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Hu et al.

(54) **VESSEL APPARATUS WITH FLOW CONTROL ELEMENT**

(71) Applicant: **GENERAL ELECTRIC COMPANY**, Schenectady, NY (US)

(72) Inventors: **Lishun Hu**, Shanghai (CN); **Wei Chen**, Shanghai (CN)

(73) Assignee: **General Electric Company**, Schenectady, NY (US)

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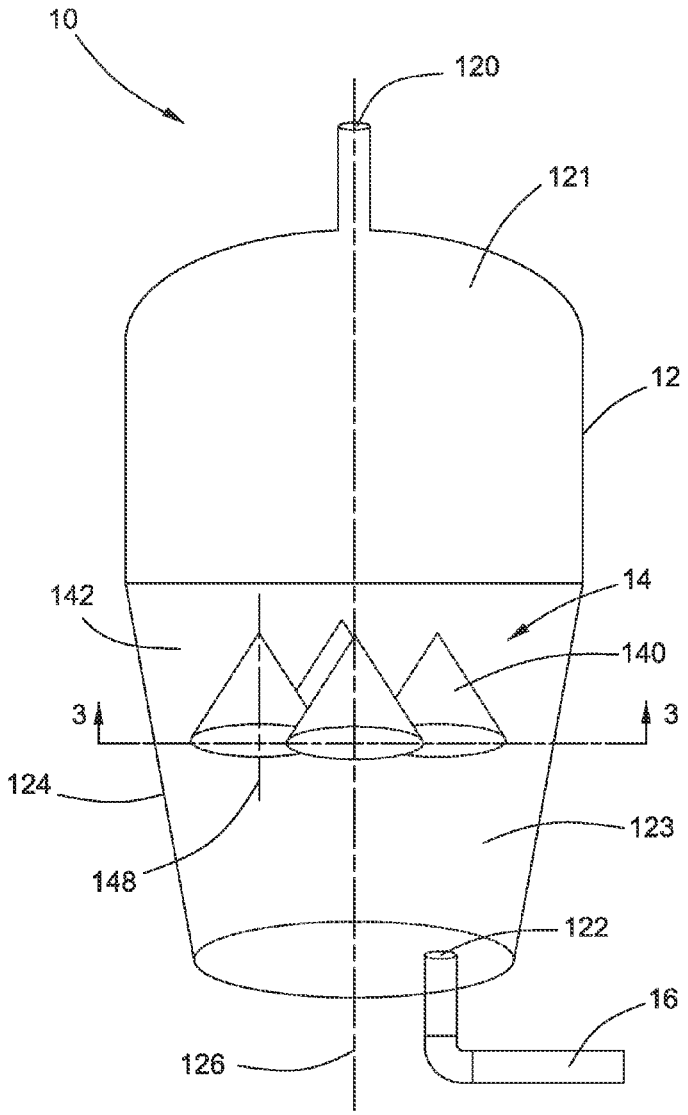
(57) **ABSTRACT**

A vessel apparatus includes a pressurized vessel and at least one flow control element. The at least one flow control element is located within the pressurized vessel and has an upwardly-converging wall.



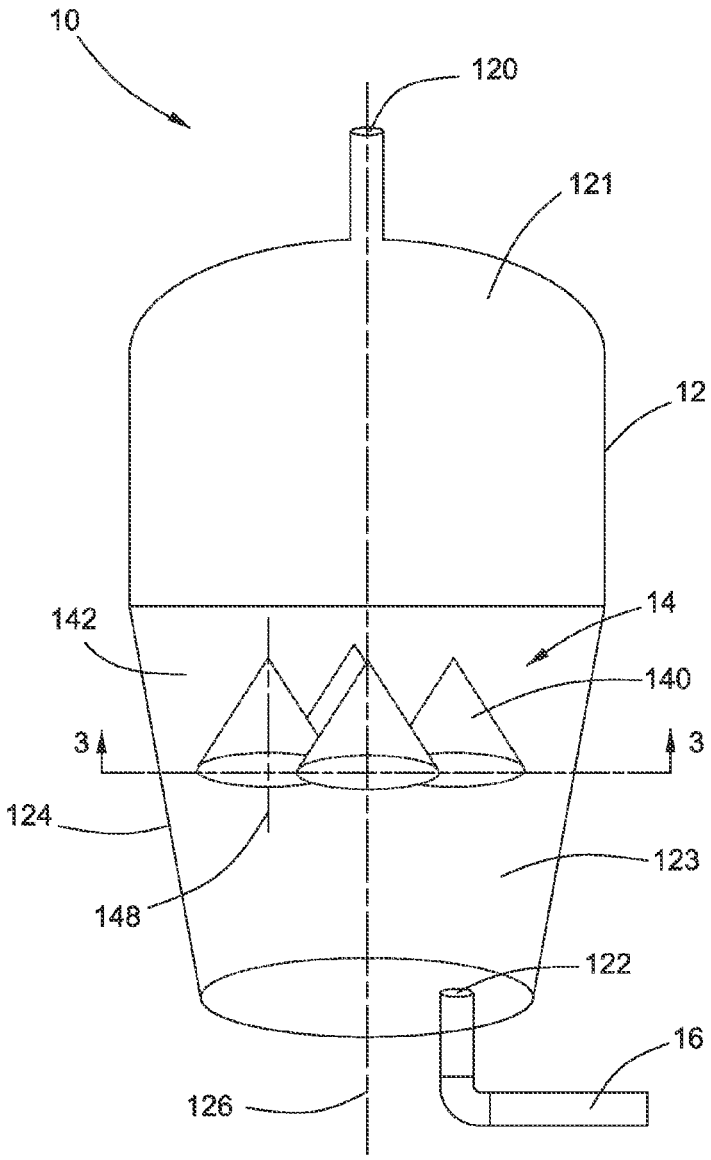


FIG. 1

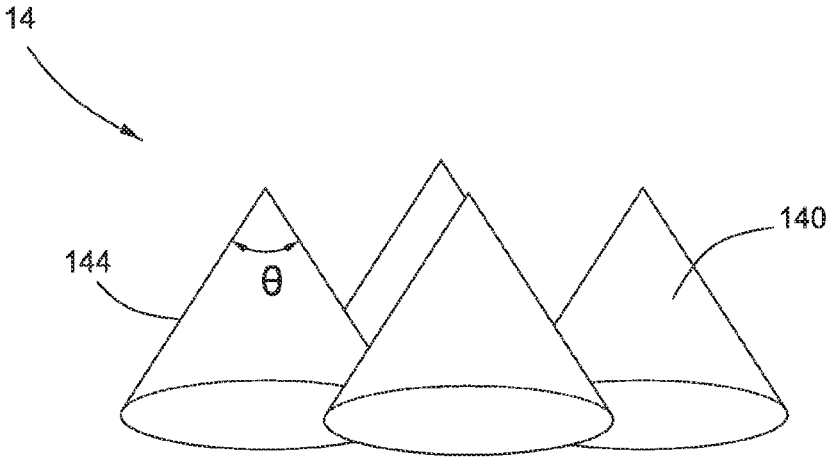


FIG. 2

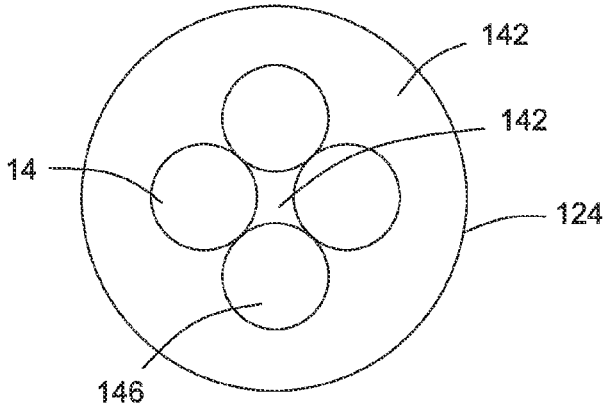


FIG. 3

VESSEL APPARATUS WITH FLOW CONTROL ELEMENT

BACKGROUND

[0001] Embodiments of the present invention relate generally to a vessel apparatus, and more particularly relate to a high pressure vessel apparatus having one or more flow control elements in a pressurized vessel to equalize a flow rate of substances discharged from the pressurized vessel.

[0002] Various vessel apparatuses have been built for discharging substances such as particulate solids. The vessel apparatus includes a pressurized vessel having an inlet orifice at an upper end thereof and an outlet orifice at a lower end thereof. The substances are injected into the pressurized vessel from the inlet orifice and discharged from the outlet orifice. Usually, the substances not near walls of the pressurized vessel flow out easily and form a flow path, and the substances near the walls of the pressurized vessel flow slowly or even stagnate to form a dead region. After the substances in the flow path are discharged, the substances in the dead region collapse which results in the flow rate of the substances decreases. Therefore, the flow rate of the substances is unstable and affects the injection of the substances into an apparatus, such as a burner, receiving the substances from the outlet orifice of the vessel apparatus.

[0003] It is desirable to provide a vessel apparatus to address the above-mentioned problem.

BRIEF DESCRIPTION

[0004] In accordance with an embodiment of the present invention, a vessel apparatus includes a pressurized vessel and at least one flow control element. The at least one flow control element is located within the pressurized vessel and has an upwardly-converging wall.

[0005] In accordance with an embodiment of the present invention, a vessel apparatus includes a pressurized vessel and at least one flow control element. The pressurized vessel has a downwardly-converging wall. The at least one flow control element is located within the pressurized vessel and has an upwardly-converging wall. One or more downwardly-converging channels are formed between the downwardly-converging wall and the upwardly-converging wall.

[0006] In accordance with an embodiment of the present invention, a vessel apparatus includes a pressurized vessel and a flow control mechanism. The flow control mechanism is mounted in the pressurized vessel and forms one or more downwardly-converging channels in the pressurized vessel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] These and other features and aspects of the present disclosure will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

[0008] FIG. **1** is a schematic diagram of a vessel apparatus in accordance with an embodiment of the present invention;

[0009] FIG. **2** is a schematic diagram of flow control elements of the vessel apparatus of FIG. **1**; and

[0010] FIG. **3** is a sectional view of the vessel apparatus taken along line **3-3** of FIG. **1**.

DETAILED DESCRIPTION

[0011] Unless defined otherwise, technical and scientific terms used herein have the same meaning as is commonly understood by one of ordinary skill in the art to which this disclosure belongs. The terms "first", "second", and the like, as used herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another. Also, the terms "a" and "an" do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced items. The use of "including," "comprising" or "having" and variations thereof herein are meant to encompass the items listed thereafter and equivalents thereof as well as additional items. The terms "connected" and "coupled" are not restricted to physical or mechanical connections or couplings, and can include electrical connections or couplings, whether direct or indirect.

[0012] FIG. **1** illustrates a schematic diagram of a vessel apparatus **10** in accordance with an embodiment of the present invention. The vessel apparatus **10** for uniformly discharging substances (not shown), such as particulate solids, therefrom includes a pressurized vessel **12** and a flow control mechanism **14** mounted in the pressurized vessel **12**. The pressurized vessel **12** is configured to receive and discharge the substances. The pressurized vessel **12** is structured to withstand pressures ranging from about 0 bar absolute to about 200 bar absolute. In the illustrated embodiment of the present invention, the pressurized vessel **12** has an upper portion **121** and a lower portion **123** communicating with the upper portion **121**. The upper portion **121** is substantially cylinder-shaped for receiving the substances. The lower portion **123** has a downwardly-converging wall **124** for discharging the substances. The lower portion **123** is back-off circular truncated cone shaped. In an embodiment of the present invention, the lower portion **123** is hopper-shaped or in any other shapes.

[0013] The pressurized vessel **12** has an inlet orifice **120** in the upper portion **121** thereof and an outlet orifice **122** in the lower portion **123** thereof. The substances are injected from the inlet orifice **120** into the pressurized vessel **12** and discharged from the outlet orifice **122** into a device (not shown), such as a burner, a reactor and so on, which communicates with the vessel apparatus **10**. In the illustrated embodiment of the present invention, the vessel apparatus **10** has an outlet pipe **16** connecting the outlet orifice **122** and the device (not shown). The pressurized vessel **12** has only one outlet orifice **122** so as to measure and control the discharged substances easily. In embodiments of the present invention, the pressurized vessel **12** has two or more than two outlet orifices **122**.

[0014] Referring to FIGS. **1** to **3**, the flow control mechanism **14** is positioned in the lower portion **123** of the pressurized vessel **12**. The flow control mechanism **14** forms one or more downwardly-converging channels **142** in the pressurized vessel **12**. The downwardly-converging channels **142** are formed between the flow control mechanism **14** and the downwardly-converging wall **124** of the pressurized vessel **12** and/or formed through the flow control mechanism **14**. The substances flow though the downwardly-converging channels **142** to form local mass flow, thus it improves the flow ability and increases the discharging stability.

[0015] The flow control mechanism **14** includes at least one flow control element **140** located within the pressurized vessel **12**. The illustrated embodiment of the present invention shows four flow control elements **140** for example. The number of the flow control elements **140** may change according to

particular applications. In embodiments of the present invention, the flow control mechanism **14** may have one, two or more than two flow control elements **140**. The bulkier the pressurized vessel **12** is, the more flow control elements **140** may be utilized to make sure the downwardly-converging channels **142** is narrow enough to form local mass flow.

[0016] The flow control elements **140** are positioned in the lower portion **123** of the pressurized vessel **12**. A height of each of the flow control elements **140** is less than that of the lower portion **123** of the pressurized vessel **12** and the flow control elements **140** are away from a lower end of the pressurized vessel **12**. Each of the flow control elements **140** has an upwardly-converging wall **144**. The downwardly-converging channels **142** are formed between the downwardly-converging wall **124** of the pressurized vessel **12** and the upwardly-converging wall **144** and formed between the upwardly-converging walls **144** of the flow control elements **140**.

[0017] The flow control elements **140** have the same shape and size which are preferred to minimize interferences between the flow control elements **140** so as to equalize the flow rate of the discharged substances. Each of the flow control elements **140** is cone-shaped having an included angle θ less than 90 degrees, preferably 20-40 degrees. The included angle θ of the flow control element **140** can be changed to form the local mass flow and lower wall friction. The exterior of the upwardly-converging walls **144** of the flow control elements **140** and/or the interior of the downwardly-converging wall **124** of the pressurized vessel **12** may be coated with polyethylene or with any other material well known to the art for reducing the wall friction.

[0018] Each of the flow control elements **140** has a longitudinal axis **148** parallel to a longitudinal axis **126** of the pressurized vessel **12** because parallelism contributes to uniform substances movement by gravity so as to achieve an equalized flow rate of substances discharged therefrom. The flow control elements **140** are arranged latitudinal and adjacent to each other. Round bottom surfaces **146** of adjacent flow control elements **140** are tangent. In embodiments of the present invention, the flow control elements **140** are close to each other but don't contact each other to leave spaces there between.

[0019] The flow control element **140** may be formed by molding so that it is easy to manufacture. The flow control element **140** may be solid or hollow. The flow control element **140** is mounted in the pressurized vessel **12** through thin sticks (not shown) or any other means connecting the flow control element **140** and the pressurized vessel **12**. In embodiments of the present invention, the flow control element **140** and the pressurized vessel **12** may be molded integrally.

[0020] While embodiments of the present invention have been described herein, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the present invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the present invention not be limited to the particular embodiment of the present invention disclosed as the best mode contemplated for carrying out the present invention, but that the present invention will include all embodiments falling within the scope of the appended claims.

[0021] Furthermore, the skilled artisan will recognize the interchangeability of various features from different embodiments of the present invention. The various features described, as well as other known equivalents for each feature, can be mixed and matched by one of ordinary skill in this art to construct additional systems and techniques in accordance with principles of this disclosure.

What is claimed is:

1. A vessel apparatus comprising:
a pressurized vessel; and
at least one flow control element located within the pressurized vessel and having an upwardly-converging wall.

2. The vessel apparatus of claim **1**, wherein the at least one flow control element is cone-shaped.

3. The vessel apparatus of claim **2**, wherein the at least one flow control element has an included angle less than 90 degrees.

4. The vessel apparatus of claim **2**, wherein the at least one flow control element has a longitudinal axis parallel to a longitudinal axis of the pressurized vessel.

5. The vessel apparatus of claim **1**, wherein a lower portion of the pressurized vessel has a downwardly-converging wall, and the at least one flow control element is positioned in the lower portion of the pressurized vessel.

6. The vessel apparatus of claim **1**, wherein the at least one flow control element comprises multiple flow control elements arranged latitudinal.

7. The vessel apparatus of claim **6**, wherein the multiple flow control elements have the same shape and size.

8. A vessel apparatus comprising:
a pressurized vessel having a downwardly-converging wall; and
at least one flow control element located within the pressurized vessel and having an upwardly-converging wall;
wherein one or more downwardly-converging channels are formed between the downwardly-converging wall and the upwardly-converging wall.

9. The vessel apparatus of claim **8**, wherein the at least one flow control element is cone-shaped.

10. The vessel apparatus of claim **9**, wherein the at least one flow control element has an included angle less than 90 degrees.

11. The vessel apparatus of claim **9**, wherein the at least one flow control element has a longitudinal axis parallel to a longitudinal axis of the pressurized vessel.

12. The vessel apparatus of claim **8**, wherein the at least one flow control element comprises multiple flow control elements arranged latitudinal.

13. The vessel apparatus of claim **12**, wherein the multiple flow control elements have the same shape and size.

14. A vessel apparatus comprising:
a pressurized vessel; and
a flow control mechanism mounted in the pressurized vessel and forming one or more downwardly-converging channels in the pressurized vessel.

15. The vessel apparatus of claim **14**, wherein the flow control mechanism comprises at least one flow control element having an upwardly-converging wall.

16. The vessel apparatus of claim **15**, wherein the at least one flow control element is cone-shaped.

17. The vessel apparatus of claim **16**, wherein the at least one flow control element has an included angle less than 90 degrees.

18. The vessel apparatus of claim **16**, wherein the at least one flow control element has a longitudinal axis parallel to a longitudinal axis of the pressurized vessel.

19. The vessel apparatus of claim **15**, wherein the at least one flow control element comprises multiple flow control elements arranged latitudinal.

20. The vessel apparatus of claim **14**, wherein a lower portion of the pressurized vessel has a downwardly-converging wall, and the flow control mechanism is positioned in the lower portion of the pressurized vessel.

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