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(54) **IN-LINE DISPERSER AND POWDER MIXING METHOD**

INLINE-DISPERGATOR UND PULVERMISCHVERFAHREN

DISPOSITIF D DISPERSION EN LIGNE ET PROCÉDÉ DE MÉLANGE DE POUDRES

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(56) References cited:
EP-A2- 0 925 827
WO-A1-98/56696
JP-A- 63 262 338
US-A- 5 722 802
US-A1- 2005 201 199

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Description

Field of the Invention

[0001] The invention relates to in-line powder dispersion apparatus, and particularly to dispersers that can be used to disperse particulate materials in an industrial process.

Background of the Invention

[0002] It can be very important to understand the characteristics, such as particle size, of particulate materials used in many industrial processes. In some cases application parameters are such that an entire process stream can be directed through an analyzer flowcell to measure its characteristics. This is the case with small scale micronization and spray drying processes where product stream is dilute and can be contained in a 2,54 cm - 5,08 cm (1 - 2") diameter process line. But aggregation of the materials in process lines, which can be caused by static charge buildup, can be a problem that can lead to erroneous readings. WO98/56696 discloses a device in accordance with the preamble of claim 1 for transporting bulk granular or powdery material through a line by introducing a pressurised gas into the line. The pressurised gas is introduced via bores at an angle to the direction of flow. The velocity of the material is measured near the location at which pressurised gas is introduced.

[0003] US2005/0201199 discloses a material transfer device in which pressurised air is used to transport material along a pipe. The pressurised air is introduced via an air inlet manifold encircling the pipe.

[0004] EP0925827 discloses a cyclonic mixer comprising a pair of concentric tubes. The outer tube is closed at either end, and has a plurality of holes at angles through to the inner tube. Air is admitted to the outer tube to create a swirling motion in the inner mixing tube. The inlet of the tubes is fed dry particles intended to be mixed.

[0005] US5722802 discloses a powder delivery apparatus for use in a paint supply system. A flexible inner porous hose is provided. A flexible outer hose surrounds the inner hose. Air is forced radially through the pores in the wall of the inner hose, which promotes atomisation of powder being transported in the inner tube.

[0006] JP 63 262338 discloses a coanda spiral flow controller with sealing members that partially seal an annular slit, as required. The sealing members are moveable by means of screws to adjust the input speed of a pressurised fluid from the annular slit.

Summary of the Invention

[0007] According to a first aspect of the invention there is provided an in-line powder dispersion apparatus according to claim 1.

[0008] Such a dispersion apparatus can be connected directly into a process line via the first and second line apertures, so as to form a continuation of the process line. Aggregation of materials in the process line may be discouraged or reduced by injecting mixing gas into the mixing chamber through the first gas injection port(s).

[0009] The apparatus may further include a mixing gas source having a mixing gas outlet for pneumatic connection to the gas injection port

[0010] The first and second line apertures may be the same, and may be the same as an aperture of the mixing chamber.

[0011] An injection direction of the mixing gas outlet of the first injection port is placed at an angle with respect to an expected flow direction through the mixing chamber, such that a first component of the injection direction lies in the downstream direction and a second component lies in an inward, radial direction with respect to the conduit. An injection direction of the or one of the gas inlet ports may be 75 degrees from a flow direction in the mixing chamber.

[0012] The apparatus may include a plurality of first gas injection ports, and may include at least four first gas injection ports distributed around a periphery of the mixing chamber. Each gas injection port may have an inlet responsive to a mixing gas outlet of a mixing gas source and a mixing outlet that opens into the mixing chamber. The gas injection ports may be defined by at least one segmented disperser contact face. The apparatus may include a plurality of gas injection ports, and may in particular include first and second gas injection ports, each having an inlet responsive to a mixing gas outlet of a mixing gas source and a mixing outlet that opens into the mixing chamber. The first and second gas injection ports may comprise part of a multipart aperture that at least substantially surrounds a circumference of the mixing chamber. The first and second gas injection ports may be separated by bosses.

[0013] The apparatus may further include a plenum in a pneumatic path between a mixing gas outlet of a mixing gas source and the gas injection ports to evenly distribute a flow of gas from the mixing gas source between the first and second gas injection ports. At least four gas injection ports may be distributed around a periphery of the mixing chamber, each being responsive to the mixing gas outlet of the mixing gas source via the plenum. The plenum may be defined between an inner conduit section and an outer conduit section that each surround a pneumatic flow path that passes from the inlet to the outlet of the apparatus. The mixing chamber may comprise the pneumatic flow path. The conduit sections may be substantially cylindrical.

[0014] The apparatus may comprise the four gas injection ports, which may be separated by bosses facing in a direction parallel to the flow path from an end face or area of a inner, possibly cylindrical, conduit section and butting against another, possibly cylindrical, conduit section that surrounds the pneumatic flow path.

[0015] The first gas injection port may at least substantially surround a circumference of the mixing chamber.

[0016] According to a second aspect of the invention there is provided an in-line powder mixing method according to claim 15.

[0017] The different directions may comprise different radial directions. The different directions may each comprise a component in the direction of the pneumatic flow

[0018] It will be appreciated that the above features and aspects of the invention may be combined in any order or combination, and that features of the first aspect of the invention may be used in the second aspect of the invention if required, and vice versa.

Brief Description of the Drawings

[0019]

Fig. 1 is an end view of an illustrative in-line disperser according to the invention;

Fig. 2 is a cross-sectional view of the in-line disperser of Fig. 1, viewed along a line A-A in Fig. 1;

Fig. 3 is an expanded detail view of the cross sectional view of Fig 2, identified by a circular inset B in Fig 2;

Fig. 4 is a perspective view of the in-line disperser of Fig. 1;

Fig. 5 is a perspective view of an upstream portion of the in-line disperser of Fig. 1 with its outer sleeve partially cut away;

Fig. 6 is an expanded detail view of the perspective view of Fig 5, identified by a circular inset C in Fig 5;

Fig. 7 is a perspective cutaway view of the in-line disperser of Fig. 1; and

Fig. 8 is an expanded detail view of the perspective cutaway view of Fig 7.

Detailed Description of an Illustrative Embodiment

[0020] Referring to Figs. 1-3, an illustrative in-line disperser 10 includes a pneumatic inlet 102 having a first line aperture, a mixing chamber 106 placed pneumatically downstream of the pneumatic inlet, and a pneumatic outlet 104 placed pneumatically downstream of the mixing chamber. In the example shown, the disperser includes a body that spans from a pneumatic inlet at an upstream end 12 to a pneumatic outlet at a downstream end 14. A mixing chamber, in the form of a conduit 20, is defined between the ends.

[0021] The disperser also includes at least one, and in this example four, gas injection ports 108. Each gas injection port includes an inlet responsive to a mixing gas outlet of a mixing gas source, and a mixing outlet that opens in to the mixing chamber 106.

[0022] The disperser may further include a mixing gas source having a mixing gas outlet, although this is not shown in the figures. The gas injection ports are arranged to direct mixing gas into a fluid flowing in the mixing chamber. The gas injection ports are distributed at different radial positions around the mixing chamber, and are, in this example, angled so as to direct gas into the mixing chamber in a direction that has a first generally radial component (with respect to the mixing chamber), and a second generally axial component in a downstream direction (with respect to the expected or intended direction of the pneumatic flow through the mixing chamber). The injection ports may be in connection with a mixing gas source via a shared manifold or plenum, an example of which is described in more detail below. However, it will be appreciated that each gas injection port might have an individual mixing gas supply, if required.

[0023] In the example shown, the body of the disperser is made of an upstream portion 16 and a downstream portion 18 that are connected by a sleeve 19 in such a way as to define a gas injection path between the conduit 20 (via the gas injection ports 108) and one or more gas input ports 22, which can be connected to a gas source, such as a bottled gas source. While this type of two-part construction is the currently preferred approach to defining the gas injection path, one of ordinary skill in the art would recognize that other approaches, such as casting or machining a single part, could also be employed. And while the conduit is shown with a continuous diameter along a flow axis of the disperser, other geometries could also be devised.

[0024] Referring to Figs. 4-6, the upstream body portion 16 can be made up of two segments of successively smaller outer diameters 16A and 168, where the outer diameter of segment 16B is smaller than the outer diameter of segment 16A, and segment 16B is downstream of segment 16A. Conversely, the downstream body portion 18 can be made up of two segments of successively smaller inner diameters 18A and 18B, where the inner diameter of segment 18A is larger than the inner diameter of segment 18B, and segment 18A is upstream of segment 18B. The inner diameter of downstream segment 18A is larger than the outer diameter of upstream segment 16B, so that the two segments are able to overlap, defining a space between them through which gas can flow. The disperser segments, 16, 18 make face to face contact at a plurality of discrete points, establishing a plurality of gaps - the injection ports - through which a mixing gas, such as air, can flow.

[0025] At the downstream end of the upstream portion 16, which is part of its inner segment or layer 16B, in particular an end face of segment 16B, a series of bosses 24 are provided. These bosses extend along the flow direction and each culminate in a raised contact surface to form a segmented disperser contact face, proving a 'segmented' gap through which the mixing gas can flow. In one embodiment, there are four bosses that are each

0.5 mm high. This dimension was chosen empirically based on gas consumption, but other dimensions may be more suitable and an optimal exact diameter is likely to be application-specific.

[0026] Referring to Fig. 7, an outer sleeve 19 is clamped in place with gaskets to align and draw the upstream body portion 16 against the downstream body portion 18. As shown best in Fig. 1, the gaskets include an internal groove shaped to receive protrusions extending from both the sleeve and body portions 16 and 18, so holding the portions securely in place. When the body portions are drawn together and aligned, the contact surfaces of the bosses 24 on the innermost layer 16B press against the upstream end of the innermost layer 18B of the downstream body portion. In this position, the upstream body portion and the downstream body portion provide a structural framework for the gas injection path. In the example shown in Fig 2, the gaskets are 3,81 cm (1-1/2) inch tri-clamp gaskets, which provide axial pressure to ensure that the disperser segments are kept in face to face contact with each other.

[0027] Referring also to Fig. 8, the beginning of the gas injection path is defined by a gap 30 between the downstream end of the outer layer 16A of the upstream body portion 16 and the upstream end of the outer layer 18A of the downstream body portion 18. A second part of the gas injection path is defined by an annular volume 32 defined between the radially outward-facing wall of the inner layer 16B of the upstream body portion and the radially inward facing wall of the outer layer 18A of the inner wall of the downstream body portion. This annular volume 30 acts as a plenum to evenly distribute a flow of gas from the two gas input ports 22. The final part of the injection path is defined by a ring of curved gaps 34 between the bosses 24, which gaps define the gas injection ports 108. The end surfaces of the inner layers of the upstream and downstream body portions can be angled to direct the gas flow into a mixing area 36 of the conduit 20 at selected angle. That is, the end face of the bosses may be at an angle to the radius of the mixing chamber, and the end face of the inner downstream segment 18B may also be at an angle to the radius, so that the gas injection ports are not normal to the flow direction, but instead have a component in the flow direction. In one embodiment, this angle is a relatively steep 75° with respect to the flow direction (i.e., the introduction is 15° closer to the flow direction than a right angle introduction would be). As a result, vacuum created by the disperser is gentle and should not interfere with operation of upstream equipment.

[0028] In operation, the in-line disperser is positioned between an upstream source of particles, such as a milling machine, and a downstream measuring device, such as one of the Insitec laser diffraction instruments available from Malvern Instruments, which is used to measure their characteristics. The pressurized injected gas creates turbulence in the mixing area and breaks up aggregated particles and/or prevents aggregation that might otherwise take place. The measuring device then receives the pneumatically conveyed particulate flow and monitors the size of the particles it contains.

[0029] The present invention has now been described in connection with a specific embodiment thereof. However, numerous modifications which are contemplated as falling within the scope of the present invention should now be apparent to those skilled in the art. Therefore, it is intended that the scope of the present invention be limited only by the scope of the claims appended hereto. In addition, the order of presentation of the claims should not be construed to limit the scope of any particular term in the claims.

Claims

1. Apparatus comprising:

an in-line powder disperser (10), comprising:

a pneumatic inlet (102) having a first line aperture,
a mixing chamber (106) placed pneumatically downstream from the pneumatic inlet (102),
at least a first gas injection port (108) having an inlet (22) responsive to a mixing gas outlet of a mixing gas source and a mixing outlet that opens into the mixing chamber, and
a pneumatic outlet (104) placed pneumatically downstream from the mixing chamber (106) and having a second line aperture;
characterised in that the apparatus further comprises:
a downstream measuring device arranged to receive a pneumatically conveyed particle flow from the pneumatic outlet (104) and configured to monitor the size of the particles in the particle flow;
wherein the powder disperser (10) is operable to break up aggregated particles and/or prevent aggregation of particles by creating turbulence in the particle flow in the mixing chamber when pressurised mixing gas is injected through the gas injection port (108), and
wherein an injection direction of the mixing outlet of at least the first injection port (108) is placed at an angle with respect to the flow with a first component in the downstream direction and a second larger component in an inward radial direction with respect to the conduit.

2. The apparatus of claim 1 further comprising a mixing gas source having a mixing gas outlet.

3. The apparatus of claim 1 or claim 2 wherein the first and second line apertures are the same size and shape and are the same size and shape as an aperture of the mixing chamber (106).

4. The apparatus of any one of claims 1 to 3 wherein an injection direction of the mixing outlet of the first injection port is 75 degrees from a flow direction in the mixing chamber (106).

5. The apparatus of any one of claims 1 to 4 further including a second gas injection port (108) having an inlet responsive to a mixing gas outlet of a mixing gas source and a mixing outlet that opens into the mixing chamber (106).

6. The apparatus of claim 5 wherein the first and second gas injection ports (108) are part of a multipart aperture that at least substantially surrounds a circumference of the mixing chamber (106).

7. The apparatus of claim 5 or claim 6 wherein the first and second gas injection ports (108) are separated by bosses (24).

8. The apparatus of any one of claims 5 to 7 further including a plenum (30) in a pneumatic path between the mixing gas outlet of the mixing gas source and the first and second gas injection ports (108) to evenly distribute a flow of gas from the mixing gas source between the first and second gas injection ports (108).

9. The apparatus of claim 8 wherein at least four first gas injection ports (108) are distributed around a periphery of the mixing chamber (106) and each is responsive to the mixing gas outlet of the mixing gas source via the plenum (30).

10. The apparatus of claim 8 or claim 9 wherein the plenum (30) is defined between an inner cylindrical conduit section and an outer cylindrical conduit section that each surround a pneumatic flow path that passes from the inlet to the outlet of the dispenser.

11. The apparatus of claim 8 or claim 9 or claim 10 wherein the four gas injection ports (108) are separated by bosses (24) facing in a direction parallel to the flow path from a circular end area of the inner cylindrical conduit section and butting against another cylindrical conduit section that surrounds the pneumatic flow.

12. The apparatus of any preceding claim wherein the first gas injection port (108) at least substantially surrounds a circumference of the mixing chamber (106).

13. The apparatus of any preceding claim wherein at least four first gas injection ports (108) are distributed around a periphery of the mixing chamber (106) and each has an inlet responsive to a mixing gas outlet of a mixing gas source and a mixing outlet that opens into the mixing chamber (106).

14. The apparatus of claim 13 wherein the gas injection ports (108) are defined by at least one segmented disperser contact face.

15. An in-line powder mixing method, comprising:

receiving a pneumatic flow that includes suspended particles in an apparatus according to claim 1,
causing turbulence in the received pneumatic flow by injecting a mixing gas from a plurality of different directions in the received pneumatic flow to create a dispersed flow by breaking up aggregated particles and/or preventing aggregation of particles, and
providing the dispersed flow to a downstream measuring instrument, and using the instrument to monitor the size of particles in the dispersed flow;wherein the directions of injection of a mixing gas are placed at an angle with respect to the pneumatic flow with a first component in the downstream direction and a second larger component in an inward radial direction with respect to the conduit.

Patentansprüche

1. Eine Vorrichtung bestehend aus:

einem Inline-Pulverdispergator (10), bestehend aus:

einem Pneumatikeinlass (102) mit einer ersten Anschlussöffnung,
einer Mischkammer (106), die pneumatisch nach dem Pneumatikeinlass (102) platziert ist,
mindestens einem ersten Gas-Injektionsbrenner (108) mit einem Einlass (22), der von einem Mischgasauslass einer Mischgasquelle und einem Mischauslass abhängig ist, der sich in die Mischkammer öffnet, und
einem Pneumatikauslass (104), der pneumatisch nach der Mischkammer (106) platziert ist und eine zweite Anschlussöffnung aufweist;

dadurch gekennzeichnet, dass die Vorrichtung darüberhinaus Folgendes umfasst:

ein nachgeordnetes Messgerät, das so angeordnet ist, dass es einen pneumatisch beförderten Teilchenfluss vom Pneumatikauslass (104) aufnehmen kann, und so gestaltet ist, dass es die Größe der Teilchen im Teilchenfluss überwachen kann;
wobei der Pulverdispergator (10) die zusammengeballten Teilchen aufbrechen kann und/oder die Zusammenballung der Teilchen durch die Erzeugung einer Verwirbelung im Teilchenfluss in der Mischkammer verhindern kann, wenn druckbeaufschlagtes Mischgas durch den Gas-Injektionsbrenner (108) injiziert wird, und
wobei eine Injektionsrichtung des Mischauslasses mindestens des ersten Injektionsbrenners (108) in einem Winkel zum Durchfluss mit einer ersten Komponente in ablaufseitiger Richtung und einer zweiten größeren Komponente in einer nach innen verlaufenden radialen Richtung zur Leitung platziert ist.

2. Die Vorrichtung in Anspruch 1 darüberhinaus bestehend aus einer Mischgasquelle mit einem Mischgasauslass.

3. Die Vorrichtung in Anspruch 1 oder Anspruch 2, wobei die erste und zweite Anschlussöffnung gleich groß sind und dieselbe Form haben, und gleich groß sind und die gleiche Form haben wie eine Öffnung in der Mischkammer (106).

4. Die Vorrichtung in einem der Ansprüche 1 bis 3, wobei die Injektionsrichtung des Mischauslasses des ersten Injektionsbrenners bei 75 Grad von einer Flussrichtung in der Mischkammer (106) liegt.

5. Die Vorrichtung eines der Ansprüche 1 bis 4, die darüberhinaus einen zweiten Gas-Injektionsbrenner (108) mit einem Einlass einschließt, der von einem Mischgasauslass einer Mischgasquelle und einem Mischauslass abhängig ist, der sich in die Mischkammer (106) öffnet.

6. Die Vorrichtung in Anspruch 5, wobei der erste und der zweite Gas-Injektionsbrenner (108) Teil einer mehrteiligen Öffnung sind, die mindestens im Wesentlichen einen Umfang der Mischkammer (106) umgibt.

7. Die Vorrichtung in Anspruch 5 oder Anspruch 6, wobei der erste und der zweite Gas-Injektionsbrenner (108) durch Naben (24) getrennt sind.

8. Die Vorrichtung in einem der Ansprüche 5 bis 7 darüberhinaus bestehend aus einem Plenum (30) auf einem Pneumatikpfad zwischen dem Mischgasauslass der Mischgasquelle und dem ersten und zweiten Gas-Injektionsbrenner (108), um einen Gasfluss aus der Mischgasquelle zwischen dem ersten und zweiten Gas-Injektionsbrenner (108) gleichmäßig zu verteilen.

9. Die Vorrichtung in Anspruch 8, wobei mindestens vier erste Gas-Injektionsbrenner (108) um einen Umfang der Mischkammer (106) verteilt sind und jeweils vom Mischgasauslass der Mischgasquelle über das Plenum (30) abhängig sind.

10. Die Vorrichtung in Anspruch 8 oder Anspruch 9, wobei das Plenum (30) zwischen einem inneren zylindrischen Leitungsabschnitt und einem äußeren zylindrischen Leitungsabschnitt definiert ist, die jeweils einen Pneumatik-Durchflussweg umgeben, der vom Einlass zum Auslass des Dispergators verläuft.

11. Die Vorrichtung in Anspruch 8 oder Anspruch 9 oder Anspruch 10, wobei die vier Gas-Injektionsbrenner (108) durch Naben (24) getrennt sind, die in eine Richtung parallel zum Durchflussweg von einem kreisförmigen Endbereich des inneren zylindrischen Leitungsabschnitts zeigen und gegen einen anderen zylindrischen Leitungsabschnitt stoßen, der den Pneumatikstrom umgibt.

12. Die Vorrichtung in einem der vorhergehenden Ansprüche, wobei der erste Gas-Injektionsbrenner (108) mindestens im Wesentlichen einen Umfang der Mischkammer (106) umgibt.

13. Die Vorrichtung in einem der vorhergehenden Ansprüche, wobei mindestens vier erste Gas-Injektionsbrenner (108) um einen Umfang der Mischkammer (106) verteilt sind und jeweils einen Einlass zu einem Mischgasauslass einer Mischgasquelle und einen Mischauslass aufweisen, der sich in die Mischkammer (106) öffnet.

14. Die Vorrichtung in Anspruch 13, wobei die Gas-Injektionsbrenner (108) durch mindestens eine segmentierte Dispergator-Kontaktfläche definiert sind.

15. Ein Inline-Pulvermischverfahren, bestehend aus:

der Aufnahme eines Pneumatikstromes, der Schwebeteilchen enthält, in eine Vorrichtung gemäß Anspruch 1,
Erzeugung einer Verwirbelung im aufgenommenen Pneumatikstrom durch Injektion eines Mischgases aus einer Vielzahl unterschiedlicher Richtungen im aufgenommenen Pneumatikstrom, um eine Sprühströmung durch Aufbrechen der zusammengeballten Teilchen zu erzeugen und/oder die Verhinderung der Zusammenballung der Teilchen, und

Weiterleitung der Sprühströmung an ein nachgeordnetes Messgerät, und
Verwendung des Gerätes zur Überwachung der Größe der Teilchen in der Sprühströmung; wobei die Injektionsrichtungen eines Mischgases in einem Winkel im Verhältnis zum Pneumatikstrom mit einer ersten Komponente in ablaufseitiger Richtung und einer zweiten größeren Komponente in einer nach innen verlaufenden radialen Richtung im Verhältnis zur Leitung platziert sind.

Revendications

1. Un appareil comprenant :

un distributeur de poudre en ligne (10), comprenant :

une admission pneumatique (102) possédant une première ouverture de conduite,
une chambre de mélange (106) placée pneumatiquement en aval de l'admission pneumatique (102),
au moins un premier port d'injection de gaz (108) possédant une admission (22) réactive à une sortie de gaz mélangeur d'une source de gaz mélangeur et une sortie de mélange qui s'ouvre dans la chambre de mélange, et
une sortie pneumatique (104) placée pneumatiquement en aval de la chambre de mélange (106) et possédant une deuxième ouverture de conduite,

caractérisé en ce que l'appareil comprend en outre :

un dispositif de mesure aval agencé de façon à recevoir un flux de particules acheminé pneumatiquement à partir de la sortie pneumatique (104) et configuré de façon à surveiller la taille des particules dans le flux de particules,
où le distributeur de poudre (10) est conçu de façon à briser des particules agrégées et/ou à empêcher l'agrégation de particules par la création d'une turbulence dans le flux de particules dans la chambre de mélange lorsqu'un gaz mélangeur sous pression est injecté au travers du port d'injection de gaz (108), et
où une direction d'injection de la sortie de mélange d'au moins le premier port d'injection (108) est placée à un angle par rapport au flux avec un premier composant dans la direction aval et un deuxième composant plus grand dans une direction radiale vers l'intérieur par rapport au conduit.

2. L'appareil selon la Revendication 1 comprenant en outre une source de gaz mélangeur possédant une sortie de gaz mélangeur.

3. L'appareil selon la Revendication 1 ou 2 où les première et deuxième ouvertures de conduite sont de la même taille et forme et sont de la même taille et forme qu'une ouverture de la chambre de mélange (106).

4. L'appareil selon l'une quelconque des Revendications 1 à 3 où une direction d'injection de la sortie de mélange du premier port d'injection est de 75 degrés à partir d'une direction d'écoulement dans la chambre de mélange (106).

5. L'appareil selon l'une quelconque des Revendications 1 à 4 comprenant en outre un deuxième port d'injection de gaz (108) possédant une admission réactive à une sortie de gaz mélangeur d'une source de gaz mélangeur et une sortie de mélange qui s'ouvre dans la chambre de mélange (106).

6. L'appareil selon la Revendication 5 où les premier et deuxième ports d'injection de gaz (108) font partie d'une ouverture à parties multiples qui entoure au moins sensiblement une circonférence de la chambre de mélange (106).

7. L'appareil selon la Revendication 5 ou 6 où les premier et deuxième ports d'injection de gaz (108) sont séparés par des bossages (24).

8. L'appareil selon l'une quelconque des Revendications 5 à 7 comprenant en outre un plénum (30) dans un trajet pneumatique entre la sortie de gaz mélangeur de la source de gaz mélangeur et les premier et deuxième ports d'injection de gaz (108) de façon à distribuer de manière égale un flux de gaz à partir de la source de gaz mélangeur entre les premier et deuxième ports d'injection de gaz (108).

9. L'appareil selon la Revendication 8 où au moins quatre premiers ports d'injection de gaz (108) sont distribués autour d'une périphérie de la chambre de mélange (106) et chacun d'eux est réactif à la sortie de gaz mélangeur de la source de gaz mélangeur par l'intermédiaire du plénum (30).

10. L'appareil selon la Revendication 8 ou 9 où le plénum (30) est défini entre une section de conduit cylindrique interne et une section de conduit cylindrique externe qui entourent chacun un trajet d'écoulement pneumatique qui passe de l'admission vers la sortie du distributeur.

11. L'appareil selon la Revendication 8 ou 9 ou 10 où les quatre ports d'injection de gaz (108) sont séparés par des bossages (24) tournés dans une direction parallèle au trajet d'écoulement à partir d'une zone d'extrémité circulaire de la section de conduit cylindrique interne et venant en butée contre une autre section de conduit cylindrique qui entoure le flux pneumatique.

12. L'appareil selon l'une quelconque des Revendications précédentes où le premier port d'injection de gaz (108) entoure au moins sensiblement une circonférence de la chambre de mélange (106).

13. L'appareil selon l'une quelconque des Revendications précédentes où au moins quatre premiers ports d'injection de gaz (108) sont distribués autour d'une périphérie de la chambre de mélange (106) et chacun d'eux possède une admission réactive à une sortie de gaz mélangeur d'une source de gaz mélangeur et une sortie de mélange qui s'ouvre dans la chambre de mélange (106).

14. L'appareil selon la Revendication 13 où les ports d'injection de gaz (108) sont définis par au moins une face de contact de distributeur segmentée.

15. Un procédé de mélange de poudre en ligne, comprenant :

la réception d'un flux pneumatique qui comprend des particules suspendues dans un appareil selon la Revendication 1,
la provocation d'une turbulence dans le flux pneumatique reçu par l'injection d'un gaz mélangeur à partir d'une pluralité de directions différentes dans le flux pneumatique reçu de façon à créer un flux dispersé par le bris de particules agrégées et/ou la prévention de l'agrégation de particules, et
la fourniture du flux dispersé vers un instrument de mesure aval, et l'utilisation de l'instrument de façon à surveiller la taille de particules dans le flux dispersé, où les directions d'injection d'un gaz mélangeur sont placées à un angle par rapport au flux pneumatique avec un premier composant dans la direction aval et un deuxième composant plus grand dans une direction radiale vers l'intérieur par rapport au conduit.

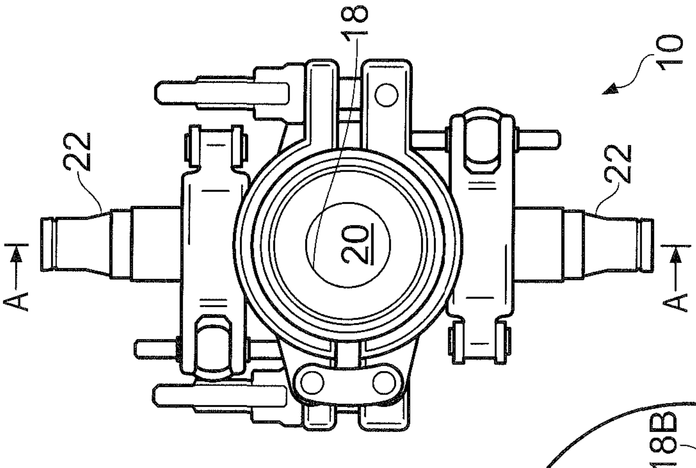
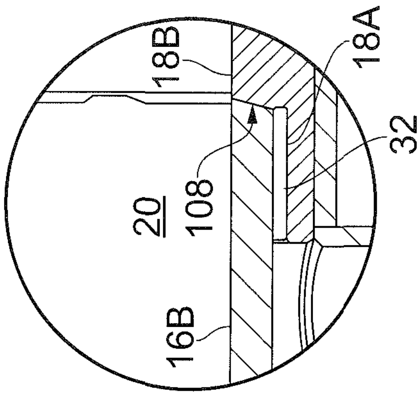


FIG. 1



DETAIL B

FIG. 3

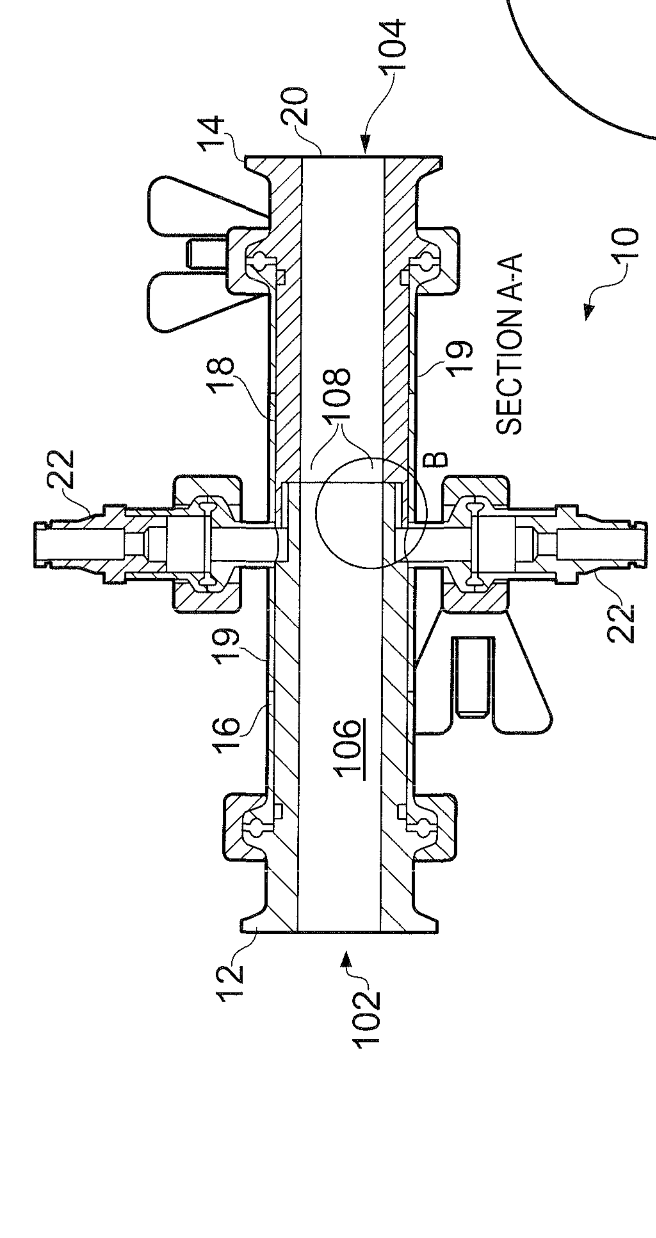


FIG. 2

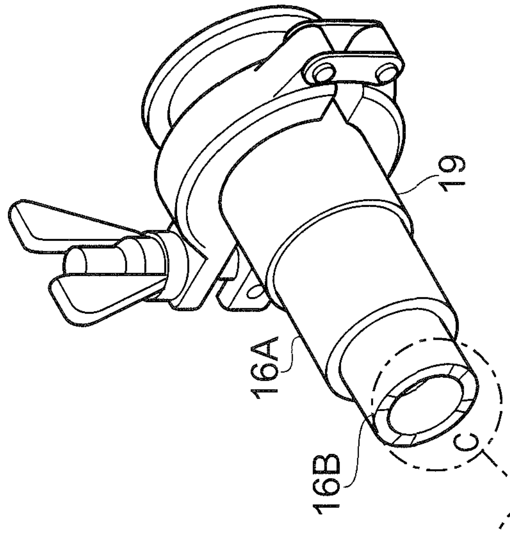
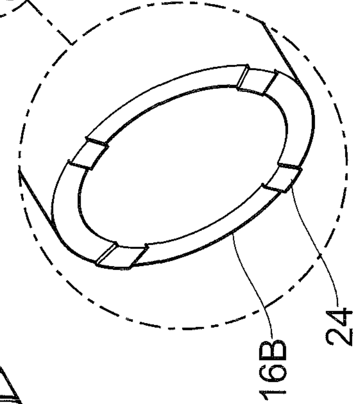


FIG. 5



DETAIL C
FIG. 6

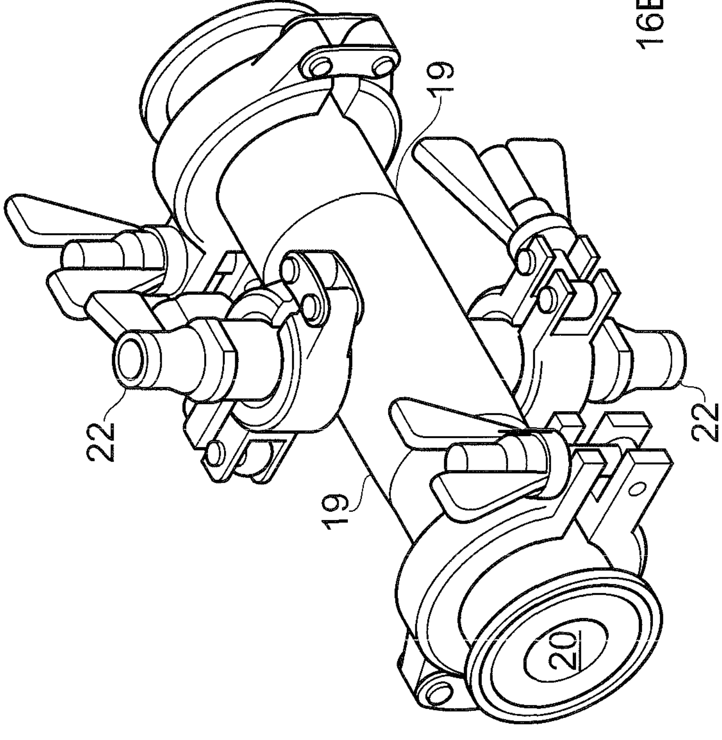


FIG. 4

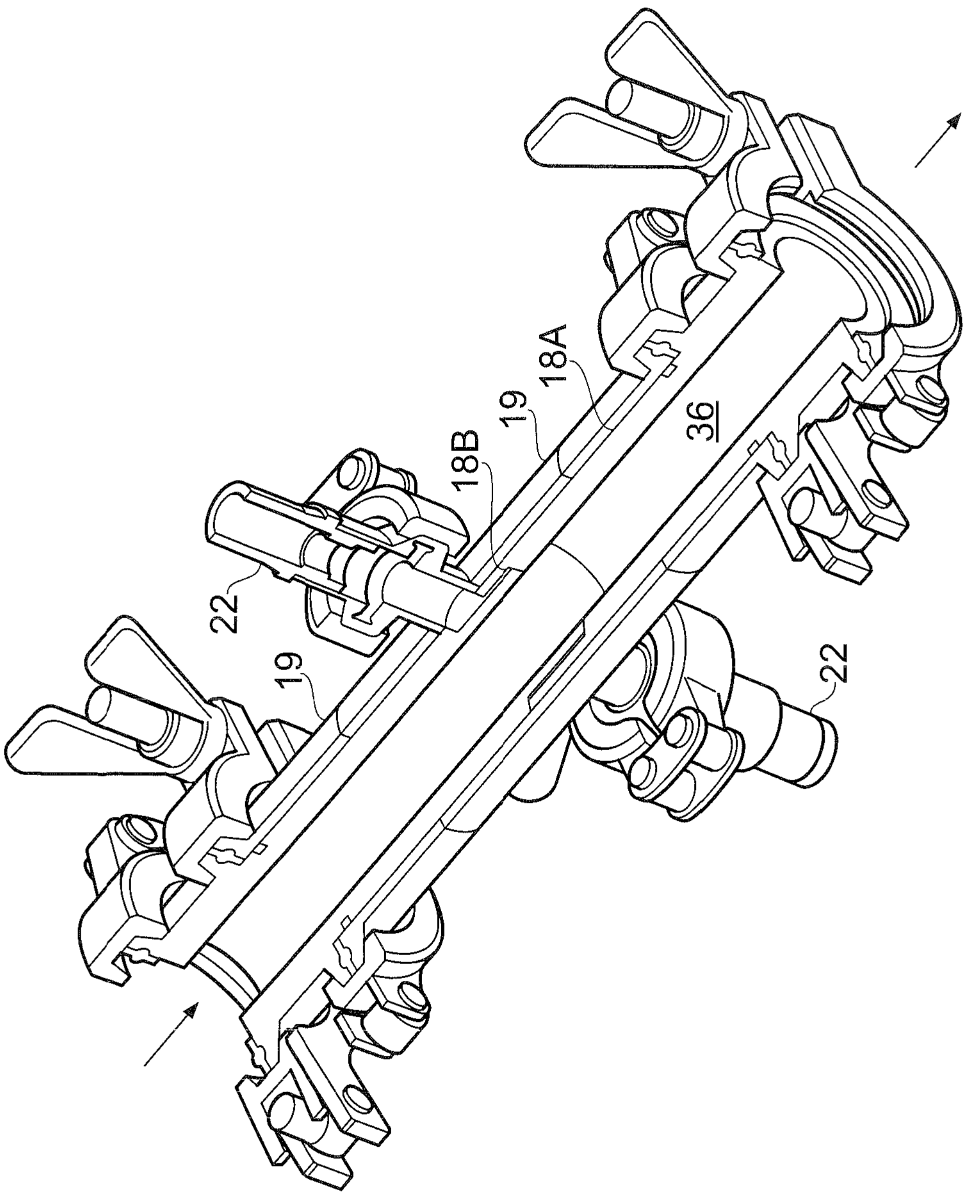


FIG. 7

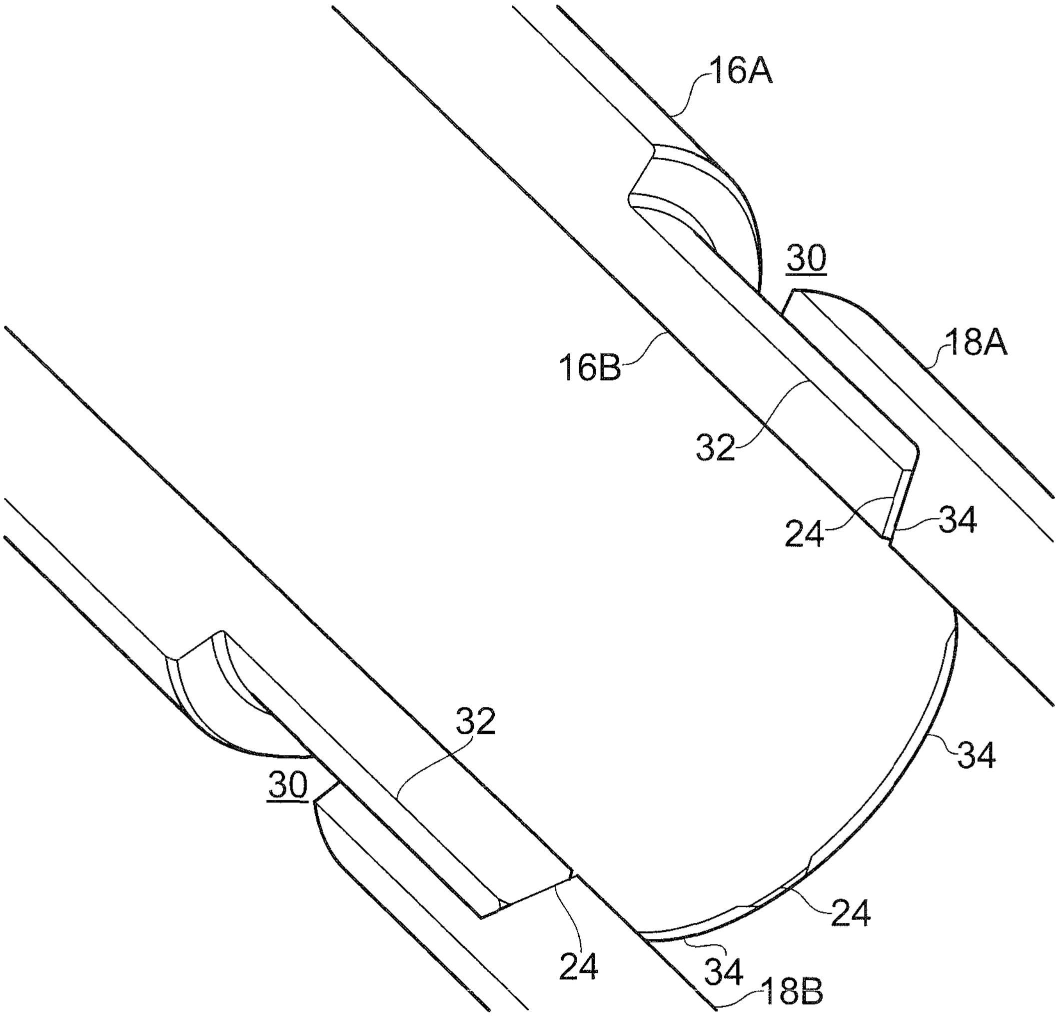


FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 9856696 A **[0002]**
- US 20050201199 A **[0003]**
- EP 0925827 A **[0004]**
- US 5722802 A **[0005]**
- JP 63262338 A **[0006]**