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THICKENER FEED DISTRIBUTOR

ABSTRACT OF THE DISCLOSURE

A feedwell comprising a plurality of holes disposed in a bottom thereof, at least some of the holes having a tube disposed thereabout which extends downward or otherwise away from an interior of the feedwell. Optionally, a large center hole can be provided and it can have a tube disposed around it. By providing a plurality of holes spread across a large portion of the bottom of the feedwell, lower velocity flow rates from the feedwell to a sedimentation chamber can be provided, thus reducing induced turbulence in the fluid within the sedimentation chamber, while still providing sufficient separation of the feedwell from the sedimentation chamber so that the contents of the feedwell can be properly and adequately mixed.

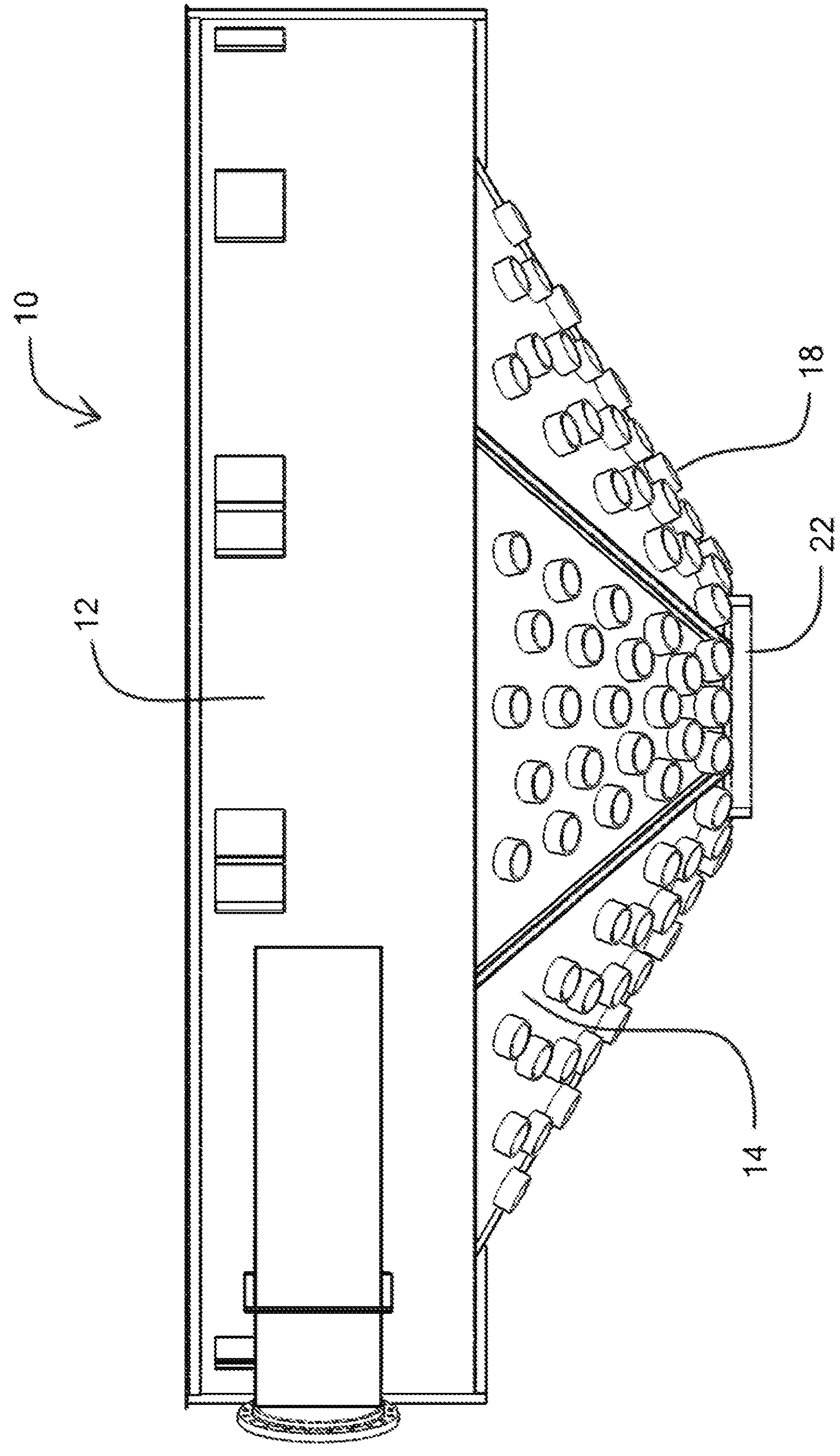

Fig. 3

THICKENER FEED DISTRIBUTOR

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and the benefit of the filing of U.S. Provisional Patent Application Serial No. 62/135,497, entitled "Thickener Feed Distributor", filed on March 19, 2015.

BACKGROUND OF THE INVENTION

Field of the Invention (Technical Field):

[0002] Embodiments of the present invention relate to feedwells for mineral processing plant thickeners and clarifiers. More particularly, embodiments of the present invention relate to feedwells having a plurality of openings disposed on a lower portion thereof for more uniform distribution of fluids from the feedwell into fluids disposed in a sedimentation chamber (also known as a thickener tank) disposed there below.

Description of Related Art:

[0003] Note that the following discussion refers to a number of publications by author(s) and year of publication, and that due to recent publication dates certain publications are not to be considered as prior art vis-a-vis the present invention. Discussion of such publications herein is given for more complete background and is not to be construed as an admission that such publications are prior art for patentability determination purposes.

[0004] For a feedwell to provide desirable results, it must permit components to be mixed and retained therein and thus have rather substantial and appropriate fluid kinetics. However, the feedwell should also isolate, to the greatest extent possible, such fluid kinetics from the contents of the sedimentation chamber, while still permitting a sufficient fluid flow rate from the feedwell to the sedimentation tank to accomplish a desired overall feed flow rate.

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[0005] A typical feedwell is shown and described in U.S. Patent Pub. No. 2011/0079563 (the '563 application), having a single, large outlet as shown in the figures thereof (reference numeral 8). Such feedwells are common and have the characteristic downside of forcing all contents of the feedwell to escape through a single large opening in the bottom. Such a configuration enhances turbulence and creates undesirable flow patterns within the upper portion of the sedimentation chamber within which it is disposed. Although the '563 application seeks to reduce such turbulence by disposing a plurality of fins into the single large opening, such fins themselves disturb the flow of the exiting fluid, thus enhancing the turbulence induced within the sedimentation chamber, which is an undesirable characteristic.

[0006] Some inventions, such as that disclosed in U.S. Patent No. 7,591,946 to Taylor, seek to minimize the induced turbulence by forcibly mixing the contents of its feedwell in a lower portion thereof and forcing the contents of the feedwell to escape therefrom at an upper opening through a Bundt pan shape. By forcing the discharge of the feedwell to be concentrated near a central bottom portion of the feedwell, the flow rate of the discharge is thus comparatively larger than would occur if Taylor instead spread the discharge of the feedwell out over a much larger area.

[0007] Like other known feedwell designs, U.S. Patent Application Serial No. 12/633,527 to Lake et al. also describes a feedwell with a single large opening disposed in its lower portion. Thus, this invention also suffers from the same undesirable turbulence and flow patterns that are induced in the sedimentation chamber as the other known systems.

[0008] U.S. Patent Application Serial No. 12/745,891 to McElvenny also discloses a feedwell with a single large opening on its bottom. The apparatus disclosed in this application, however, attempts to mitigate the disturbance to the liquid in the sedimentation chamber by placing a conical plate directly below the outlet of the feedwell so as to spread out the flow of fluid exiting the feedwell into a larger ring-shape. However, even this proposed solution does not distribute the outflow of the feedwell over a significant area, because the very plate itself blocks a significant area below the flow in which some of the outflow could travel.

[0009] Other systems have also been developed which seek to make the outflow of the feedwell more uniform by incorporating a flow-shaping zone near the single large outlet of the feedwell. However, the result is still substantially the same – the entire outflow of the feedwell is concentrated in a single entry point in the sedimentation chamber, thus inducing turbulence in the contents of the sedimentation chamber.

[0010] There is thus a present need for a method and apparatus which provides a feedwell that distributes the outflow of the feedwell into the sedimentation chamber over a vastly large area so as to minimize turbulence in the contents of the sedimentation chamber.

BRIEF SUMMARY OF THE INVENTION

[0011] An embodiment of the present invention relates to a feedwell having a feed inlet, a sidewall, a bottom, at least three holes disposed in the bottom of the feedwell, and a tube disposed around at least one of the holes and projecting down or otherwise away from an interior of the feedwell. Optionally, at least a majority of the holes each comprise a corresponding tube. One or more of the tubes can have a length which is greater than at least one half of the diameter of the corresponding hole about which or within which it is disposed. The feedwell can have at least 12 holes and optionally at least 36 holes disposed in its bottom. In one embodiment, the hole size can be several times the diameter of an expected floccule, thus permitting floccules to pass through the holes without being broken down. The feedwell can also include an inlet and/or at least one opening in its sidewall. Optionally, a plurality of openings can be disposed in a sidewall of the feedwell. The openings can be disposed in an upper half of the sidewall.

[0012] In one embodiment, the feedwell can comprise a comparatively large opening in the center of the bottom of the feedwell. Optionally, the central opening can comprise a cross-sectional area that is two or more times larger than a cross-sectional area of one of the other holes disposed in the bottom of the feedwell.

[0013] An embodiment of the present invention also relates to a feedwell having a sidewall, a bottom, a first opening in the bottom, a plurality of second openings in the bottom, each of the plurality of second openings having a cross-sectional area which is less than one-half of a cross-sectional area of said first opening; and at least some of the second openings comprising a corresponding tube disposed around the openings which projects down or away from an interior of the feedwell. Optionally, the feedwell can have a bottom that is downwardly-depending and cone-shaped. A velocity regulator and/or a flow rate regulator can be communicably coupled to one or more of the holes.

[0014] An embodiment of the present invention also relates to a method for dispensing contents of a feedwell into a sedimentation chamber which includes passing the contents from within the feedwell through a plurality of openings disposed in a bottom of the feedwell, wherein the plurality of openings number at least six openings. The method can also include guiding at least some of the contents from within the feedwell to a location within the sedimentation chamber by directing them through one or more tubes disposed around at least some of the openings. Optionally, at least three openings can be disposed in the bottom of the feedwell. Preferably, the openings and tubes are consistent in design radially.

[0015] Embodiments of the feedwell of the present invention permit deaeration, mixing at the right energy level, flocculation, and solids contact therein. The holes allow the feed to be evenly distributed into a sedimentation chamber in a controlled manner with little turbulence. Feedwells according to embodiments of the present invention maintain retention required for optimal mixing. The tubes connected to the holes in the bottom of the feedwell allows for instantaneous recovery of the liquid via the open channels which can be created with an off-set pattern in the layout. The liquid can be recovered very close to the feedwell underside, thereby shortcutting the typical scenario which is normally only achieved lower in the thickener. This process in known systems is often hindered by settling solids, rise rates, and other dynamics within the thickener proper.

[0016] Objects, advantages and novel features, and further scope of applicability of the present invention will be set forth in part in the detailed description to follow, taken in conjunction with the accompanying drawings. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0017] The accompanying drawings, which are incorporated into and form a part of the specification, illustrate one or more embodiments of the present invention and, together with the description, serve to explain the principles of the invention. The drawings are only for the purpose of illustrating one or more preferred embodiments of the invention and are not to be construed as limiting the invention. In the drawings:

Fig. 1 is an elevated side-view drawing which illustrates a feedwell according to an embodiment of the present invention;

Fig. 2 is a drawing which illustrates an underside of a feedwell according to an embodiment of the present invention;

Fig. 3 is a side-view drawing of a feedwell according to an embodiment of the present invention;

Fig. 4 is a top-view drawing of a feedwell according to an embodiment of the present invention;

Fig. 5 and Fig. 6 are elevated side-view drawings which illustrate a feedwell according to an embodiment of the present invention disposed within a sedimentation chamber;

Fig. 7 is a section-view/cutaway drawing which illustrates a feedwell according to an embodiment of the present invention disposed in a sedimentation chamber;

Fig. 8 is a side-view drawing of a feedwell illustrating the modular bottom floor construction according to an embodiment of the present invention;

Fig. 9A and Fig. 9B are side-view drawings which illustrate an embodiment of the present invention wherein a fluid-flow modification structure is disposed below the feedwell;

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Fig. 10A and Fig. 10B are cut-away drawings which illustrate an embodiment wherein a vertical tube passes through the feedwell and wherein a fluid-flow modification structure is disposed on the lower end of the vertical tube; and

Fig. 11 is a cut-away side-view drawing which illustrates an embodiment wherein a vertical tube passes through the feedwell and wherein the bottom of the feedwell has an upwardly-projecting conical shape.

DETAILED DESCRIPTION OF THE INVENTION

[0018] Embodiments of the present invention relate to a feedwell for a thickener or clarifier, also generally referred to as a “thickener feed distributor.” The thickeners and clarifiers, used in mineral processing plants, rely on compartments or “feedwells” located at an upper center portion of a sedimentation chamber. The purpose of such feedwells is to deaerate the feed; permit introduction and mixing of slurries, flocculant, dilution water, or materials to a homogenous state; promote rapid flocculant/particle aggregate formation; capture fine and coarse particles into flocculant/particle aggregate formation through mixing at the right energy levels; prevent break-down of such flocculant/particle aggregates through excessive energy levels; and then simultaneously allow such materials to enter the sedimentation chamber with as little turbulence as possible after having been mixed so as to avoid agitating the sedimentation process. Fluid flow plays a major role in these sedimentation units and their successful operation depends, to a large extent, on having a feedwell correctly designed for the particular application.

[0019] Referring now to the drawings, feedwell **10** preferably comprises sidewall **12** and bottom **14**. Bottom **14** preferably comprises a plurality of holes **16**. Holes **16** preferably comprise tubes **18** disposed around holes **16**. Tubes **18** are preferably disposed on the outside portion of feedwell **10** and thus extend away from an interior of feedwell **10**. Holes and tubes are preferably radially consistent in pattern or design. An embodiment of the present invention also relates to a method and apparatus for controlling and/or regulating the flow rate and/or exit velocity of the contents of feedwell **10** through holes **16** in bottom **14** of feedwell **10**. This can be achieved by a self-regulating or adjustable valve, a one way valve, one directional flap, a port, a diaphragm, combinations thereof, and the like, which can be incorporated into

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and/or attached to one or more of holes **16** and/or tubes **18** of feedwell **10**. In one embodiment, feedwell **10** comprises a generally circular shape. In an alternative embodiment, feedwell **10** does not comprise a generally circular shape.

[0020] In one embodiment, in addition to a plurality of holes **16**, a large hole **20** is preferably disposed in a central portion of bottom **14** of feedwell **10**. Hole **20** also preferably has tube **22** disposed around it and tube **22** also is preferably disposed on an outside portion of feedwell **10** and thus extends away from an interior of feedwell **10**. Although a preferred embodiment provides feedwell **10** having a generally cylindrical shape, feedwell **10** need not be limited only to generally cylindrical shapes and can comprise any shape which permits materials to be mixed or clarified, including but not limited to rectangular, square and other shapes.

[0021] Although holes **16** can comprise any shape, including but not limited to triangular, square, rectangular, oval, etc., in a preferred embodiment, holes **16** are most preferably circular in shape. For embodiments in which non-circular shaped holes **16** are provided, tubes **18** preferably comprise a similar shape to non-circular holes **16**. Optionally, holes **16** need not all be the same shape and size. For example, some of holes **16** can be large squares, small squares, large rectangles, small rectangles, large triangles, small triangles, large circles and small circles. Optionally, the shapes and/or sizes of holes **16** can progressively change as they approach the center of bottom **14** or they can be interspersed in patterns or randomly. For example, in one embodiment, the holes nearest sidewall **12** can comprise a diameter which is smaller than those which are near the center of bottom **14**. Although the number and spacing of holes **16** can be varied to provide specific results for a particular application and for different sizes of feedwells, in one embodiment, there are at least three holes **16**, at least 6 holes **16**, at least 12 holes **16**, at least 24 holes **16**, at least 32 holes **16**, at least 36 holes **16**, or at least 60 holes **16**.

[0022] In one embodiment, bottom **14** of feedwell **10** can be flat or at least substantially flat. However, in a preferred embodiment, at least a portion of bottom **14** comprises a concave or conical shape, such as that illustrated in the figures. Optionally, a portion of bottom **14** nearest sidewall **12** can be flat while the rest of bottom **14** can have a concave shape (see for example Figs. 1 and 2). If the feed to the feedwell is tangential to a nearest sidewall, a flat portion of the bottom of the feed inlet nearest the sidewall is preferably proportional in width to the feed flow rate. In one embodiment, the flat portion of the feedwell is preferably below the bottom of the feed inlet by approximately the feed inlet height.

[0023] Tubes **18** can optionally comprise a length which is uniform to each of holes **16**. Optionally, however, some of tubes **18** can have a length which is longer or shorter than other tubes **18**. For example, in one embodiment, tubes **18** of holes **16** nearest sidewall **12** can have a length which is short in relation to tubes **18** of holes **16** which are nearest the center of bottom **14**. Optionally, the length of tubes **18** can be varied in a consistent manner – for example, the tubes nearest sidewall **12** can be long and each tube nearer to a center of bottom **14** can be progressively larger such that tubes **18** nearest the bottom are longer than tubes **18** which are nearest sidewall **12** (or vice-versa). Alternatively, the length of tubes **18** can be varied in some predetermined pattern or can be varied randomly. In one embodiment, wherein feedwell **10** comprises holes **16** with varying diameters, the length of tubes **18** can also vary as their diameters vary – optionally, the length of a tube **18** can relate directly to the diameter of its accompanying hole **16**. In one embodiment, the length of a tube is preferably at least half of the diameter of its accompanying hole. For example, if a first hole **16** is small and a second hole **16** is large, the length of the tube on the small first hole can be short and the length of the tube on the large second hole can be long. Optionally, tubes **18** can be connected to bottom **14** such that they project down or otherwise away from an interior of feedwell **10** in a desired and predetermined direction. For example, in one embodiment, wherein feedwell **10** comprises a flat bottom, tubes **18** nearest sidewall **12** can have their proximal end cut at an angle, such as for example 45 degrees. This outer ring of tubes can be oriented such that they project down or otherwise away from a center of bottom **14** at a 45 degree angle, and a row of tubes **18** further away from sidewall **12** can have their proximal ends cut at some other angle, for example, 30 degrees, etc. In such a configuration, the outer-most tubes **18** can be directed in a direction different from that of other tubes. Of course these are merely illustrative examples that one or more of tubes **18** can be made to point in a different direction than other tubes **18**. In one embodiment, tubes **18** can be arranged in a radially consistent pattern.

[0024] Optionally, all or some of tubes **18** can be made long and can comprise one or more bends. For example, in one embodiment, tubes **18** nearest sidewall **12** can comprise a bend and can be extended such that they project radially just below sidewall **12**. Further, providing tubes **18** connected to one or more of holes **16** permit a user to design a specific-purpose feedwell system which permits fluids to exit feedwell **10** and be piped directly to any desired location within a sedimentation chamber. In one embodiment, the hole and tube arrangement is preferably radially consistent in pattern for a round sedimentation chamber.

[0025] In one embodiment, tubes **18** can connect to bottom **14** via a removable connection. For example, tubes **18** can screw onto short nipples or other fittings such that a user can selectively connect tubes of different lengths, shapes, and/or sizes about any of holes **16**. Optionally, placement, size, and/or shape of holes **16** can be determined based on computer modeling for a particular application. In one embodiment, each of holes **16** comprise a corresponding tube **18**. In an alternative embodiment, a majority of holes **16** comprise a corresponding tube **18**. In yet a further embodiment, only one or some of holes **16** comprise a corresponding tube **18**. In an alternative embodiment, none of holes **16** comprise a corresponding tube **18**.

[0026] In one embodiment, central hole **20** can be significantly larger than any of holes **16**. Alternatively, however, hole **20** can be slightly larger, the same size as, or even smaller than any of holes **16**. In a further embodiment, hole **20** and/or tube **22** are not provided. Tube **22** can have the same length as tubes **18** or it can be shorter or longer than tubes **18**. As with tubes **18**, tube **22** can also comprise any desired length and can be shaped in in a number of ways such as concave-shape or cone shape and can connect to a connector, including but not limited to a nipple, which is attached to bottom **14** of feedwell **10**. Optionally tubes **18** and/or **22** can comprise one or more structures disposed therein which promote a laminar flow therefrom. For example, an array of smaller diameter tubes can be packed or otherwise formed within tubes **18** and/or **22**.

[0027] Fluid preferably enters feedwell **10** via inlet **24.** Optionally, a plurality of inlets **24** can be provided. Inlet **24** is preferably positioned on sidewall **12** and is most preferably positioned such that fluid entering feedwell **10** enters tangentially. Alternatively, however, inlet

24 can be disposed such that fluid enters into the open top of feedwell **10**. Also, inlet **24** can be positioned such that fluid does not enter tangentially into feedwell **10**. In one such embodiment, the feed can be introduced to feedwell **10** so that a radially inward or outward flow pattern is created. In a further embodiment, more than one inlet **24** can be provided. For example, in one embodiment, a first inlet can be configured to force incoming fluid to enter feedwell **10** in a counter-clockwise manner and a second inlet can be configured to also enter feedwell **10** in a counter-clockwise manner but at a location on an opposite side of feedwell **10** from the first inlet, thus promoting circulation. Alternatively, however, in some applications where increased turbulence is desired within feedwell **10**, the second inlet can be configured to enter feedwell **10** in a clockwise direction, thus forcing the incoming fluid streams to collide against one another. Like tubes **18** and **22**, one or more structures can be disposed or formed within inlet **24** which promote a laminar flow or any other flow pattern desired for a particular application.

[0028] In one embodiment, sidewall **12** can comprise a solid structure. In an alternative embodiment, sidewall **12** is not provided at all. In this embodiment, bottom **14** can be conical or otherwise downwardly-depending and inlet **24** can simply enter into the downwardly-depending bottom structure. In one embodiment, feed dilution can be carried out before the introduction of the feed to feedwell **10**. In an alternative embodiment, however, one or more openings **26** (see Fig. 1) can be provided in sidewall **12**, or of the conical or downwardly-depending structure, for embodiments which do not comprise a sidewall. Openings **26** can comprise any shape or combination of shapes and can be disposed in a predetermined pattern or at random. In a preferred embodiment, however, openings **26** are disposed near an upper edge of sidewall **12**, or an upper half of sidewall **12**, or the conical or downwardly-depending structure, for embodiments which do not comprise a sidewall, such that supernatant or dilution liquid can easily pass into the upper portion of feedwell **10** to dilute the contents thereof. In one embodiment, openings **26** are positioned near a top portion of sidewall **12** at a location which is left of inlet **24**. Optionally, one or more openings **26** can comprise a damper or other closable structure which reduces the size of openings **26** so that a user can adjust the size and number of openings **26** to meet a desired dilution rate.

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[0029] In one embodiment, feedwell **10** can be disposed such that it hangs just above or slightly into a surface of fluid in sedimentation chamber **28**. In a preferred embodiment, however, feedwell **10** is most preferably positioned such that a significant portion of it is submerged within the fluid contained in sedimentation chamber **28** (see Figs. 5-7 which illustrate a most preferred placement of feedwell **10** with regard to sedimentation chamber **28**).

[0030] Optionally, as best illustrated in Fig. 8, the bottom of the feedwell can be formed from a plurality of individual sections **30** that can be welded, bolted, or otherwise connected together. Sections **30** can be made from a urethane material, carbon or stainless steel, rubber-coated steel, rubber, fiber glass, aluminum, other metals, other composites, other plastics including but not limited to nylon, materials that provide desired wear and/or wear-resistance characteristics, materials that provide desired corrosion and/or corrosion resistance characteristics, combinations thereof and the like. Optionally, sections **30** can have a wedge or pie shape, or any other shape which is capable of forming a bottom of a feedwell. Thus, when one or more sections **30** wear out, they can quickly and easily be replaced.

[0031] In one embodiment, feedwell bottom **14** preferably comprises a conical or otherwise downwardly-depending shape rather than a flat or upward-projecting shape as more typical feedwells have. Because of the downward-depending shape of bottom **14**, the total volume of feedwell **10** is increased without requiring the diameter of feedwell **10** to be increased. Thus, compared to an upwardly-projecting bottom of a conventional feedwell, embodiments of the present invention provide a feedwell having a similar overall weight and diameter, but with significantly more internal volume - thus increasing the amount of retention, mixing, and floccule growth for the same size of footprint.

[0032] As best illustrated in Figs. 9A, 9B, 10A, and 10B, in one embodiment, one or more structures **32** can be disposed on a lower portion of, or directly below feedwell **10**. Structures, **32** preferably promote further fluid flow modifications to achieve desired objectives for particular applications of feedwell **10**. Although the one or more structures **32** can comprise any shape which is useful for achieving a particular objective for a given application of feedwell **10**, in one embodiment, structures **32** can include, but are not limited to, an inverted cone, radially placed blades, combinations thereof, and the like. In one embodiment, one or more structures **32** can be incorporated into or otherwise communicably coupled to tube **22** disposed around hole **20**, which can be disposed in a central location of bottom **14** of feedwell **10** (see Figs. 9A and 9B).

[0033] In an alternative embodiment, as is best illustrated in Fig. 10A, one or more structures **32** can be disposed around tube **34** which extends upwardly through feedwell **10**. In another embodiment, as illustrated in Fig. 10B, tube **34**, which extends upwardly through feedwell **10**, can be communicably coupled to tube **22** disposed around hole **20**, which can be disposed in a central location of bottom **14** of feedwell **10**. Thus, in one embodiment, tube **34** can be disposed in an at least substantially central portion of feedwell **10**. Optionally, as illustrated in Figs. 10A, 10B, and 11, one or more openings **38** can be provided such that an interior of tube **34** is communicably coupled to an exterior thereof, and thereby an interior of tube **34** can be communicably coupled to an interior of feedwell **10**. Tube **34** can be disposed within an interior of feedwell **10**. In one embodiment, tube **34** can extend from the top of feedwell **10** to bottom **14** of feedwell **10**. The one or more openings **38** are most preferably disposed near an upper portion of tube **34**, but can optionally be disposed at one or more locations at any position along the length of tube **34** to promote further fluid flow modifications including feed dilution, fines capture, and recirculation to achieve desired objectives for particular applications. Elongated member **36**, which can comprise a rotating shaft, one or more hydraulic hoses, or any other elongated structure, can optionally pass through or be disposed at least partially within tube **34**.

[0034] As best illustrated in Fig. 11, bottom **14** of feedwell **10** can comprise an upwardly-projecting conical shape. As with other embodiments of feedwell **10**, tube **34** can extend from a position above a top of feedwell **10** and can extend to bottom **14**.

[0035] Although the invention has been described in detail with particular reference to these preferred embodiments, other embodiments can achieve the same results.

CLAIMS

What is claimed is:

1. A method for dispersing contents of a feedwell into a sedimentation chamber, the method comprising:

   passing at least some content from within the feedwell through a plurality of openings disposed in a bottom of the feedwell, wherein the plurality of openings comprise at least three openings; and

   guiding the at least some content from within the feedwell to a location outside of the feedwell by directing the at least some content down through one or more tubes, that are radially consistent in pattern or design, and out into a sedimentation chamber.

2. The method of claim 1 further comprising directing an incoming feed of content into the feedwell by passing the incoming feed of content through an opening in an upper portion of a sidewall of the feedwell.

3. The method of claim 1 further comprising regulating a flow rate of the at least some content with a regulator that is communicably coupled to at least one of the plurality of openings.

4. The method of claim 1 further comprising modifying a flow of the at least some content with a fluid-flow modification structure comprising a plurality of fins.

5. The method of claim 1 further comprising guiding the at least some of the content from within the feedwell to a location outside of the feedwell by directing the at least some content through an opening in a center opening in a bottom of the feedwell.

6. The method of claim 1 wherein directing the at least some content down through one or more tubes comprises directing the at least some content down through one or more tubes that have a length that is greater than at least half of its diameter.

7. The method of claim 1 further comprising modifying a fluid flow of the at least some content by disposing a fluid-flow modification structure in a path of the at least some content on an underside of the feedwell.

8. The method of claim 1 further comprising regulating a velocity of the at least some

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content by passing the at least some content through a velocity regulator.

9. The method of claim 8 wherein passing the at least some content through a velocity regulator comprises passing the at least some content through a velocity regulator as it passes through the one or more tubes.

10. The method of claim 1 further comprising regulating a flow rate of the at least some content by passing the at least some content through a flow rate regulator.

11. The method of claim 10 wherein passing the at least some content through a flow rate regulator comprises passing the at least some content through a flow rate regulator as it passes through the one or more tubes.

12. A method for dispersing contents of a feedwell into a sedimentation chamber, the method comprising:

    passing at least some first content from within the feedwell through a plurality of openings disposed in a bottom of the feedwell, wherein the plurality of openings comprise at least three openings; and

    guiding the at least some first content from within the feedwell to a location outside of the feedwell by directing the at least some first content down through one or more tubes; and

    passing at least some second content from within the feedwell through a substantially central vertically-oriented tube by passing the at least some second content through an opening disposed in a sidewall of the vertically-oriented tube.

13. The method of claim 12 further comprising directing an incoming feed of content into the feedwell by passing the incoming feed of content through an opening in an upper portion of a sidewall of the feedwell.

14. The method of claim 12 further comprising regulating a flow rate of the at least some first content with a regulator that is communicably coupled to at least one of the plurality of openings.

15. The method of claim 12 further comprising modifying a flow of the at least some first content with a fluid-flow modification structure comprising a plurality of fins.

16. The method of claim 12 wherein directing the at least some first content down through one or more tubes comprises directing the at least some first content down through one or more tubes that have a length that is greater than at least half of its diameter.

17. The method of claim 12 further comprising modifying a fluid flow of the at least some first content by disposing a fluid-flow modification structure in a path of the at least some first content on an underside of the feedwell.

18. The method of claim 12 further comprising regulating a velocity of the at least some first content by passing the at least some first content through a velocity regulator.

19. The method of claim 18 wherein passing the at least some first content through a velocity regulator comprises passing the at least some first content through a velocity regulator as it passes through the one or more tubes.

20. The method of claim 12 further comprising regulating a flow rate of the at least some first content by passing the at least some first content through a flow rate regulator.

21. The method of claim 20 wherein passing the at least some first content through a flow rate regulator comprises passing the at least some first content through a flow rate regulator as it passes through the one or more tubes.

22. The method of claim 12 wherein passing the at least some second content through an opening disposed in a sidewall of the vertically-oriented tube comprises passing the at least some second content through a plurality of openings disposed in a sidewall of the vertically-oriented tube.

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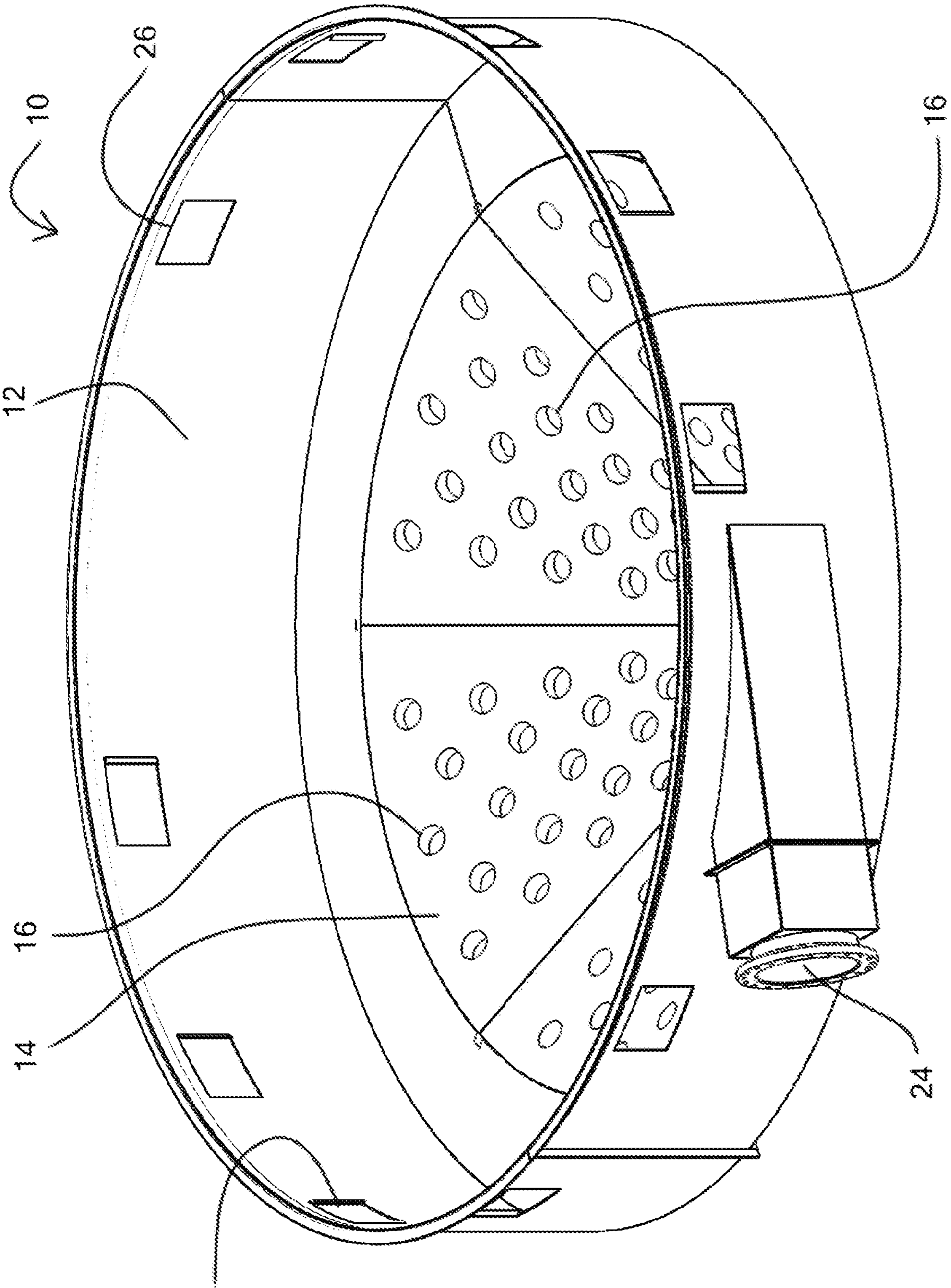

Fig. 1

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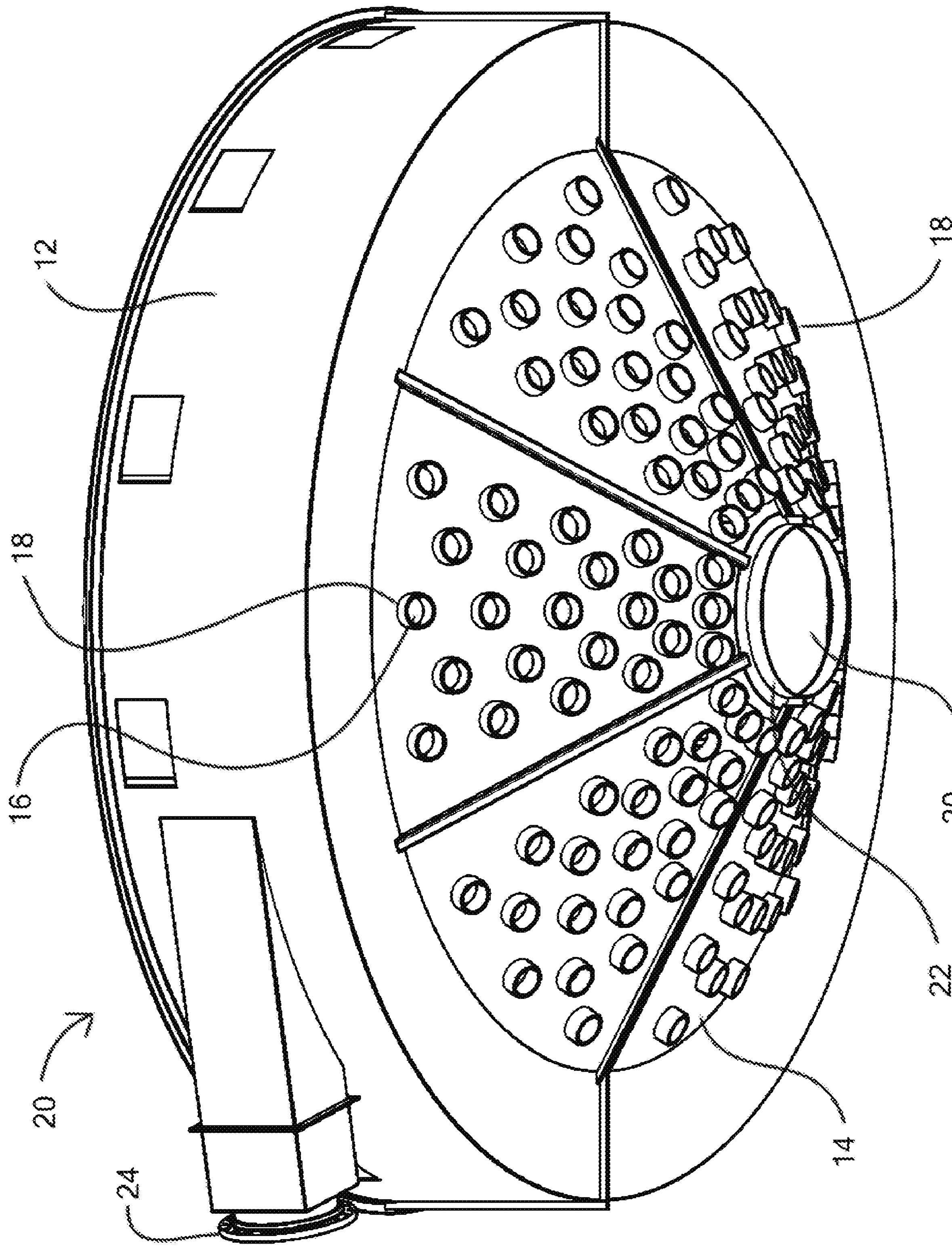

Fig. 2

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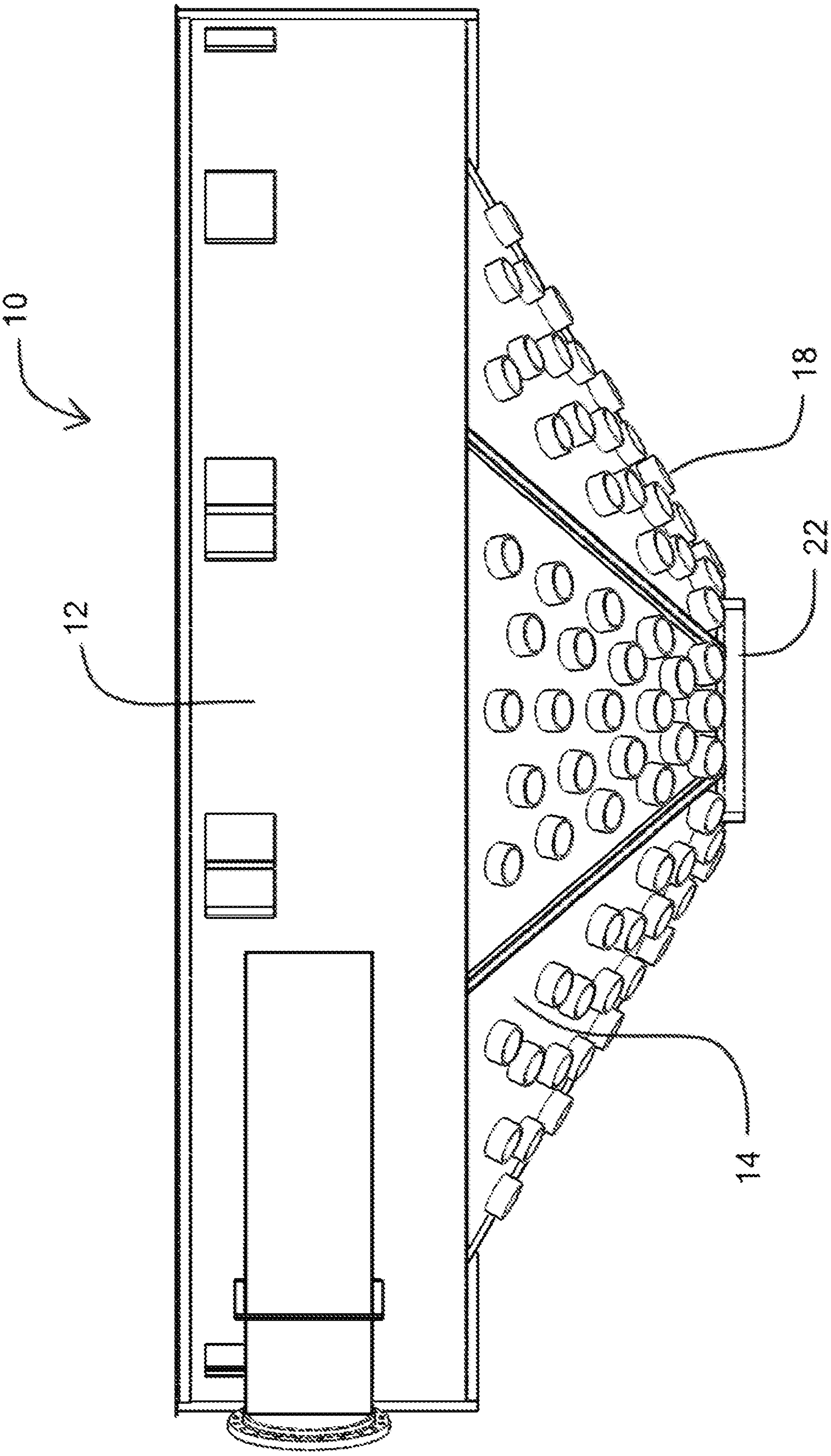

Fig. 3

2019200379 21 Jan 2019

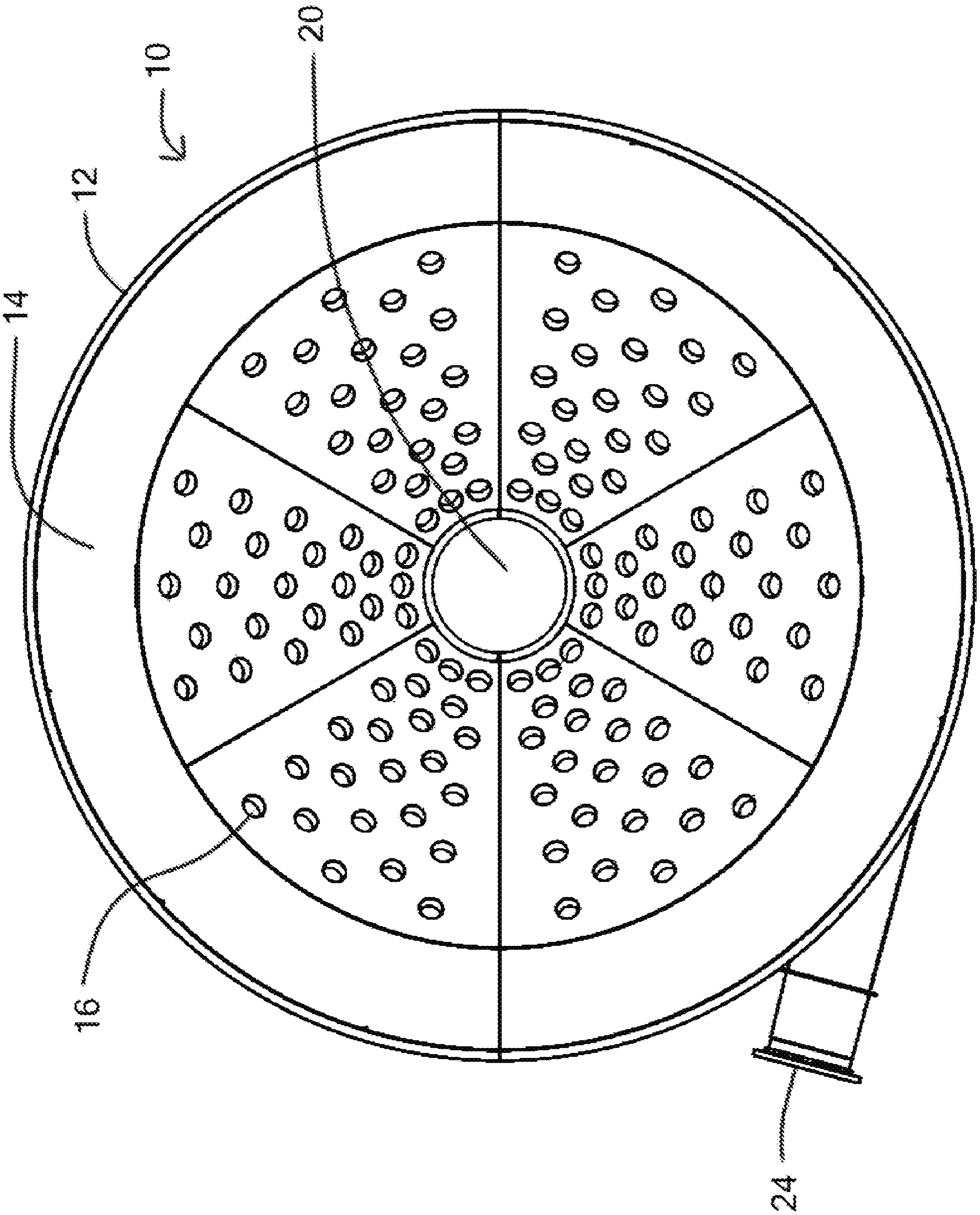

Fig. 4

2019200379 21 Jan 2019

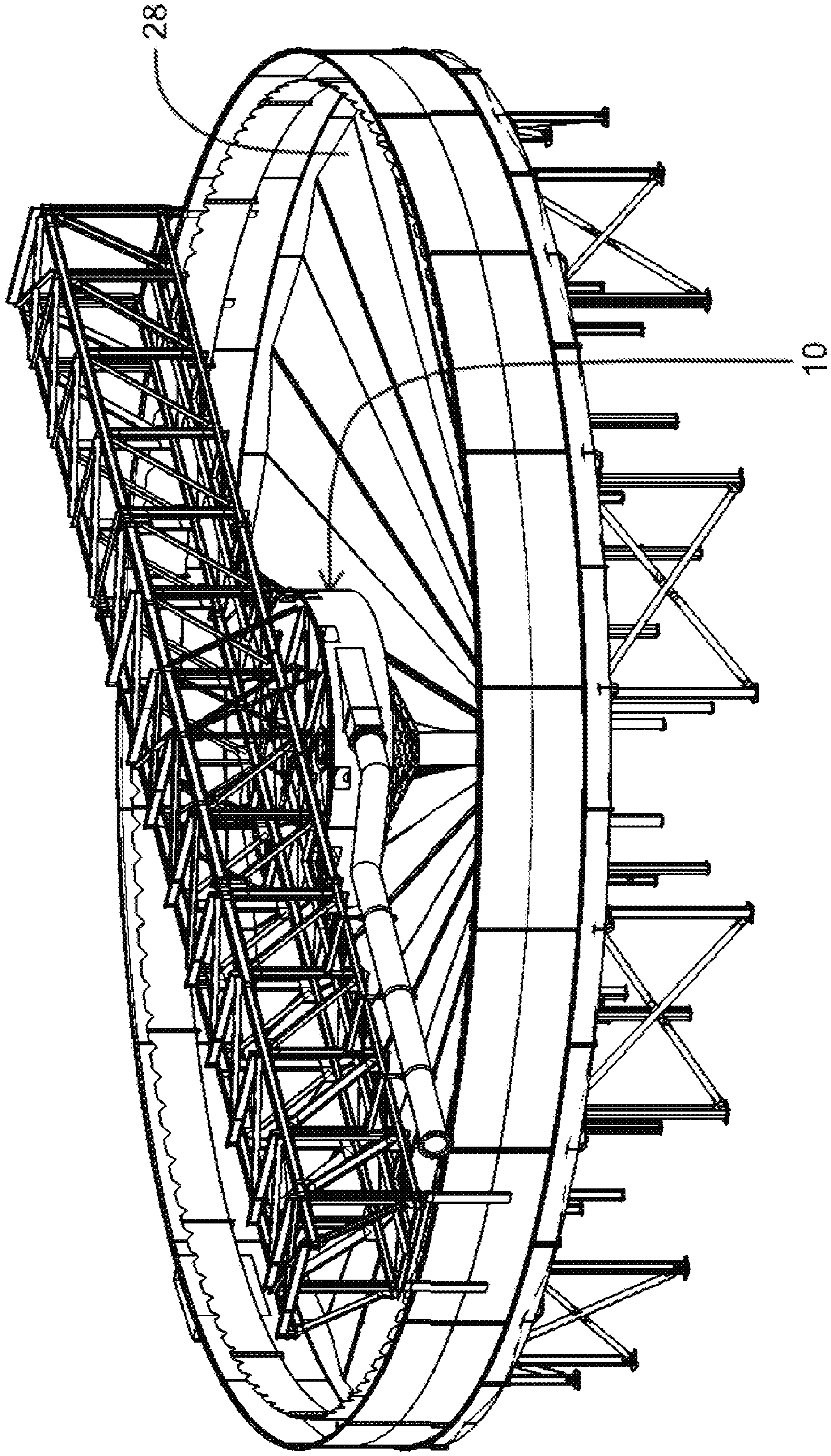

Fig. 5

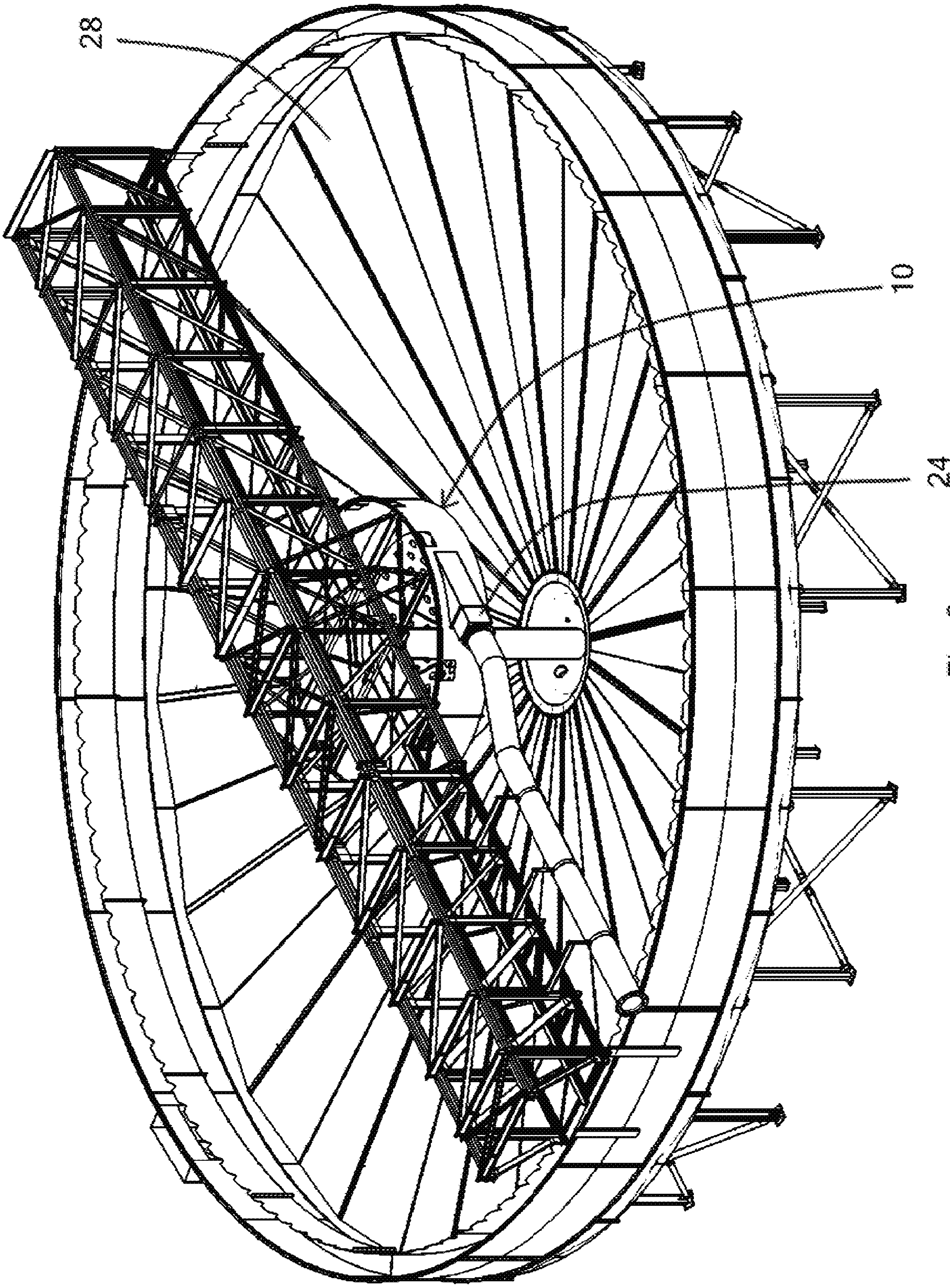

Fig. 6

2019200379 21 Jan 2019

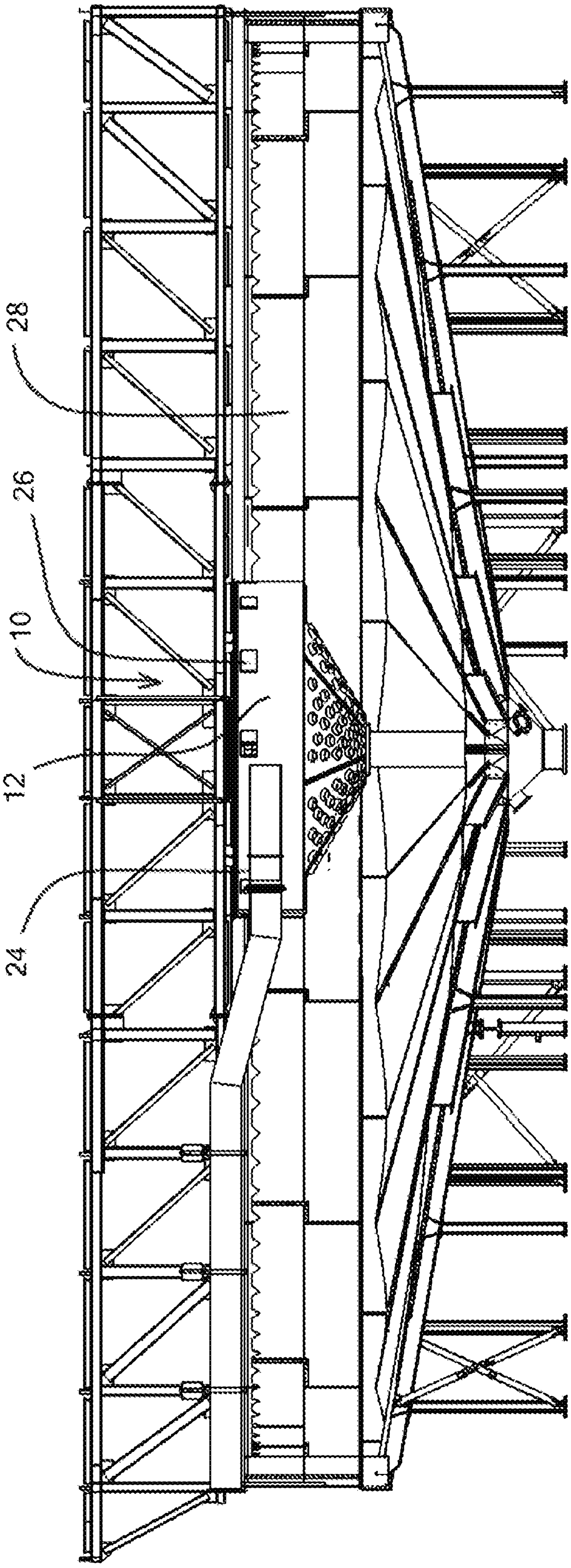

Fig. 7

2019200379 21 Jan 2019

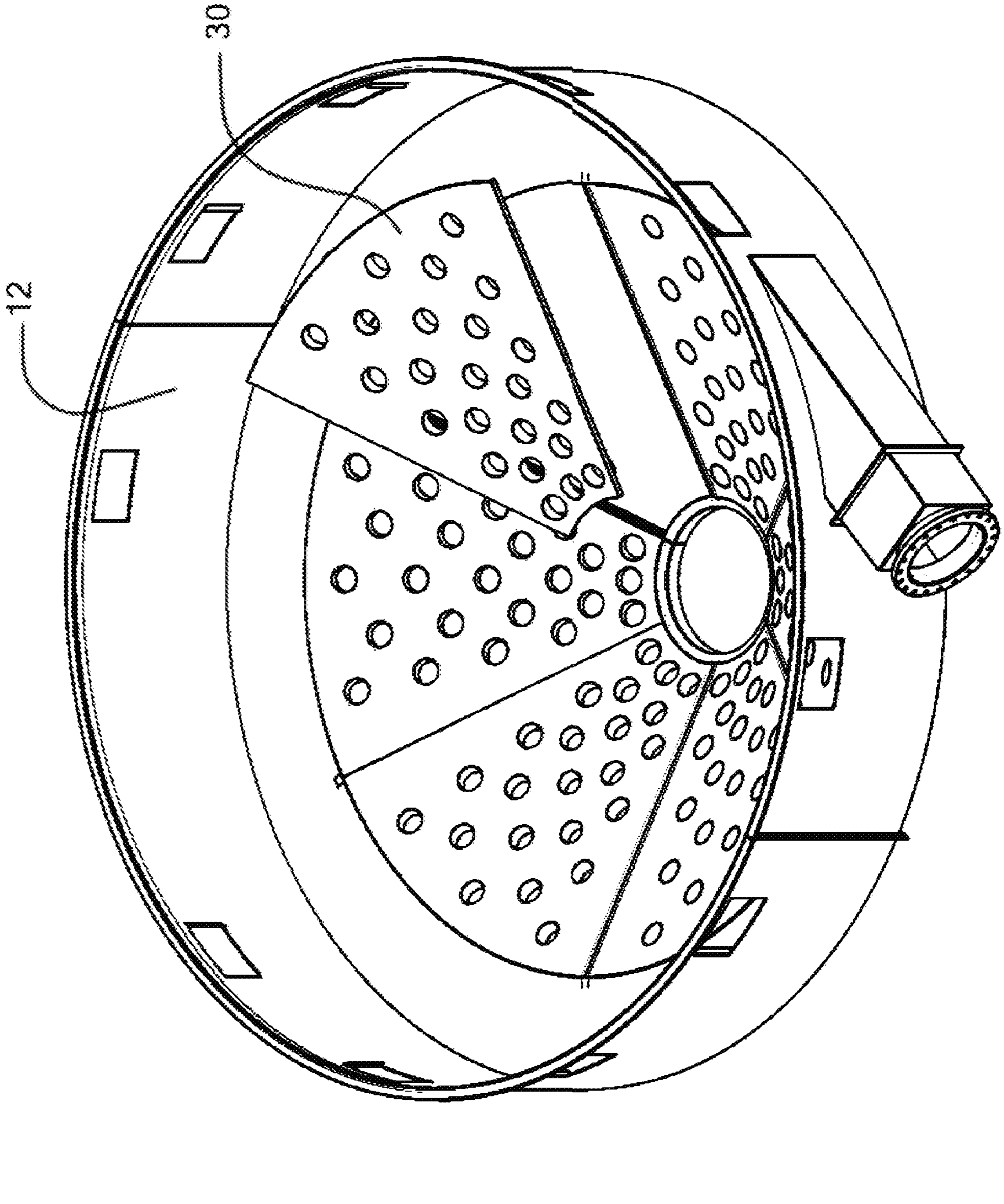

Fig. 8

2019200379 21 Jan 2019

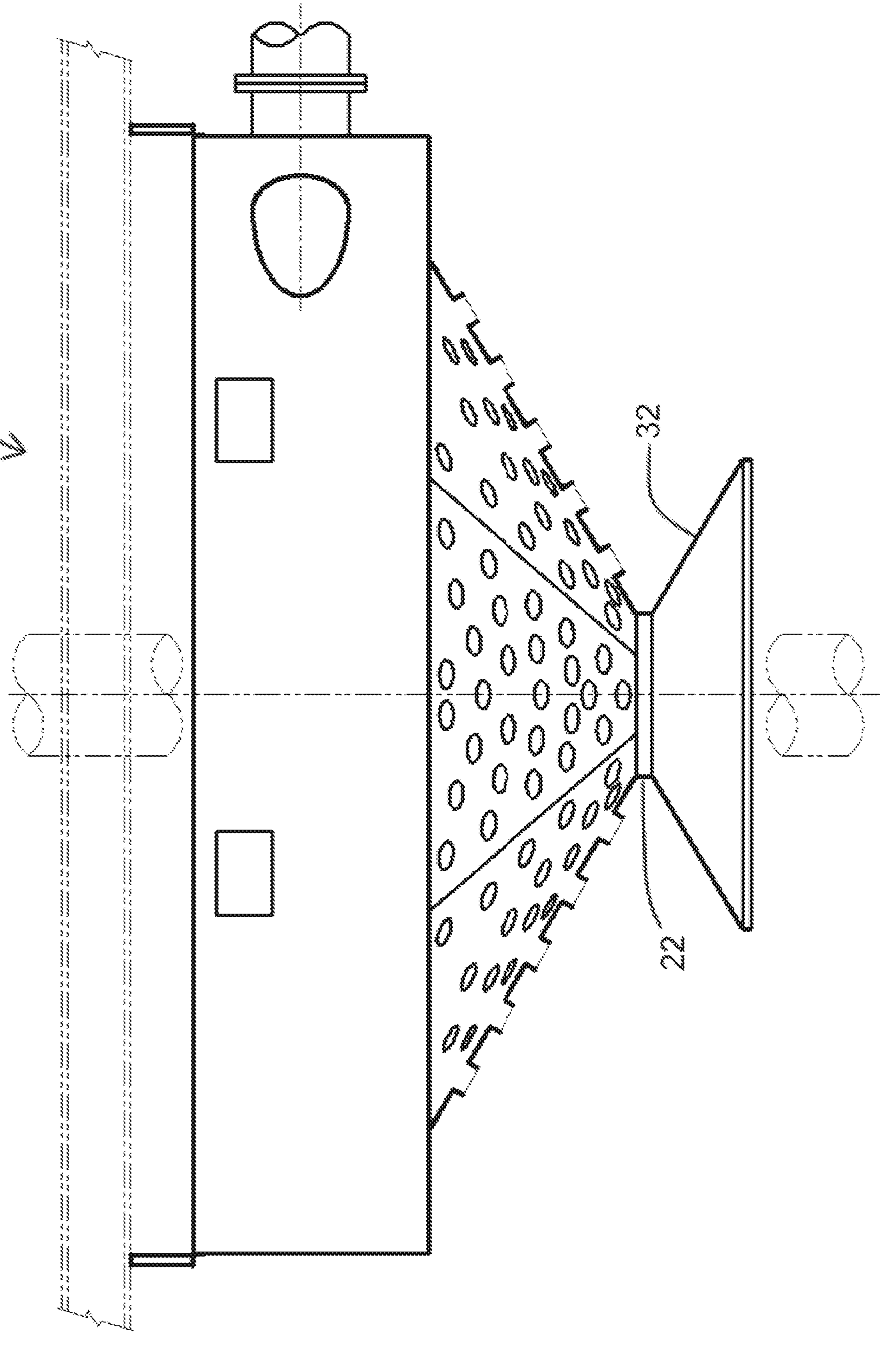

Fig. 9A

2019200379 21 Jan 2019

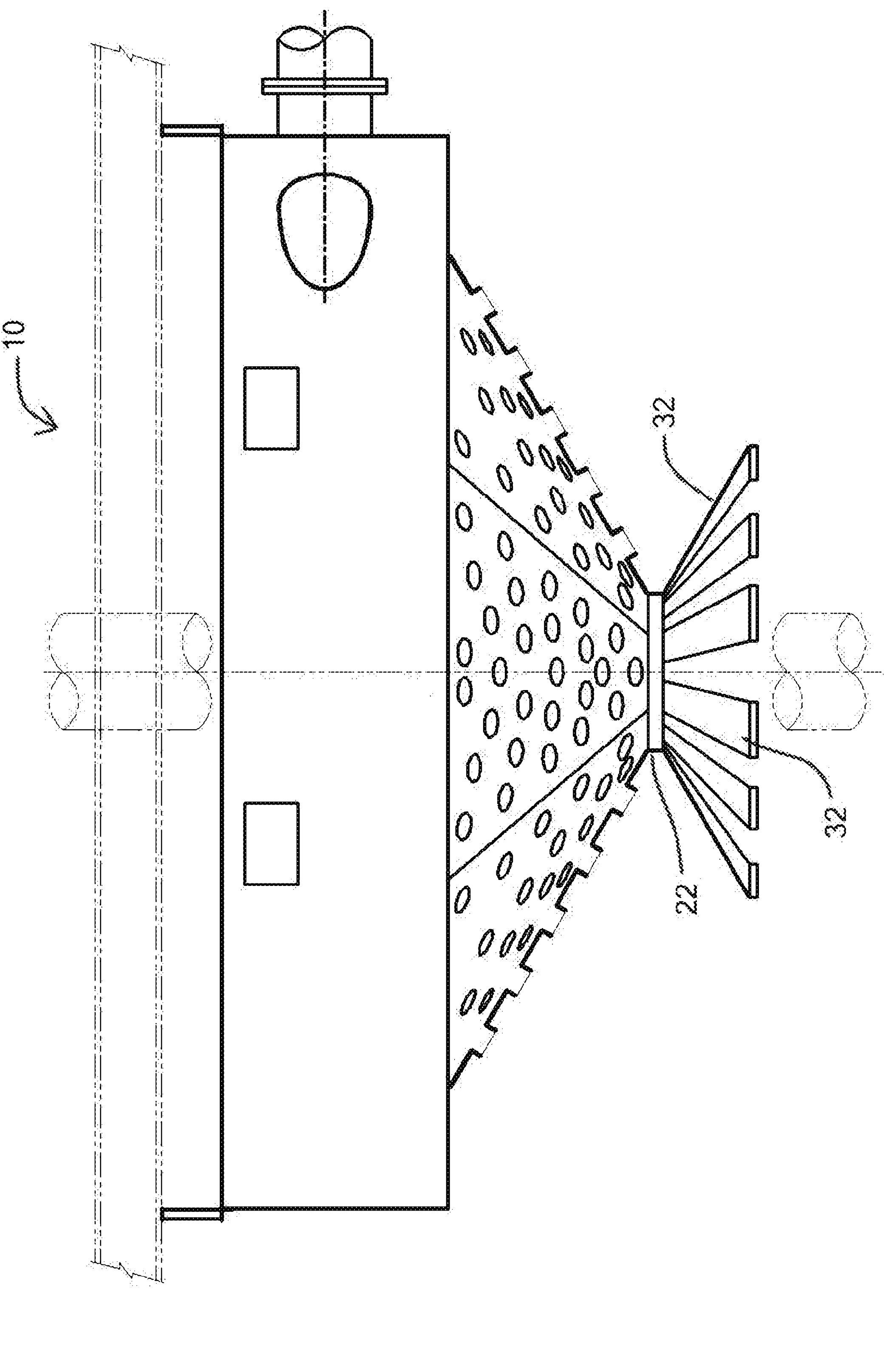

Fig. 9B

2019200379 21 Jan 2019

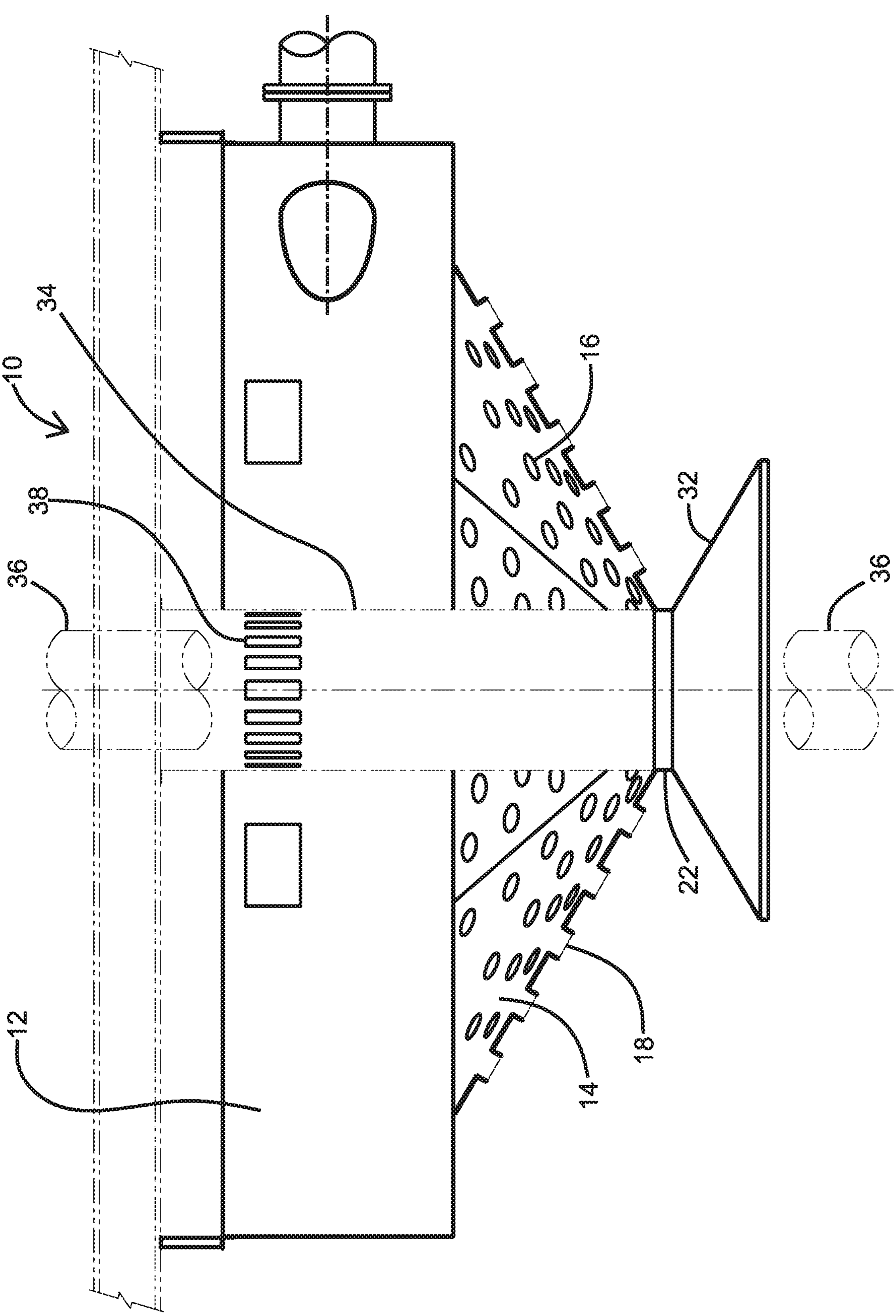

Fig. 10A

2019200379 21 Jan 2019

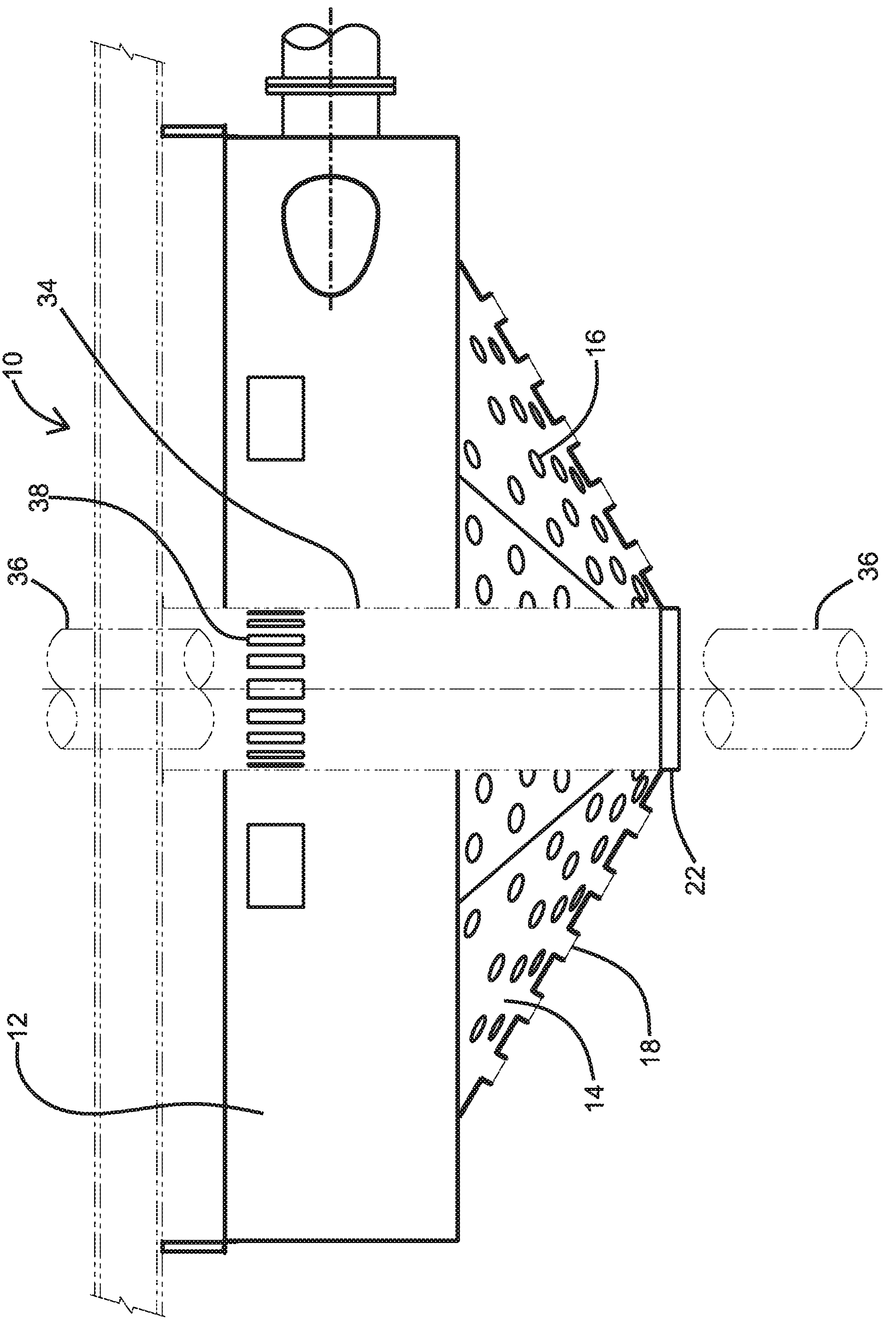

Fig. 10B

2019200379 21 Jan 2019

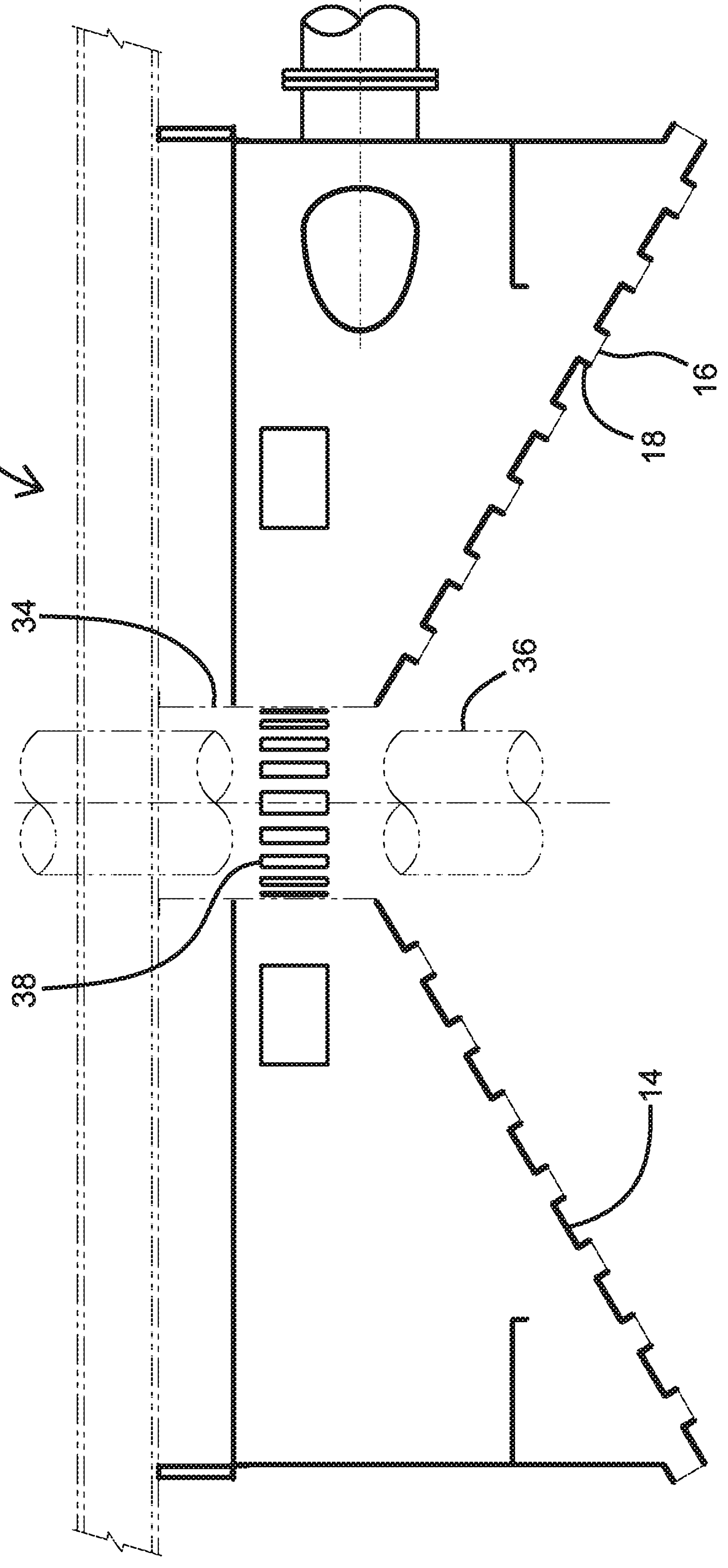

Fig. 11