as a rotary star valve 74 interposed therein, is connected to the second end 30 of the mixing tube 26 to withdraw blended particulate materials or solids. Conduit 72 is connected to a withdrawal conduit 76 in which a valve 78 is interposed. In some operations it may be desirable to recycle blended particulate materials or solids from the conduit 72 back to the upper region of the vessel 10. This can be accomplished by means of a conduit 80, having a valve 82 interposed therein, which extends from conduit 72 to the solids inlet 18. A conduit 84, having a valve 86 interposed therein, extends from a source of pneumatic pressure, not shown, to the inlet of conduit 80. The blended particulate materials or solids can thus be elevated and reintroduced into the vessel 10 via conduit 80 by means of pressurized air from the source of pneumatic pressure. The vent 20 permits the transport air entering the conduit 80 to be exhausted from the vessel 10.

In a first method of operation in accordance with this invention, the rotation of valve 74 is stopped to block flow through the valve 74 and the vessel 10 is filled with particulate materials or solids to be blended via the conduit 70. The valve 74 is then rotated to allow flow therethrough and the valve 78 is opened to permit the particulate materials or solids to drain by gravity from the vessel 10 through the mixing tube 26 to the withdrawal conduit 76. Valve 86 is closed at this time so that no particulate materials or solids are recycled. In another method of operation of this invention, the vessel 10 can be operated in the same manner except that blending is accomplished continuously with particulate materials or solids to be blended being introduced through the solids inlet 18 and withdrawn through the conduit 72 at the same time. In still another method of operation, a part or all of the blended particulate materials or solids can be recycled through conduit 80 back to the solids inlet 18 for further blending.

It is presently preferred to assemble the vessel 10 illustrated in Figure 1 in the following manner. Initially, the mixing tube 26, as shown in Figure 3, is formed. The outer tube 32, inner tube 34 and divider plates 36 are each formed separately by any suitable means, such as extrusion. The first end 38 of each divider plate 36 is fixedly secured to the outer surface of the inner tube 34 by any suitable means, such as welding, in order to form an inner baffle means. Welding is defined for the purposes of this application to mean the localized coalescencing of metal wherein coalescencing is produced by heating to suitable temperatures, with or without the application of pressure, and with or without the use of filler metal. Alternatively, the inner tube 34 and the divider plates 36 can be formed as one single member by any suitable means, such as extrusion. The inner baffle means formed by the combination of the inner tube 34 and the divider plates 36 is suspended over the outer tube 32 in axial alignment with the outer tube 32. At least one of the inner baffle means and the outer tube 32 is moved in a direction toward the other. Preferably, the inner baffle means is lowered into the outer tube 32 so that the inner surface of the outer tube 32 is sealingly engaged with the second end 40 of each divider plate 36. A plurality of openings 44 are cut into the outer tube 32 by any suitable means at varying elevations on the outer tube 32 positioned around the circumference of the outer tube 32 so that each longitudinally extending compartment 42 that exists between the inner baffle means and the outer tube 32 is in direct fluid flow communication with the exterior of the outer tube 32 by means of at least one opening 44.

The mixing tube 26 is then axially aligned with the vessel 10. The first end 28 of the mixing tube 26 is then inserted through the second opening 24 in the bottom wall 16 of the vessel 10, then passed upwardly through the entire length of the vessel 10.

The outer surface of the mixing tube 26 is fixedly secured to the inner surface of the bottom wall 16 of the vessel 10 by any suitable means, such as welding.

The baffles 46 are then fixedly secured between the mixing tube 26 and the bottom wall 16 of the vessel 10. The second edge 58 of the first side 48 and the second edge 62 of the second side 50 of each baffle 46 are secured to the bottom wall 16 of the vessel 10 by any suitable means, such as welding. The third edge 60 of the first side 48 and the third edge 64 of the second side 50 of the baffles 46 are secured to the outer surface of the mixing tube 26 by any suitable means, such as welding. After the mixing tube 26 is fixedly secured to the bottom wall 16 of the vessel 10 and the baffles 46 are fixedly secured between the mixing tube 26 and the bottom wall 16 of the vessel 10, the top closure 14 is fixedly secured to the side wall 12 of the vessel 10 with the mixing tube 26 passing through the first opening 22 in the top closure 14 so that the mixing tube 26 is sealingly engaged with the top closure 14, and assembly of the blending apparatus is complete.

It should be noted that a significant feature of the apparatus of the present invention is that all particulate material flows through a single mixing tube 26. With only a single mixing tube 26 to be positioned within the vessel 10, the apparatus is more easily fabricated in the field. Additionally, each longitudinally extending compartment 42 of the mixing tube 26 is essentially straight. Thus, the particulate materials are neither subjected to angular flow within the longitudinally extending compartments 42 nor potential material retention at angular welds, which provides greater assurance of equal flow from each longitudinally extending compartment 42. Additionally, this provides for a simplified wash system of the apparatus by providing for more complete cleaning of the longitudinally extending compartments 42 and affording an improved inspection potential of the longitudinally extending compartments 42. Furthermore, the elimination of the need for internal supports to hold the mixing tube 26 in position will diminish the obstruction of flow patterns and possible retention of particulate material within the vessel 10.

From the foregoing detailed description, it will be seen that the apparatus and method of its use described and illustrated herein imminently achieve the objects of the present invention. Changes may be made in the combination and arrangement of parts or elements as heretofore set forth in the specification and shown in the drawings without departing from the spirit and scope of the invention as defined in and limited only by the following claims.

Claims

1. A blending apparatus comprising:

a vessel having an upper region, a solids inlet in said upper region thereof, a lower region being defined by a downwardly converging generally frustoconically-shaped bottom wall;

a single mixing tube having a first end and a second end positioned within said vessel so as to extend in a generally vertical direction downwardly from said upper region through said lower region and through said bottom wall along a line of intersection therebetween so that said second end of said mixing tube is positioned below said bottom wall, wherein said mixing tube contains at least one longitudinally extending divider means for dividing said mixing tube into a plurality of longitudinally extending compartments, at least a portion of said compartments having at least one first opening therein to permit solids in said vessel to enter the mixing tube and flow by gravity downwardly through said compartments and each of said compartments extending downwardly from said upper region through said lower region and through and below said bottom wall.

2. Blending apparatus in accordance with claim 1, wherein said divider means comprises an inner tube having substantially the same axis of symmetry as said mixing tube so as to define an annular space between said inner tube and said mixing tube, and a plurality of divider plates extending radially outward from said inner tube to said mixing tube.

3. Blending apparatus in accordance with claim 1, wherein said longitudinally extending divider means divides said mixing tube into from about 4 to about 36 longitudinally extending compartments.

4. Blending apparatus in accordance with claim 1, wherein at least one of said first openings comprises at least one bottom opening which is in contact with a point on said mixing tube at which said said mixing tube contacts said bottom wall of said vessel.

5. Blending apparatus in accordance with claim 4 characterized further to include at least one baffle means disposed within said vessel in contact with said bottom wall so as to direct the flow of particles toward a corresponding at least one bottom opening.

6. Blending apparatus in accordance with claim 4 characterized further to include four of said bottom openings each in contact with the line of intersection between said mixing tube and said bottom wall of said vessel.

7. Blending apparatus in accordance with claim 6 characterized further to include four equally spaced baffle means disposed within said vessel in contact with said bottom wall for directing the flow of particles toward each of the four bottom openings.

8. A method of blending solids in solids blending apparatus comprising a vessel having an upper region, a solids inlet in said upper region thereof, a lower region being defined by a downwardly converging generally frustoconically-shaped bottom wall, a single mixing tube having a first end and a second end positioned within said vessel so as to extend in a generally vertical direction downwardly from said upper region through said lower region and through said bottom wall so that said second end of said mixing tube is positioned below said bottom wall, wherein said mixing tube contains at least one longitudinally extending divider means for dividing said mixing tube into a plurality of longitudinally extending compartments, at least a portion of said compartments having at least one first opening therein to permit solids within said vessel to enter the mixing tube and flow by gravity downwardly through said compartments and each of said compartments extending downwardly from said upper region through said lower region and through and below said bottom wall, which comprises:

introducing solids to be blended into said vessel through said solids inlet, allowing said solids to flow by means of gravity through said compartments via said at least one first opening from said vessel to provide blended solids at the second end of said mixing tube, and withdrawing said thus produced blended solids through said second end of said mixing tube.

9. A method of blending solids in accordance with claim 8 wherein solids are not withdrawn from said second end of said mixing tube until all of the solids to be blended at a given time are disposed in said vessel.

10. A method of blending solids in accordance with claim 8 wherein solids are withdrawn from said second end of said mixing tube during the time that solids are introduced through said solids inlet.

11. A method of blending solids in accordance with claim 8 wherein a portion of the solids withdrawn from said second end of said mixing tube are returned to an upper portion of said upper region.

12. A method of assembly of a blending apparatus comprising the steps of:

positioning a single mixing tube having a first end and a second end and containing at least one longitudinally extending divider means for dividing said mixing tube into a plurality of longitudinally extending compartments, at least a portion of said compartments having at least one first opening therein, in axial alignment with a vessel having an upper region, a solids inlet in said upper region thereof, a lower region being defined by a downwardly converging generally frustoconically-shaped bottom wall;

moving at least one of the mixing tube and the vessel in a direction toward the other until the first end of said mixing tube passes through the bottom wall of said vessel and through and beyond the upper region of said vessel; and

fixedly securing the outer surface of said mixing tube to the inner surface of the bottom wall of said vessel.

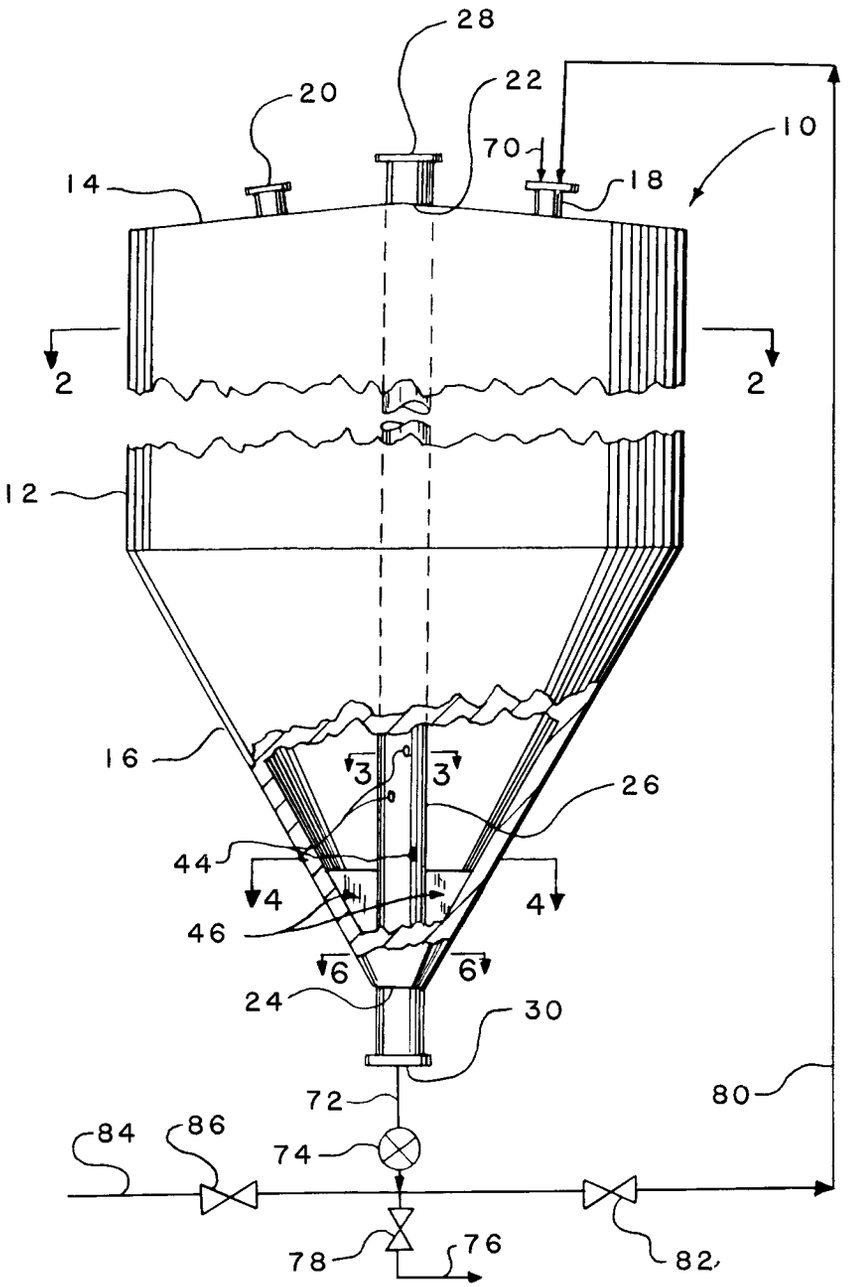
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FIG. 1

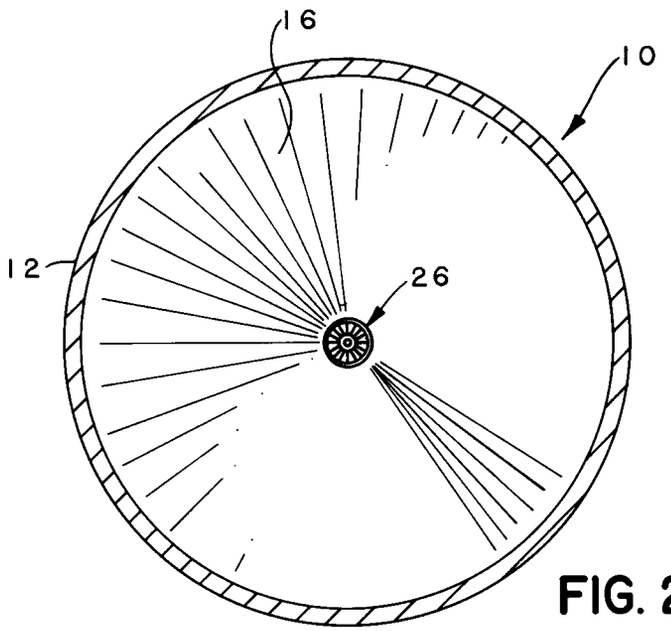


FIG. 2

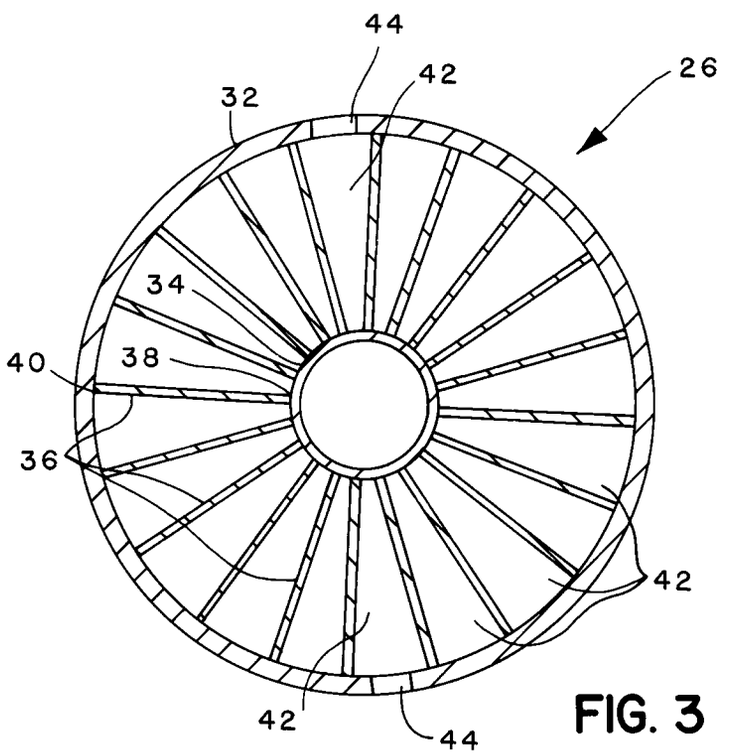
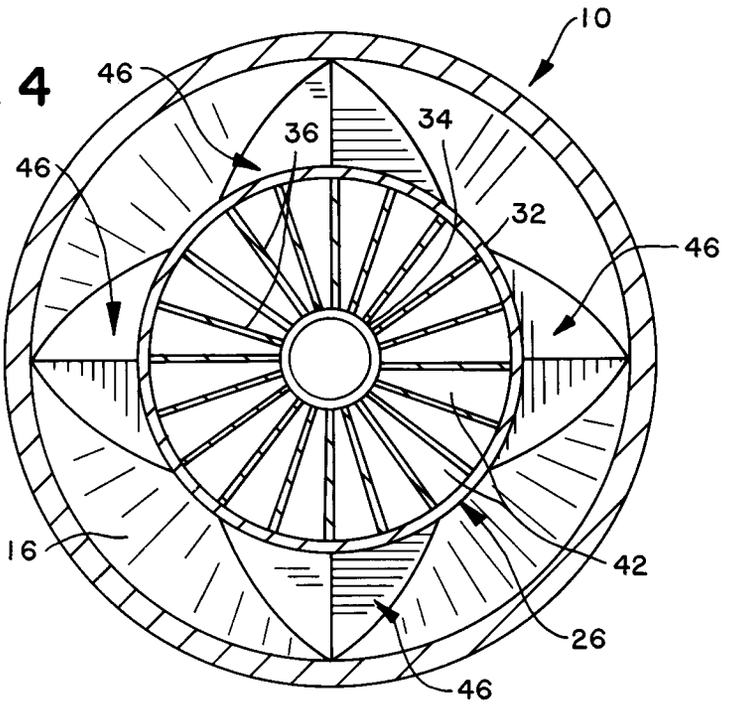


FIG. 3

FIG. 4



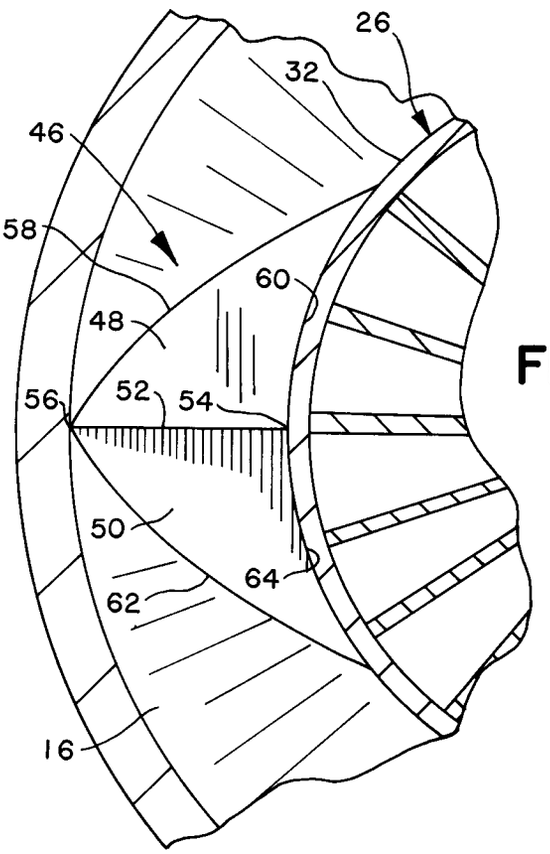
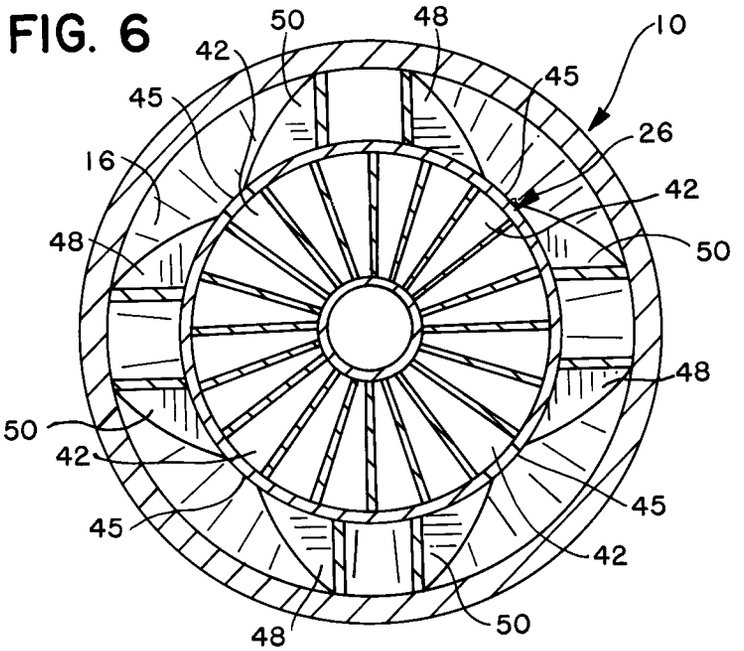


FIG. 5

FIG. 6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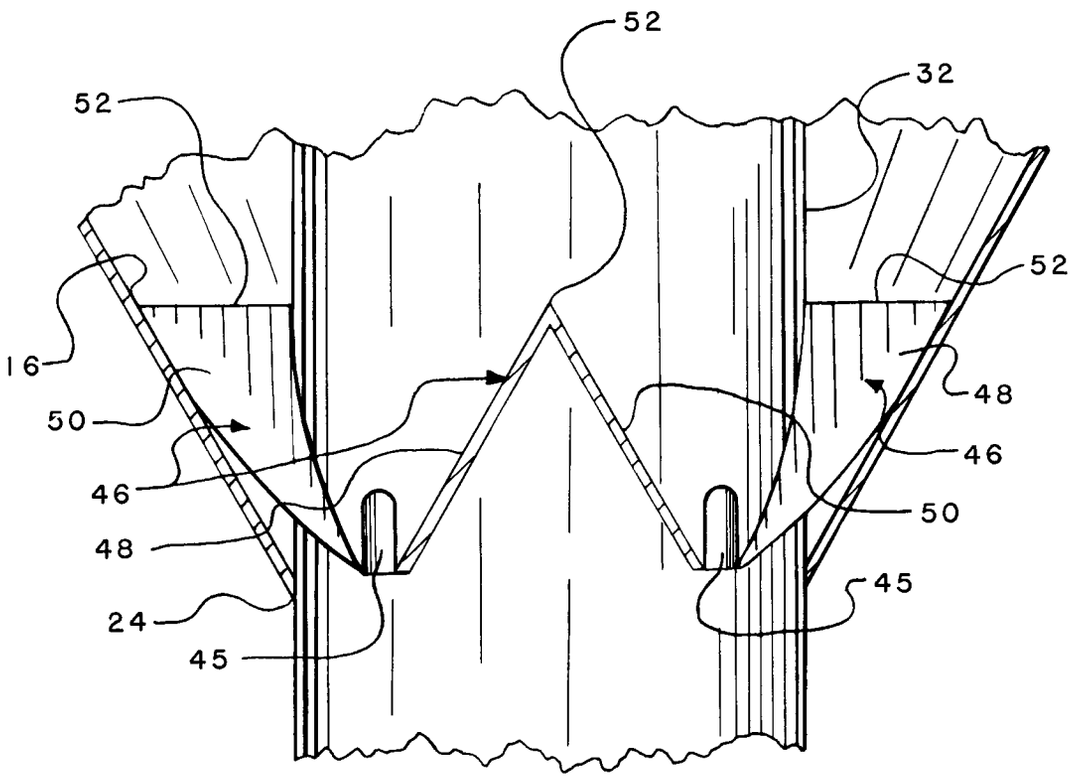
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FIG. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 11 3777

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-A-3 707 264 (KRAMBROCK)	1-3,8-12	B01F5/24
X	DE-A-2 006 770 (MIAG)	1	
X	DE-A-3 401 687 (HAHN)	1	
A	US-A-3 539 154 (GOINS)	4-7	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B01F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 NOVEMBER 1992	PEETERS S.

CATEGORY OF CITED DOCUMENTS

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