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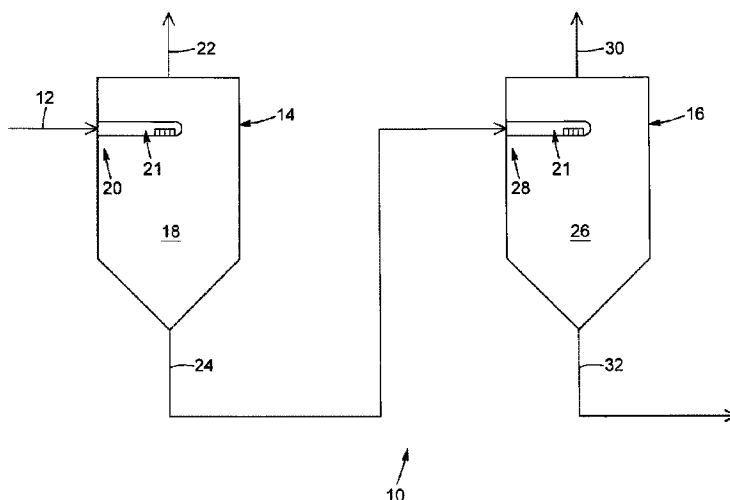
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(54) Titre : ASSEMBLAGES DE DISTRIBUTEUR ET METHODES DE SEPARATION DU SOLVANT DES RESIDUS

(54) Title: DISTRIBUTOR ASSEMBLIES AND METHODS FOR SEPARATING SOLVENT FROM TAILINGS



(57) **Abrégé/Abstract:**

A distributor assembly for introducing a multiphase feed into a separation vessel can include a distributor body having a proximal end for receiving the multiphase feed and a distal end for introducing the multiphase feed into the separation vessel, and a distributor adapter coupled to the distributor body. The distributor body can include a wall defining a feed passage for receiving the multiphase feed, a distributor body opening provided through the distributor body, and a closed end portion at the distal end of the distributor body. The distributor adapter can include a distributor adapter wall mounted to the distributor body and covering the distributor body opening, and at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the separation vessel for introducing the multiphase feed into the separation vessel.



ABSTRACT

A distributor assembly for introducing a multiphase feed into a separation vessel can include a distributor body having a proximal end for receiving the multiphase feed and a distal end for introducing the multiphase feed into the separation vessel, and a distributor adapter coupled to the distributor body. The distributor body can include a wall defining a feed passage for receiving the multiphase feed, a distributor body opening provided through the distributor body, and a closed end portion at the distal end of the distributor body. The distributor adapter can include a distributor adapter wall mounted to the distributor body and covering the distributor body opening, and at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the separation vessel for introducing the multiphase feed into the separation vessel.

DISTRIBUTOR ASSEMBLIES AND METHODS FOR SEPARATING SOLVENT FROM TAILINGS

TECHNICAL FIELD

[001] The technical field generally relates to techniques for treating solvent diluted tailings. In particular, the technical field relates to techniques for separating a multiphase stream, such as solvent diluted tailings, using a distributor assembly configured to introduce the solvent diluted tailings into a separation vessel that is part of a bitumen froth treatment operation.

BACKGROUND

[002] Recovering solvent from solvent diluted tailings has various challenges. Solvent diluted tailings are often derived from extraction operations that use solvent to aid in the separation of the valuable product, such as bitumen, from other components of an ore.

[003] In bitumen extraction operations, various stages of the bitumen extraction can include the addition of hydrocarbon-based solvent to a bitumen-containing mixture in order to produce solvent diluted bitumen and solvent diluted tailings. For instance, oil sands ore can be subjected to primary extraction where the oil sands ore is mixed with water and the resulting slurry is supplied to a primary extraction system that produces tailings and bitumen froth. The bitumen froth can then be subjected to secondary extraction that involves the addition of solvent to the bitumen froth. Secondary extraction can also be referred to as "froth treatment" and may include the addition of paraffinic solvent, naphthenic solvent (often referred to as "diluent"), or other hydrocarbon-based solvents. The bitumen froth includes water and mineral solids that should be removed in order to produce a bitumen stream that can be stored and pipelined. Such solvent-assisted extraction can be carried out in a froth separation unit (FSU) and enables water and mineral solids to be substantially removed from the bitumen froth. The FSU thus produces solvent diluted bitumen and solvent diluted tailings.

[004] Solvent diluted tailings, which may be produced as an underflow stream of the FSU, can include water, mineral solids, residual bitumen, as well as precipitated asphaltene-containing flocs or aggregates when certain precipitation solvents (e.g.,

paraffinic solvents) are used. Recovering the solvent typically involves supplying the solvent diluted tailings to one or more separation vessels, which are part of a tailings solvent recovery unit (TSRU) and are operated so that the solvent vaporizes and is recovered as an overhead stream while the other less volatile components including water and mineral solids are recovered as a solvent depleted underflow stream.

[005] However, introducing the solvent diluted tailings into the separation vessels of the TSRU can be challenging. For instance, the solvent diluted tailings include solid mineral particles that can increase the wear on equipment particularly in the context of vapour-slurry separation. Premature flashing of the solvent in the feed stream prior to introduction into the chamber of the separation vessel accelerate the solids and cause significant erosion of the inlet equipment.

SUMMARY

[006] A multiphase stream, such as a solvent diluted tailings stream, can be separated to recover various components by introducing the multiphase stream into a separation vessel via one or more distributor assemblies. A distributor assembly can have various features as described herein to provide enhanced operation, for instance in terms of maintenance and durability. For example, the distributor assembly can include a distributor body and a distributor adapter engaged therewith, and the distributor adapter can include at least one pressure let-down aperture for introducing the multiphase stream into the separation vessel.

[007] In accordance with an aspect, there is provided a tailings solvent recovery unit (TSRU) for recovering solvent from solvent diluted tailings, the TSRU comprising:

- a flash vessel comprising:

- a flashing chamber for receiving the solvent diluted tailings and configured to enable vaporization of the solvent;

- a feed inlet line for supplying the solvent diluted tailings to the flash vessel;

- a tailings outlet for withdrawing a solvent depleted tailings component from the flashing chamber;

a solvent outlet for withdrawing a recovered solvent component from the flashing chamber; and

an inlet spray system fluidly connected to the feed inlet line for receiving the solvent diluted tailings for spraying into the flashing chamber, the inlet spray system comprising a distributor assembly that comprises:

a distributor body extending into the flashing chamber and comprising a tubular portion and a closed end portion, the tubular portion comprising:

a tubular wall having an outer surface and an inner surface, the tubular wall defining a feed passage for receiving the solvent diluted tailings; and

a distributor body opening provided through the tubular wall; and

a distributor adapter removably engageable with the distributor body and comprising:

a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the flashing chamber for introducing the solvent diluted tailings into the flashing chamber.

[008] In some implementations, the distributor adapter wall comprises an adapter insert portion receivable into the distributor body opening and comprising the at least one pressure let-down aperture.

[009] In some implementations, the adapter insert portion has a complimentary shape relative to the distributor body opening to fit therein.

[0010] In some implementations, the TSRU further comprises a seal between the distributor body opening and the distributor adapter.

[0011] In some implementations, the seal comprises an epoxy sealant.

[0012] In some implementations, the distributor body opening comprises an opening upstream edge and an opening downstream edge, and the adapter insert portion comprises an adapter upstream edge and an adapter downstream edge.

[0013] In some implementations, at least one of the opening upstream edge and the opening downstream edge is substantially perpendicular to a length of the distributor body.

[0014] In some implementations, at least one of the opening upstream edge and the opening downstream edge comprises a tapered opening edge, and a corresponding one of the adapter upstream edge and the adapter downstream edge comprises a tapered adapter edge.

[0015] In some implementations, at least one of the opening upstream edge and the opening downstream edge comprises an opening rabbeted edge and a corresponding one of the adapter upstream edge and the adapter downstream edge comprises an adapter rabbeted edge.

[0016] In some implementations, the distributor body opening and the adapter insert portion each have a shorter length in proximity of the outer surface of the tubular wall than in proximity of the inner surface of the tubular wall, when measured in a longitudinal direction.

[0017] In some implementations, wherein a portion of the distributor adapter wall is configured to overlay part of the outer surface of the tubular wall of the distributor body.

[0018] In some implementations, the distributor adapter is removably securable to the outer surface of the tubular wall of the distributor body via a fastener.

[0019] In some implementations, the adapter rabbeted edge of the distributor adapter is removably securable to the opening rabbeted edge of the distributor body opening via a fastener.

[0020] In some implementations, the distributor assembly further comprises a retention member to removably secure the distributor adapter to the distributor body.

[0021] In some implementations, the retention member is provided over the outer surface of the tubular wall of the distributor body.

[0022] In some implementations, the retention member comprises:

at least two bands provided in a spaced-apart relationship over the outer surface of the tubular wall of the distributor body on each side of the distributor body opening and over part of the distributor adapter wall; and

a first series of retention member fasteners to connect each of the at least two bands to at least the distributor adapter wall.

[0023] In some implementations, the first series of retention member fasteners further connects each of the at least two bands to the tubular wall of the distributor body.

[0024] In some implementations, the retention member further comprises a second series of retention member fasteners to connect each of the at least two bands to the distributor adapter wall and to the tubular wall of the distributor body.

[0025] In some implementations, the retention member comprises:

at least two clamps provided in a spaced-apart relationship over the outer surface of the tubular wall of the distributor body on each side of the distributor body opening and over part of the distributor adapter wall, wherein each clamp comprises a flange at each end for tightening the clamp via at least one flange fastener.

[0026] In some implementations, the retention member further comprises a bracket extending between opposite clamps.

[0027] In some implementations, the retention member further comprises a first series of retention member fasteners to connect the at least two clamps to at least the distributor adapter wall.

[0028] In some implementations, the retention member further comprises a second series of retention member fasteners to connect the at least two clamps to the distributor wall and to the tubular wall of the distributor body.

[0029] In some implementations, the distributor body and the distributor adapter are made of different materials.

[0030] In some implementations, the distributor adapter comprises High Chrome White Iron (HCWI).

[0031] In some implementations, the distributor adapter comprises chrome carbide.

[0032] In some implementations, the tubular portion is configured to extend from a side wall of the flash vessel into the flashing chamber.

[0033] In some implementations, the tubular portion is configured to have a substantially horizontal orientation within the flashing chamber.

[0034] In some implementations, the tubular portion is configured such that the feed passage has a substantially constant diameter along a length thereof.

[0035] In some implementations, the inlet spray system comprises more than one distributor assembly.

[0036] In some implementations, the distributor assembly comprises more than one distributor adapter coupled to the distributor body.

[0037] In some implementations, the tubular portion is a pipe section and the distributor adapter wall substantially follows a curvature of the pipe section.

[0038] In some implementations, the distributor adapter is configured to introduce the solvent diluted tailings downwardly into the flashing chamber through the at least one pressure let-down aperture.

[0039] In some implementations, the at least one pressure let-down aperture has a rectangular shape.

[0040] In some implementations, the at least one pressure let-down aperture has a discorectangular shape.

[0041] In some implementations, the at least one pressure let-down aperture is shaped as a pressure let-down slot.

[0042] In some implementations, the at least one pressure let-down aperture has a transverse orientation with respect to a longitudinal axis of the tubular portion.

[0043] In some implementations, the at least one pressure let-down aperture comprises multiple pressure let-down apertures.

[0044] In some implementations, the multiple pressure let-down apertures are substantially identical to each other in shape and size.

[0045] In some implementations, the multiple pressure let-down apertures are spaced-apart such that each pair of adjacent pressure let-down apertures defines a corresponding strip each having a substantially same width.

[0046] In some implementations, the strips have substantially the same wall thickness.

[0047] In some implementations, the at least one pressure let-down aperture comprises a throat defined by throat walls, a leading edge, and a trailing edge.

[0048] In some implementations, the throat walls include smooth surfaces to inhibit cavitation within the throat.

[0049] In some implementations, the leading edge is smooth-edged, chamfered or tapered.

[0050] In some implementations, the trailing edge is sharp or square.

[0051] In some implementations, the multiple pressure let-down apertures comprise at least one downstream pressure let-down aperture positioned proximate to the closed end portion to facilitate expelling backflow of the solvent diluted tailings from the closed end portion into the flashing chamber.

[0052] In some implementations, the tubular portion is configured for connection to a retractable lance, and has an internal diameter that is substantially identical to that of the retractable lance.

[0053] In accordance with another aspect, there is provide a distributor assembly for introducing a multiphase feed into a separation vessel, the distributor assembly comprising:

a distributor body having a proximal end for receiving the multiphase feed and a distal end for introducing the multiphase feed to the separation vessel, the distributor body comprising:

at least one wall having an outer surface and an inner surface, the at least one wall defining a feed passage for receiving the multiphase feed;

a distributor body opening provided through the distributor body; and

a closed end portion at the distal end of the distributor body; and

a distributor adapter coupled to the distributor body and comprising:

a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the separation vessel for introducing the multiphase feed into the separation vessel.

[0054] In some implementations, the distributor adapter is removably engageable with the distributor body.

[0055] In some implementations, the distributor body opening is provided through the at least one wall of the distributor body.

[0056] In some implementations, the distributor body opening is proximate to the distal end of the distributor body.

[0057] In some implementations, the distributor adapter wall comprises an adapter insert portion receivable into the distributor body opening and comprising the at least one pressure let-down aperture.

[0058] In some implementations, the adapter insert portion has a complimentary shape relative to the distributor body opening to fit therein.

[0059] In some implementations, the distributor assembly further comprises a seal between the distributor body opening and the distributor adapter.

[0060] In some implementations, the seal comprises an epoxy sealant.

[0061] In some implementations, the distributor body opening comprises an opening upstream edge and an opening downstream edge, and the adapter insert portion comprises an adapter upstream edge and an adapter downstream edge.

[0062] In some implementations, at least one of the opening upstream edge and the opening downstream edge is substantially perpendicular to a length of the distributor body.

[0063] In some implementations, at least one of the opening upstream edge and the opening downstream edge comprises a tapered opening edge, and a corresponding one of the adapter upstream edge and the adapter downstream edge comprises a tapered adapter edge.

[0064] In some implementations, at least one of the opening upstream edge and the opening downstream edge comprises an opening rabbeted edge and a corresponding one of the adapter upstream edge and the adapter downstream edge comprises an adapter rabbeted edge.

[0065] In some implementations, the distributor body opening and the adapter insert portion each have a smaller length in proximity of the outer surface of the at least one wall than in proximity of the inner surface of the at least one wall, when measured in a longitudinal direction.

[0066] In some implementations, a portion of the distributor adapter wall is configured to overlay part of the outer surface of the at least one wall of the distributor body.

[0067] In some implementations, the distributor adapter is removably securable to the outer surface of the at least one wall of the distributor body distributor body via a fastener.

[0068] In some implementations, the adapter rabbeted edge of the distributor adapter is removably securable to the opening rabbeted edge of the distributor body opening via a fastener.

[0069] In some implementations, the distributor assembly further comprises a retention member to removably secure the distributor adapter to the distributor body.

[0070] In some implementations, the retention member is provided over the outer surface of the at least one wall of the distributor body.

[0071] In some implementations, the retention member comprises:

at least two bands provided in a spaced-apart relationship over the outer surface of the at least one wall of the distributor body on each side of the distributor body opening and over part of the distributor adapter wall; and

a first series of retention member fasteners to connect each of the at least two bands to at least the distributor adapter wall.

[0072] In some implementations, the first series of retention member fasteners further connects each of the at least two bands to the at least one wall of the distributor body.

[0073] In some implementations, the retention member further comprises a second series of retention member fasteners to connect each of the at least two bands to the distributor adapter wall and to the at least one wall of the distributor body.

[0074] In some implementations, the retention member comprises:

at least two clamps provided in a spaced-apart relationship around the outer surface of the at least one wall of the distributor body on each side of the distributor body opening and over part of the distributor adapter wall, wherein each clamp comprises a flange at each end to tighten the clamp via at least one flange fastener.

[0075] In some implementations, the retention member further comprises a bracket extending between opposite clamps.

[0076] In some implementations, the retention member further comprises a first series of retention member fasteners to connect the at least two clamps to at least the distributor adapter wall.

[0077] In some implementations, the retention member further comprises a second series of retention member fasteners to connect the at least two clamps to the distributor wall and to the at least one wall of the distributor body.

[0078] In some implementations, the distributor body and the distributor adapter are made of different materials.

[0079] In some implementations, the distributor adapter comprises High Chrome White Iron (HCWI).

[0080] In some implementations, the distributor adapter comprises chrome carbide.

[0081] In some implementations, the distributor body is configured to extend from a side wall of the separation vessel into the separation vessel.

[0082] In some implementations, the distributor body is configured to have a substantially horizontal orientation within the separation vessel.

[0083] In some implementations, the distributor body is configured such that the feed passage has a substantially constant diameter along a length thereof.

[0084] In some implementations, the inlet spray system comprises more than one distributor assembly.

[0085] In some implementations, the distributor assembly comprises more than one distributor adapter coupled to the distributor body.

[0086] In some implementations, the distributor body is a pipe section and the distributor adapter wall substantially follows a curvature of the pipe section.

[0087] In some implementations, the distributor adapter is configured to introduce the solvent diluted tailings downwardly into the separation vessel through the at least one pressure let-down aperture.

[0088] In some implementations, the at least one pressure let-down aperture has a rectangular shape.

[0089] In some implementations, the at least one pressure let-down aperture has a discorectangular shape.

[0090] In some implementations, the at least one pressure let-down aperture is shaped as a pressure let-down slot.

[0091] In some implementations, the at least one pressure let-down aperture has a transverse orientation with respect to a longitudinal axis of the distributor body.

[0092] In some implementations, the at least one pressure let-down aperture comprises multiple pressure let-down apertures.

[0093] In some implementations, the multiple pressure let-down apertures are substantially identical to each other in shape and size.

[0094] In some implementations, the multiple pressure let-down apertures are spaced-apart such that each pair of adjacent pressure let-down apertures defines a corresponding strip each having a substantially same width.

[0095] In some implementations, the strips have substantially the same wall thickness.

[0096] In some implementations, the at least one pressure let-down aperture comprises a throat defined by throat walls, a leading edge, and a trailing edge.

[0097] In some implementations, the throat walls include smooth surfaces to inhibit cavitation within the throat.

[0098] In some implementations, the leading edge is smooth-edged, chamfered or tapered.

[0099] In some implementations, the trailing edge is sharp or square.

[00100] In some implementations, the multiple pressure let-down apertures comprise at least one downstream pressure let-down aperture positioned proximate to the distal

end of the distributor body to facilitate expelling backflow of the solvent diluted tailings from the closed end portion into the separation vessel.

[00101] In some implementations, the distributor body is configured for connection to a retractable lance, and has an internal diameter that is substantially identical to that of the retractable lance.

[00102] In some implementations, the distributor assembly is for use in a Tailings Solvent Recovery Unit (TSRU).

[00103] In some implementations, the multiphase feed is a hydrocarbon-containing feed.

[00104] In some implementations, the hydrocarbon-containing feed is a bituminous feed.

[00105] In some implementations, the bituminous feed is a solvent diluted tailings stream.

[00106] In some implementations, the separation vessel is a flashing chamber.

[00107] In some implementations, the distributor body comprises a tubular portion.

[00108] In accordance with another aspect, there is provided a tailings solvent recovery process for recovering a solvent from solvent diluted tailings, the process comprising:

introducing the solvent diluted tailings to a flashing chamber through a distributor assembly extending within the flashing chamber, the distributor assembly comprising:

a distributor body extending into the flashing chamber and comprising a tubular portion and a closed end portion, the tubular portion comprising:

a tubular wall having an outer surface and an inner surface, the tubular wall defining a feed passage for receiving the solvent diluted tailings; and

a distributor body opening provided through the tubular wall; and
a distributor adapter removably engageable with the distributor body and comprising:

a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the flashing chamber for introducing the solvent diluted tailings into the flashing chamber;

recovering flashed solvent from the flashing chamber as a solvent overhead stream;

recovering a solvent depleted tailings component from the flashing chamber as an underflow stream; and

removing the distributor adapter from the distributor assembly and replacing the distributor adapter by a replacement distributor adapter removably engageable with the distributor body.

[00109] In some implementations, the tubular portion of the distributor body is connectable to a retractable lance.

[00110] In some implementations, the process further comprises displacing the retractable lance when the tubular portion of the distributor body is connected thereto from an operational configuration wherein the distributor assembly extends within the flashing chamber to a retracted configuration wherein the distributor assembly is out of the flashing chamber.

[00111] In some implementations, the removing of the distributor adapter from the distributor assembly and the replacing of the distributor adapter by the replacement distributor adapter are performed when the retractable lance is in the retracted configuration.

[00112] In some implementations, following the removing of the distributor adapter from the distributor assembly and the replacing of the distributor adapter by the replacement distributor adapter, the retractable lance is displaced back into the operational configuration.

[00113] In some implementations, the retractable lance is in the retracted configuration, the solvent diluted tailings is introduced into to the flashing chamber through a second distributor assembly extending within the flashing chamber, the second distributor assembly comprising a second distributor body and a second distributor adapter.

[00114] In some implementations, the second distributor assembly is connectable to a second retractable lance displaceable from an operational configuration to a retractable configuration and vice-versa.

[00115] In some implementations, when the retractable lance is displaced back into the operational configuration, the second retractable lance is in the retracted configuration and the second distributor adapter is removed from the second distributor assembly and replaced by a second replacement distributor adapter removably engageable with the second distributor body.

[00116] In some implementations, following the removing of the second distributor adapter from the second distributor assembly and the replacing of the second distributor adapter by the second replacement distributor adapter, the process further comprises displacing the retractable lance back into the operational configuration.

[00117] In accordance with another aspect, there is provided a method of operating a tailings solvent recovery unit (TSRU) for recovering solvent from solvent diluted tailings, the method comprising:

in a first phase, introducing a first stream of solvent diluted tailings to a flashing chamber through a distributor assembly extending within the flashing chamber, the distributor assembly comprising:

a distributor body extending into the flashing chamber and comprising a tubular portion and a closed end portion, the tubular portion comprising:

a tubular wall having an outer surface and an inner surface, the tubular wall defining a feed passage for receiving the solvent diluted tailings; and

a distributor body opening provided through the tubular wall; and

a first phase distributor adapter removably engageable with the distributor body and comprising:

a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the flashing chamber for introducing the solvent diluted tailings into the flashing chamber;

recovering flashed solvent from the flashing chamber as a solvent overhead stream;

recovering a solvent depleted tailings component from the flashing chamber as an underflow stream;

monitoring a property of the first stream of solvent diluted tailings, wherein when the property of the first stream of solvent diluted tailings is above or below a given threshold, terminating the first phase, wherein terminating the first phase comprises:

replacing the first phase distributor adapter by a second phase distributor adapter removably engageable with the distributor body; and

in a second phase, introducing a second stream of solvent diluted tailings to the flashing chamber via the distributor assembly having the second distributor adapter.

[00118] In some implementations, the first phase further comprises selecting at least one of a shape, a number and a size of the at least one pressure let-down aperture for the second phase distributor adapter.

[00119] In some implementations, the property is a solvent content of the first stream of solvent diluted tailings.

[00120] In some implementations, the at least one pressure let-down aperture of the first phase distributor assembly is sized according to the solvent content exiting the at least one pressure let-down aperture.

[00121] In some implementations, the at least one pressure let-down aperture of the second phase distributor assembly is sized according to the solvent content exiting the at least one pressure let-down aperture.

[00122] In some implementations, in the first phase, the solvent content of the first stream of solvent diluted tailings is above the given threshold, and the at least one pressure let-down aperture of the first phase distributor adapter are configured to enable explosion flashing of solvent upon introduction of the first solvent diluted tailings stream into the flashing chamber.

[00123] In some implementations, in the second phase, the solvent content of the second stream of solvent diluted tailings is below the given threshold, and the at least one pressure let-down aperture enables formation of fan-shaped streams upon introduction into the corresponding flashing chamber.

[00124] In some implementations, the tubular portion of the distributor body is connected to a retractable lance.

[00125] In some implementations, terminating the first phase further comprises displacing the retractable lance from an operational configuration wherein the distributor assembly extends within the flashing chamber to a retracted configuration wherein the distributor assembly is out of the flashing chamber.

[00126] In some implementations, replacing the first phase distributor adapter by the second phase distributor adapter is performed when the retractable lance is in the retracted configuration.

[00127] In some implementations, following the replacing of the first phase distributor adapter by the second phase distributor adapter, the retractable lance is displaced back into the operational configuration.

[00128] In accordance with another aspect, there is provided a system for separating a multiphase stream into a volatile component and a liquid component, the system comprising:

a flash vessel comprising:

a flashing chamber for receiving the multiphase stream and configured to enable vaporization of the volatile component;

a feed inlet line for supplying the multiphase stream to the flashing chamber;

a liquid outlet for withdrawing the liquid component from the flashing chamber;

a volatile component outlet for withdrawing a recovered volatile component from the flashing chamber; and

an inlet spray system fluidly connected to the feed line for receiving the multiphase stream for spraying into the flashing chamber, the inlet spray system comprising a distributor that comprises:

a distributor body extending into the flashing chamber and comprising a tubular portion and a closed end portion, the tubular portion comprising:

a tubular wall having an outer surface and an inner surface, the tubular wall defining a feed passage for receiving the solvent diluted tailings; and

a distributor body opening provided through the tubular wall; and

a distributor adapter removably engageable with the distributor body and comprising:

a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

at least one spaced-apart pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the flashing chamber for introducing the solvent diluted tailings into the flashing chamber.

[00129] In accordance with another aspect, there is provided a process for producing a bitumen product from oil sands, the process comprising:

mining oil sands ore to obtain mined oil sands ore;

crushing the mined oil sands ore in a mixing unit to form crushed ore;

subjecting the crushed ore to sizing and addition of process water to form an oil sands slurry;

supplying the oil sands slurry to a primary separation vessel (PSV) to separate the oil sands slurry and form a bitumen froth stream;

subjecting the bitumen froth stream to froth treatment to produce solvent diluted bitumen and solvent diluted tailings; and

recovering solvent from the solvent diluted bitumen to produce the bitumen product;

introducing the solvent diluted tailings into a flashing chamber of a flash vessel through a distributor assembly extending within the flashing chamber, the distributor assembly comprising:

a distributor body extending into the flashing chamber and comprising a tubular portion and a closed end portion, the tubular portion comprising:

a tubular wall having an outer surface and an inner surface, the tubular wall defining a feed passage for receiving the solvent diluted tailings; and

a distributor body opening provided through the tubular wall; and

a distributor adapter removably engageable with the distributor body and comprising:

a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the flashing chamber for introducing the solvent diluted tailings into the flashing chamber;

recovering flashed solvent from the flashing chamber as a solvent overhead stream; and

recovering a solvent depleted tailings component from the flashing chamber as an underflow stream.

[129a] In one aspect, there is provided a distributor assembly for introducing a multiphase feed into a separation vessel, the distributor assembly comprising:

a distributor body having a proximal end for receiving the multiphase feed and a distal end for introducing the multiphase feed to the separation vessel, the distributor body comprising:

at least one wall having an outer surface and an inner surface, the at least one wall defining a feed passage for receiving the multiphase feed;

a distributor body opening provided through the distributor body; and

a closed end portion at the distal end of the distributor body; and

a distributor adapter coupled to the distributor body and comprising:

a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the separation vessel for introducing the multiphase feed into the separation vessel;

wherein the distributor adapter comprises a material having a higher wear resistance than the distributor body.

[129b] In another aspect, there is provided a tailings solvent recovery process for recovering a solvent from solvent diluted tailings, the process comprising:

introducing the solvent diluted tailings into a flashing chamber through a distributor assembly extending within the flashing chamber, the distributor assembly comprising:

a distributor body extending into the flashing chamber and comprising a tubular portion and a closed end portion, the tubular portion comprising:

a tubular wall having an outer surface and an inner surface, the tubular wall defining a feed passage for receiving the solvent diluted tailings; and

a distributor body opening provided through the tubular wall; and

a distributor adapter removably engageable with the distributor body and comprising:

a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the flashing chamber for introducing the solvent diluted tailings into the flashing chamber;

wherein the distributor adapter comprises a material having a higher wear resistance than the distributor body;

recovering flashed solvent from the flashing chamber as a solvent overhead stream;

recovering a solvent depleted tailings component from the flashing chamber as an underflow stream; and

removing the distributor adapter from the distributor assembly and replacing the distributor adapter by a replacement distributor adapter removably engageable with the distributor body.

[129c] In another aspect, there is provided a method of operating a tailings solvent recovery unit (TSRU) for recovering solvent from solvent diluted tailings, the method comprising:

in a first phase, introducing a first stream of solvent diluted tailings to a flashing chamber through a distributor assembly extending within the flashing chamber, the distributor assembly comprising:

a distributor body extending into the flashing chamber and comprising a tubular portion and a closed end portion, the tubular portion comprising:

a tubular wall having an outer surface and an inner surface, the tubular wall defining a feed passage for receiving the solvent diluted tailings; and

a distributor body opening provided through the tubular wall; and

a first phase distributor adapter removably engageable with the distributor body and comprising:

a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the flashing chamber for introducing the solvent diluted tailings into the flashing chamber;

wherein the distributor adapter comprises a material having a higher wear resistance than the distributor body;

recovering flashed solvent from the flashing chamber as a solvent overhead stream;

recovering a solvent depleted tailings component from the flashing chamber as an underflow stream;

monitoring a property of the first stream of solvent diluted tailings, wherein when the property of the first stream of solvent diluted tailings is above or below a given threshold, terminating the first phase, wherein terminating the first phase comprises:

replacing the first phase distributor adapter by a second phase distributor adapter removably engageable with the distributor body;
and

in a second phase, introducing a second stream of solvent diluted tailings to the flashing chamber via the distributor assembly having the second distributor adapter.

[129d] In another aspect, there is provided a process for producing a bitumen product from oil sands, the process comprising:

mining oil sands ore to obtain mined oil sands ore;

crushing the mined oil sands ore in a mixing unit to form crushed ore;

subjecting the crushed ore to sizing and addition of process water to form an oil sands slurry;

supplying the oil sands slurry to a primary separation vessel (PSV) to separate the oil sands slurry and form a bitumen froth stream;

subjecting the bitumen froth stream to froth treatment to produce solvent diluted bitumen and solvent diluted tailings; and

recovering solvent from the solvent diluted bitumen to produce the bitumen product;

introducing the solvent diluted tailings into a flashing chamber of a flash vessel through a distributor assembly extending within the flashing chamber, the distributor assembly comprising:

- a distributor body extending into the flashing chamber and comprising a tubular portion and a closed end portion, the tubular portion comprising:

- a tubular wall having an outer surface and an inner surface, the tubular wall defining a feed passage for receiving the solvent diluted tailings; and

- a distributor body opening provided through the tubular wall; and

- a distributor adapter removably engageable with the distributor body and comprising:

- a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

- at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the flashing chamber for introducing the solvent diluted tailings into the flashing chamber;

- wherein the distributor adapter comprises a material having a higher wear resistance than the distributor body;

recovering flashed solvent from the flashing chamber as a solvent overhead stream;

recovering a solvent depleted tailings component from the flashing chamber as an underflow stream; and

recycling at least a portion of the solvent overhead stream back into the bitumen froth to enable the froth treatment.

BRIEF DESCRIPTION OF THE DRAWINGS

[00130] Fig 1 is a process flow diagram of a two-stage TSRU including first and second separation vessels, each separation vessel including a distributor assembly.

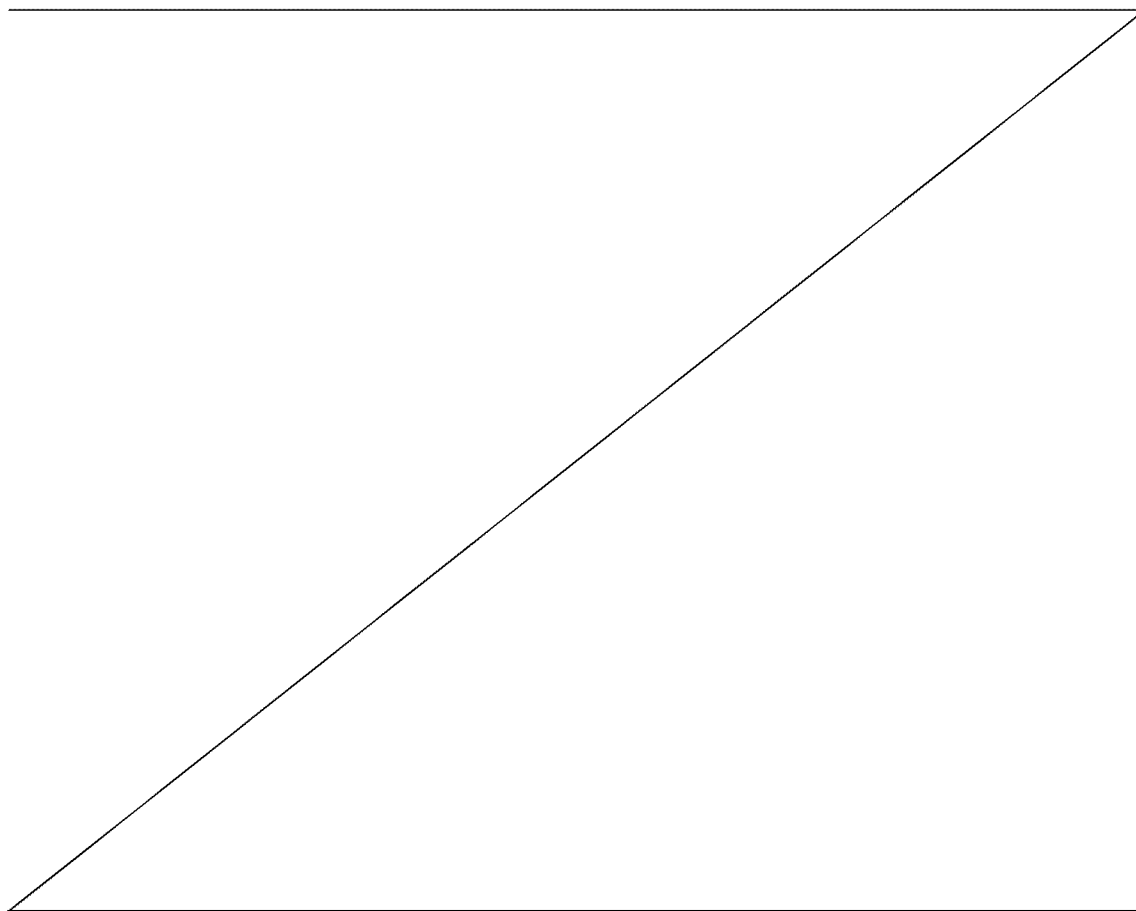
[00131] Fig 2 is a side partially-transparent view schematic a distributor assembly.

[00132] Fig 3 is a bottom partially-transparent view schematic of the distributor assembly shown in Fig 2.

[00133] Fig 4 is a bottom partially-transparent view schematic of a distributor assembly.

[00134] Fig 5 is a bottom partially-transparent view schematic of a distributor assembly.

[00135] Fig 6 is a bottom partially-transparent view schematic of a distributor assembly.



[00136] Fig 7 is a bottom partially-transparent view schematic of a distributor assembly.

[00137] Fig 8 is a bottom partially-transparent view schematic of a distributor assembly including two distributor adapters.

[00138] Fig 9 is a side cross-sectional view schematic of a portion of a distributor assembly including a distributor body and a distributor adapter.

[00139] Fig 10 is a side cross-sectional view schematic of the distributor adapter shown in Fig 9.

[00140] Fig 11 is a side cross-sectional view schematic of a portion of a distributor assembly.

[00141] Fig 12 is a side cross-sectional view schematic view of a distributor adapter.

[00142] Fig 13 is a side cross-sectional view schematic of a portion of a distributor assembly.

[00143] Fig 14 is a side cross-sectional view schematic view of a distributor adapter.

[00144] Fig 15 is a side cross-sectional view schematic of a portion of a distributor assembly.

[00145] Fig 16 is a side cross-sectional view schematic view of a distributor adapter.

[00146] Fig 17 is a side cross-sectional view schematic of a portion of a distributor assembly.

[00147] Fig 18 is a side cross-sectional view schematic view of a distributor adapter.

[00148] Fig 19A is a perspective view schematic of a distributor assembly including a distributor body, a distributor adapter and a retention member.

[00149] Fig 19B is a side cross-sectional view schematic of a portion of a distributor assembly.

[00150] Fig 20A is a partially-exploded perspective view schematic of a distributor assembly including a distributor body, a distributor adapter and a retention member.

[00151] Fig 20B is a side cross-sectional view schematic of a portion of a distributor assembly.

[00152] Fig 21A is a perspective view schematic of a distributor assembly including a distributor body, a distributor adapter and a retention member.

[00153] Fig 21B is a side cross-sectional view schematic of a portion of a distributor assembly.

[00154] Fig 22 is an exploded perspective view schematic of a distributor assembly including a distributor body, a distributor adapter and a retention member.

[00155] Fig 23 is an exploded side view schematic of a distributor assembly including a distributor body, a distributor adapter and a retention member.

[00156] Fig 24 is a side cross-sectional view schematic of a portion of a distributor adapter showing a pressure let-down aperture.

[00157] Fig 25 is a side cross-sectional view schematic of a portion of a distributor adapter showing a pressure let-down aperture.

[00158] Fig 26 is a side cross-sectional view schematic of a portion of a distributor adapter showing a pressure let-down aperture.

[00159] Fig 27 is a side cross-sectional view schematic of a portion of a distributor adapter showing a pressure let-down aperture.

[00160] Fig 28 is a side partially-transparent view schematic the distributor assembly shown in Fig 2.

[00161] Fig 29 is a front cross-sectional view schematic of a portion of the distributor adapter shown in Fig 28, including a pressure let-down aperture.

[00162] Fig 30 is a bottom view schematic of part of the distributor adapter shown in Fig 29.

[00163] Fig 31 is a side perspective view schematic of a distributor assembly connected to a retractable lance in an operational configuration.

[00164] Fig 32 is a side perspective view schematic of a distributor assembly connected to a retractable lance in a retracted configuration.

[00165] Fig 33 is a top view schematic of a first stage separation vessel that includes a pair of retractable lances, each retractable lance being configured to receive a distributor assembly therein.

[00166] Fig 34 is a top view schematic of a second stage separation vessel that includes three pairs of retractable lances, each retractable lance being configured to receive a respective distributor assembly therein.

DETAILED DESCRIPTION

[00167] A multiphase stream, such as a solvent diluted tailings stream, can be separated to recover various components by introducing the multiphase stream into a vapor-liquid separation vessel, such as a flash vessel, via one or more distributor assemblies. Each distributor assembly can include a distributor body and a distributor adapter engaged therewith, and optionally a retention member. The distributor adapter can be removably engageable with the distributor body, and includes at least one pressure let-down aperture for introducing the multiphase stream into the vapor-liquid separation vessel. The distributor adapter can be removed from the distributor body, for instance for maintenance when erosion and wear have damaged the pressure let-down apertures and replacement is desired. In some implementations, the distributor body and the distributor adapter can be made of different materials, and each of the materials can be chosen to provide given properties to the respective components of the distributor assembly. For instance, the distributor adapter can be made of a high wear material such as high chrome white iron (HCWI) or sintered tungsten carbide. The distributor adapter can also be made of a base metal overlaid with a wear resistant material such as chromium carbide, boron carbide or tungsten carbide. Different types of engagement of the distributor body with the distributor adapter are possible to form the distributor assembly, and the type of engagement can be chosen to facilitate obtaining a tight connection of the distributor body with the distributor adapter.

[00168] The pressure let-down apertures of the distributor adapter can have various features. For example, multiple spaced-apart pressure let-down apertures can be provided and configured as spaced-apart pressure let-down slots. The spaced-apart pressure let-down apertures can have a discorectangle shape, *i.e.*, a rectangle with rounded corners, such as shown in Fig 30. The upstream and downstream edges of each pressure let-down aperture can also have various configurations. In some implementations, the leading edge of the pressure let-down aperture can be rounded, or tapered, and the trailing edge of the pressure let-down aperture can be generally square. In some implementations, this configuration of the edges of the pressure let-down apertures can facilitate preventing solvent pre-flashing.

Characteristics of the multiphase stream

[00169] In some implementations, the multiphase feed stream is derived from heavy hydrocarbon or bitumen extraction operations, from mining and/or in situ recovery processes. The multiphase feed stream can include hydrocarbon solvent as the volatile component and an aqueous slurry as the low-volatility component. The aqueous slurry can include water, mineral solids, as well as residual bitumen or heavy hydrocarbons. Such multiphase feed streams can include tailings streams or other streams derived from extraction operations using a hydrocarbon solvent. The volatile solvent component can be a paraffinic solvent, an aromatic solvent, a naphthenic solvent, or another type of solvent, or a mixture of hydrocarbon solvents, where the solvent is more volatile than the aqueous slurry component. In some implementations, the volatile component and the liquid/slurry component have a vapor pressure difference similar to or greater than the vapour pressure difference between water and a C₄ to C₈ alkane.

[00170] In some implementations, the multiphase feed stream includes a low-volatility slurry component that includes erosive material, such as mineral solids. In other implementations, the low-volatility component can be a liquid that is substantially free of solids. Nevertheless, the distributor assembly designs and separation processes described herein can be particularly beneficial for multiphase streams that include a liquid phase, a solid phase, and a volatile component that is flashed upon exiting the distributor and then separated as a gas stream.

[00171] In one implementation, the multiphase stream is solvent diluted tailings produced by a paraffinic froth treatment (PFT) process that utilizes pentane as the solvent, and the solvent diluted tailings include mineral solids, water, pentane as well as precipitated asphaltenes. The solvent diluted tailings are supplied to a TSRU in which the distributor assemblies are used.

General TSRU implementations

[00172] In the following sections, the distributor assembly will be described in further detail in the context of a process for recovering solvent from a solvent diluted tailings stream in which the distributor assembly is used to introduce the solvent diluted tailings stream into a separation vessel of a tailings solvent recovery unit (TSRU) that is part of a bitumen froth treatment operation. However, it is to be understood that the distributor assembly designs and associated separation methods can be implemented to treat other multiphase feed streams that include a volatile component and a liquid or slurry component for flashing and separating the volatile component.

[00173] Referring to Fig 1, a solvent diluted tailings stream 12 is introduced into a flash vessel via a distributor assembly 21. The solvent diluted tailings stream 12 can be derived from a bitumen froth separation unit (FSU), more particularly as an underflow stream withdrawn from a second or third stage gravity separator that is part of the FSU. The solvent diluted tailings stream 12 can include water, solid mineral material, residual bitumen components, and solvent. The solvent may include paraffinic solvent, naphthenic solvent, and/or other solvents capable of promoting separation of bitumen from bitumen froth.

[00174] It should be understood that the term “solvent diluted tailings” refers to a tailings suspension that includes water, solid particulate material, and a hydrocarbon component referred to herein as a “solvent”. For solvent diluted tailings that are derived from an FSU, additional compounds such as residual bitumen can also be present in the tailings. In addition, the solvent is not necessarily present in the tailings so as to function as a “diluent” in the sense of diluting extractable hydrocarbons from the tailings, and thus the term “diluted” in “solvent diluted tailings” should be seen as referring to the solvent simply being present in the tailings. In this sense, the term “solvent diluted tailings” can also be referred to as “solvent affected tailings” where there is sufficient solvent to merit

subjecting the tailings to solvent removal. In some scenarios, the solvent diluted tailings are fed to a TSRU or other types of solvent recovery units.

[00175] The TSRU 10 can include one or more stages. In Fig 1, the TSRU 10 includes a first stage flash vessel 14 and a second stage flash vessel 16 arranged in series. It should be noted that various other vessel arrangements are possible, and that multiple trains of one- or two-stage TSRUs may be used. The solvent diluted tailings stream 12 is supplied to the first stage flash vessel 14 (also referred to as a "separation vessel") and is introduced into a flashing chamber 18 via an inlet spray system 20 that includes at least one distributor assembly 21, which will be described in further detail below. The solvent diluted tailings stream 12 introduced into the first stage flash vessel 14 separates to form a gas phase solvent stream 22 that is recovered as an overhead stream, and a first stage tailings component 24 partially depleted of solvent and recovered as an underflow stream. The first stage tailings component 24 can then be supplied to the second stage flash vessel 16 and introduced into a second flashing chamber 26 via a second stage spray system 28. The second stage spray system 28 also includes at least one distributor assembly 21 that may be similar or identical in construction as the distributor assembly 21 of the first stage flash vessel 14. A second separated solvent stream 30 is recovered from the second stage flash vessel 16 and a solvent recovered tailings stream 32 (which may also be referred to as "froth treatment tailings" or FTT) is withdrawn as underflow. The froth treatment tailings can be subjected to further treatments or can be disposed of directly in a subaerial containment structure.

[00176] It should be noted that the TSRU can have various other features that are not illustrated in Fig 1. For example, part of the underflow streams can be recirculated back into the feed streams supplied into the flash vessels and/or recycled directly back into a lower part of the flash vessels. Recirculation of underflow streams back into feed streams that are supplied to the distributors can be operated to ensure a consistent pressure drop across the apertures of the distributors even during periods of low flow.

Distributor assembly implementations

Distributor body and distributor adapter

[00177] Referring to Figs 2 and 3, the distributor assembly 21 includes a distributor body 34 and a distributor adapter 36. The distributor body 36 is engaged with, or

coupled to, the distributor body 34. The distributor body 34 includes a cut-out portion 50, or distributor body opening, and the distributor adapter 36 is configured to be mounted to the distributor body 34 to cover the cut-out portion 50. In some implementations, the distributor adapter 36, or a portion thereof, can be inserted into the cut-out portion 50. In some implementations, a portion of the distributor adapter 36 can be placed against a surface of the distributor body 34. In the context of the present description, the term "cover" can thus be interpreted as the distributor adapter 36 being placed over the cut-out portion 50 and/or within the cut-out portion 50. More details regarding the engagement of the distributor adapter 36 with the distributor body 34 are provided below. The distributor adapter 36 includes a wall 40 and at least one pressure let-down aperture 38. In some implementations, multiples pressure let-down apertures 38 are provided in a spaced-apart configuration along the wall 40 of the distributor adapter 36. In some implementations, the distributor adapter 36 is designed to be removably engageable with the distributor body 34. In implementations where the distributor adapter 36 is removably engageable with the distributor body 36, the distributor adapter 36 can be removed and replaced by another distributor adapter 36, as will also be discussed in more detail below.

[00178] Still referring to Figs 2 and 3, the distributor body 34 includes a tubular portion 42 configured to extend into the flashing chamber 18 of the separation vessel, and a closed end portion 44 at the downstream extremity of the tubular portion 42. The tubular portion 42, which can be cylindrical, has a side wall 46 defining a feed passage 48 for receiving the feed stream of solvent diluted tailings 12. In some implementations, the distributor body 34 can have an internal diameter that can be similar to the internal diameter of upstream equipment (e.g., lance, feedline, etc.) in order to avoid step changes in an area prior to the pressure let-downs apertures 38 of the distributor adapter 36. The distributor body 34 can be connected to a lance (not shown here), such as a retractable lance, and can have an internal diameter that is similar to that of the lance. In turn, the lance can be connected to an upstream pipeline to supply the feed stream to the separation vessel through the distributor assembly 21.

[00179] As mentioned above, the distributor body 34 includes a cut-out portion 50 provided through the side wall 46 of the tubular portion 42, for instance in a downstream portion thereof. In some implementations, the cut-out portion 50 can be oriented such that it faces downwardly towards the bottom of the separation vessel. In the illustrated

implementations, the cut-out portion 50 is provided in the side wall 46 of the tubular portion 42, but in other implementations the cut-out portion 50 could be provided through the closed end portion 44 of the distributor body 34.

[00180] In some implementations, the cut-out portion 50 of the distributor body 34 generally has a complimentary shape to that of the distributor adapter 36, so that the distributor adapter 36 can be received therein. In some implementations, the distributor adapter 36 can include an adapter insert portion 37 that can be received into the cut-out portion 50 while a remaining portion of the distributor 36 can be superposed, or overlaid, against the outer or inner surface of the side wall 46 the distributor body 34. In some implementations, the distributor adapter 36 can have a larger area than the area of the cut-out portion 50, and be placed so that a portion of the distributor adapter 36 can abut, or be superposed, against the outer or inner surface of the side wall 46 the distributor body 34. In such implementations, the distributor adapter 36 is placed so that the pressure let-down apertures 38 can be in fluid communication with the feed passage 48, *i.e.*, the pressure let-down apertures 38 are confined within the area of the cut-out portion 50. Still in such implementations, the wall 40 of the distributor adapter 36 can be configured to follow the curvature of the side wall 46 of the distributor body 34, so that the transition from the wall 40 to the side wall 46 is substantially continuous. In other implementations, the transition from the wall 40 to the side wall 46 is can include a step change to account for the thickness of the wall 40 of the distributor adapter 36.

[00181] Figs 9, 21B and 23 illustrate an example of a distributor assembly 21 that includes a distributor adapter 36 having an adapter insert portion 37 received into the cut-out portion 50, the adapter insert portion 37 including three spaced-apart pressure let-down apertures 38. In the illustrated embodiment, the distributor adapter 36 also includes a portion of the wall 40 that is superposed against the outside of the side wall 46 of the tubular body 42, such that the length and width of the distributor adapter 36 is larger than the length and width of the cut-out portion 50.

[00182] Figs 2 and 3 illustrate a distributor adapter 36 having three pressure let-down apertures 38 arranged in series in a downstream portion of the tubular portion 42 of the distributor body 34. The pressure let-down apertures 38 are shown as having substantially the same shape and area relative to each other. Alternatively, the size and/or shape of the pressure let-down apertures 38 can be different from each other,

and can be provided according to flow segregation and composition of the feed stream (e.g., the solvent diluted tailings 12 or the first stage tailings component 24, as shown in Fig 1), as will be discussed in further detail below. Figs 4-7 illustrate various embodiments of the distributor assembly 21, showing different configurations and shapes of the distributor adapter 36 and corresponding pressure let-down apertures 38. In Fig 4, the distributor adapter 36 is shown as having an oblong shape and including multiple spaced-apart pressure let-down apertures 38. In Fig 5, an example of a distributor adapter having a larger surface area than the cut-out portion 50, and a series of pressure let-down apertures 38 having a different size from each other is shown. Fig 6 shows an embodiment where the distributor body 34 includes multiple pressure let-down apertures provided longitudinally along the length of the distributor body 34. In Fig 7, the distributor adapter 36 includes multiple circular pressure let-down openings.

[00183] In some implementations, a single distributor body 34 can be engaged with more than one distributor adapter 36 to obtain the distributor assembly 21, such as shown in Fig 8. In such implementations, the distributor body 34 includes a given number of cut-out portions 50 in the distributor body 34 to receive the corresponding number of distributor adapters 36. For instance, in reference to Fig 8, the distributor body 34 includes a first and second cut-out portions 50a, 50b that are provided in a spaced-apart relationship, and corresponding first and second distributor adapters 36a, 36b that each includes pressure let-down apertures 38. More than two cut-out portions 50 and distributor adapters 36 can also be envisioned, which can depend on the application of the resulting distributor assembly 21. When more than one distributor adapter 36 is engaged with a distributor body 34, the pressure let-down apertures 38 of each of the distributor adapters 36a, 36b can be similar or different. For instance, in some implementations, the width of the pressure let-down apertures 38a of the upstream distributor adapter 36a can be larger than the width of the pressure let-down apertures 38b of the downstream distributor adapter 36b. This configuration can provide certain benefits, such as allowing a larger amount of solids to exit when passing through the upstream pressure let-down apertures 38a compared to the downstream pressure let-down apertures 38b.

[00184] It is to be noted that the embodiments shown in Figs 4-8 are shown as examples only, and that many other configurations of the distributor adapter 36 and pressure let-down apertures 38 are within the scope of the present description.

[00185] The distributor adapter 36 and the cut-out portion 50 provided through the side wall 46 of the distributor body 34 can include various characteristics, which can depend on the type of engagement of the distributor body 34 with the distributor adapter 36. With reference to Figs 9, 11, 13, 15 and 17, the cut-out portion 50 includes a cut-out upstream edge 52, or an opening upstream edge, and a cut-out downstream edge 54, or opening downstream edge. The distance between the cut-out upstream edge 52 and the cut-out downstream edge 54 corresponds to L_{ci} when measured at the inside edge of the side wall 46 in a longitudinal direction, and to L_{co} when measured at the outside edge of the side wall 46 in a longitudinal direction. The distributor adapter 36 includes an adapter upstream edge 56 and an adapter downstream edge 58. Similarly to the cut-out portion 50, the distance between the adapter upstream edge 56 and the adapter downstream edge 58 corresponds to L_{ai} when measured at the inside edge of the wall 40 of the distributor adapter 36 in a longitudinal direction, and to L_{ao} when measured at the outside edge of the wall 40 of the distributor adapter 36 in a longitudinal direction.

[00186] In some implementations and as shown in Figs 9 and 11, the cut-out upstream edge 52 and the cut-out downstream edge 54 of the cut-out portion 50 can be substantially perpendicular to the length of the distributor body 34, and so can the adapter upstream edge 56 and the adapter downstream edge 58. In such implementations, the distance between the cut-out upstream edge 52 and the cut-out downstream edge 54 is thus substantially the same, *i.e.*, $L_{ci} \sim L_{co}$, and the distance between the adapter upstream edge 56 and the adapter downstream edge 58 is also substantially the same, *i.e.*, $L_{ai} \sim L_{ao}$. Additionally, in Figs 9 and 10, the distributor adapter 36 is shown inserted into the cut-out portion 50, which entails that the lengths L_{ai} and L_{ci} of distributor adapter 36 are at least slightly smaller than the lengths L_{ci} and L_{ai} of the cut-out portion 50, so that the distributor adapter 36 can fit within the cut-out portion 50. In such implementations, the space, or gap, between the cut-out upstream edge 52 and the adapter upstream edge 56 and between the cut-out downstream edge 54 and the adapter downstream edge 58 can be sufficient to receive a filling material such as a glue or an epoxy sealant that can fix the distributor adapter 36 within the cut-out portion 50 of the distributor body 34. In some implementations, the filling material can facilitate obtaining a fluid seal to ensure that solvent diluted tailings exit the pressure let-down apertures 38 and prevent the solvent diluted tailings from leaking out.

[00187] In implementations where the distributor adapter 36 or a portion thereof is inserted into the cut-out portion 50, the cut-out upstream edge 52 and the cut-out downstream edge 54 of the cut-out portion 50 can be tapered or wedged, so as to include a tapered opening edge. For instance, Fig 13 illustrates a scenario where both the cut-out upstream edge 52 and the cut-out downstream edge 54 are tapered, such that $L_{ci} > L_{co}$. Accordingly, in Fig 14, the corresponding distributor adapter 36 has a complimentary adapter upstream edge 56 and a complimentary adapter downstream edge 58 that are also tapered, such that $L_{ai} > L_{ao}$.

[00188] In other implementations, the cut-out upstream edge 52 and the cut-out downstream edge 54 can include one or more steps so as to form a rabbeted edge. For instance, Fig 15 illustrates a scenario where both the cut-out upstream edge 52 and the cut-out downstream edge 54 include a rabbet 60, such that $L_{ci} > L_{co}$. Accordingly, in Fig 16, the corresponding distributor adapter 36 has an adapter upstream edge 56 and a complimentary adapter downstream edge 58 that each includes a complimentary rabbet 62, such that $L_{ai} > L_{ao}$. Conversely and with reference to Figs 17 and 18, the cut-out upstream edge 52 and the cut-out downstream edge 54 include a rabbet 60, such that $L_{ci} < L_{co}$, and the corresponding distributor adapter 36 has an adapter upstream edge 56 and a complimentary adapter downstream edge 58 that each includes a complimentary rabbet 62, such that $L_{ai} < L_{ao}$.

[00189] With reference to Figs 9 and 10, when the wall 40 of the distributor adapter 36 includes a portion that abuts against the outside surface of the side wall 46 of the distributor body 34, a fastener 53 can be used to removably secure the distributor adapter 36 to the distributor body 34. With reference to Figs 15 and 16, a fastener can also be provided to removably secure respective rabbets 60, 62 together.

[00190] The edges of the cut-out portion 50 can also have any desired shape that is complementary to the shape of the edges of the distributor adapter 36. In some implementations, the shape of the edges of the cut-out portion 50 and the complementary shape of the edges of the distributor adapter 36 can be chosen to facilitate maintaining the distributor adapter 36 in place once installed, which can include the criteria that $L_{ci} > L_{co}$ and $L_{ai} > L_{ao}$. For instance, in some implementations, the distributor adapter 36 can be introduced into the feed passage 48, *i.e.*, the inside of the adapter body 34, and then be positioned into the cut-out portion 50. When the cut-out

upstream edge 52 and the cut-out downstream edge 54 are tapered, such as in Figs 13 and 14, the portion of the distributor adapter 36 that has a larger length L_{ai} can abut against the corresponding tapered adapter upstream edge 56 and adapter downstream edge 58 by gravity since the cut-out portion 50 faces the bottom of the separation vessel, and be prevented to pass through the cut-out portion 50 given the smaller length L_{co} . In a similar fashion, still when the distributor adapter 36 is introduced into the feed passage 48 to be positioned in the cut-out portion 50, the respective rabbets 60 provided at the cut-out upstream edge 52 and the cut-out downstream edge 54 can prevent the distributor adapter 36 having complimentary rabbets 62 to pass through the cut-out portion 50 when $L_{ci} > L_{co}$ and $L_{ai} > L_{ao}$.

[00191] It is to be noted that the various features described above to characterise the opening upstream edge 52, the opening downstream edge 54, the adapter upstream edge 56 and the adapter downstream edge 58, which are defined in relation with a longitudinal axis of the distributor body 34, can also be applicable to the edges of the cut-out portion 50 and the distributor adapter 36 defined in relation to a transversal axis of the distributor body 34.

[00192] Different techniques can be used to ensure that the distributor adapter 36 is fixedly engaged with the distributor body 34 and maintained in place when the distributor assembly 21 is in use. In some implementations, when the distributor adapter 36 is positioned into the cut-out portion 50 of the distributor body 34, a sealant or glue such as an epoxy can be applied between the edges 56, 58 of the wall 40 of the distributor adapter 36 and the edges 52, 54 of the cut-out portion 50. In other implementations, when the distributor adapter 36 is placed against at least a longitudinal portion of the side wall 46 such as in Figs 9, 21B and 23, the sealant or glue can be provided between the longitudinal portion and corresponding surface of the wall 40 of the distributor adapter 36.

Retention member

[00193] The distributor assembly 21 can also include additional features to maintain the engagement of the distributor adapter 36 with the distributor body 34. For instance and with reference to Figs 19-23, a retention member 80 can be provided around the side wall 46 of the tubular body 42 to partially overlay the outside surface of the wall 40

of the distributor adapter 36. The retention member 80 is configured to maintain the distributor adapter 36 in place and to prevent it from disengaging from the distributor body 34, for instance when the distributor assembly is in use. In some implementations and with reference to Figs 19A-19B, the retention member 80 can be designed as a cage-type retention member comprising a pair of clamps 81, or sealing rings or collets, the clamps 81 comprising a flange 84 at each end such that opposite flanges 84 can be joined together by a fastener 86. The fastener 86 can be for instance a screw that can be tightened to a desired level, sufficient to exert a pressure against the distributor adapter 36 to maintain it in place. The retention member 80 can also include one or more brackets 88 extending in parallel to the length of the distributor body 34 to join together the pair of clamps 81 and provide additional support on the wall 40 of the distributor adapter 36.

[00194] In other implementations and with reference to Figs 19A-23, the retention member 80 can include two bands 90 positioned in a spaced-apart relationship along the length of the distributor body 34 and around the side wall 46 so as to cover at least a portion of the wall 40 of the distributor adapter 36. In such implementations, each band 90 can be fastened directly to the side wall 46, for instance using screws or another type of fastener. Additionally, a sealant or glue can be applied against the outer surface of the bands 90 to seal the retention member against the outside surface of the side wall 46 of the distributor body 34 and the wall 40 of the distributor adapter 36. The use of the retention member 80 can be beneficial, for instance in implementations where the area of the distributor adapter 36 is larger than the cut-out portion 50 or when the cut-out edges are perpendicular to the length of the distributor body 34, since the edges 56, 58 of the distributor adapter 36 and the edges 52, 54 of the cut-out portion 50 may not interact to maintain the distributor adapter 36 in place such as shown in Figs 9-12.

Pressure let-downs apertures

[00195] The pressure let-down apertures 38 of the distributor adapter 36 provide fluid communication between the feed passage 48 and the flashing chamber 18 for introducing the solvent diluted tailings into the flashing chamber 18. In some implementations, the pressure let-down apertures have a rectangular or a discorectangular shape. In some implementations, the pressure let-down apertures 38 are shaped as slots that are provided in series and substantially perpendicularly to the

direction of the stream arriving into the feed passage 48, or perpendicularly to the length of the distributor body 34, as illustrated for example in Figs 2-8. Such slot-shaped apertures 38 can facilitate providing a thin sheet-type spray and increasing surface area of the discharged flow to enhance solvent separation. Thinner sheet-type spray can aid in jet dissipation of the injected solvent diluted tailings, facilitating gases to dissipate at a lower velocity more readily when introduced into the flash vessel in comparison to a circular jet. The pressure let-down apertures 38 that are shaped as rectangular or discorectangular apertures or slots can follow a cross-sectional curvature of the wall 40 of the distributor adapter 40, which in turn can follow the curvature of the side wall 46 of the distributor body 34.

[00196] The pressure let-down apertures 38 that have a rectangular or discorectangular shape or that are provided as slots can be provided as cut-outs in the wall 40 of the distributor adapter 36, which can facilitate manufacturing of the distributor adapter 36, but other manufacturing methods can also be used to provide the pressure let-down apertures 38. In other implementations, the pressure let-down apertures 38 can also have other shapes and configurations. For instance, the pressure let-down apertures 38 can be provided parallelly to the length of the distributor body, etc. In some implementations, the one or more pressure let-down apertures 38 can have a circular or oval shape. The choice of the shape of the pressure let-down apertures 38 and their spatial relationship can be chosen at least in part according to the properties of the multiphase stream to be separated, or the desired application.

[00197] The pressure let-down apertures 38 can be machined before the assembly of the distributor adapter 36 with the distributor body 34, which can increase the number of techniques available to make the desired pressure let-down apertures 38. For instance, in some implementations, the distributor adapter 36 can be designed and machined accordingly using additive manufacturing or computer Numerical control (CNC) deposition technology to obtain the desired configuration of the edges and/or of the pressure let-down apertures 38.

[00198] A distributor assembly 21 that includes at least one distributor adapter 36 having multiple pressure let-down apertures 38 along its wall 40 provides the opportunity to refine each of the pressure let-down apertures 38 to have a unique size or shape based on flow characteristics of the feed stream, which can facilitate control of the

pressure drop across the pressure let-down apertures 38 and limit pre-flashing. For example, solids can tend to segregate toward a bottom region of the feed stream and thus an upstream pressure let-down aperture can receive material having higher solids content compared to a downstream pressure let-down aperture. Such solids segregation can influence the pressure drop requirements across the pressure let-down apertures for limiting pre-flashing within the distributor. Thus, the design of the distributor assembly 21 and more particularly of the one or more distributor adapters 36 can be adapted by modifying the size of different upstream or downstream pressure let-down apertures 38 or the pressure let-down apertures 38 of an upstream or downstream distributor adapter 36 to ensure the adequate pressure drop across each pressure let-down aperture for discouraging pre-flashing within the distributor assembly 21. For example, if the solvent content is higher downstream, one or more downstream pressure let-down apertures 38 can have a smaller area compared to the upstream pressure let-down apertures 38 in order to mitigate potential pre-flashing in the downstream portion of the distributor assembly 21. In addition, due to solids segregation, the upstream pressure let-down aperture(s) 38 can be sized to be larger than the downstream pressure let-down aperture(s) 38 to better handle the larger solids contents in the material expelled from the upstream pressure let-down aperture(s) 38. Furthermore, the sizing of each pressure let-down apertures 38 and spacing between the pressure let-down apertures 38 can be provided based on a pre-determined composition being expelled from each pressure let-down apertures 38.

[00199] The pressure let-down apertures 38 of the distributor adapter 36 can also be designed in order to provide a total open area to obtain choked flow and solvent flashing at the given process conditions. Splitting the flow out of the distributor assembly 21 through multiple pressure let-down apertures 38 can also facilitate momentum diffusion compared to a single large orifice. In addition, the pressure let-down apertures 38 may be spaced apart from each other to avoid 'cross-talk' such that the inlet sprays from the slots do not substantially converge and thus remaining relatively separate within the flashing chamber until the solvent depleted fluid accumulates in the bottom of the separation vessel. Alternatively, the sprays from the corresponding pressure let-down apertures 38 can coalesce a certain distance downstream of the aperture discharge as the sprays experience dissipation.

[00200] Referring to Figs 2-5 and 7, in some implementations, the distributor assembly 21 includes one or more pressure let-down apertures 38 that are oriented in generally perpendicular relation to the flow of the feed stream. Perpendicular pressure let-down apertures 38 can provide advantages in terms of mitigating pre-flashing issues and dealing with solids segregation issues. As mentioned previously, solids can tend to naturally segregate toward the bottom of the pipe. With multiple pressure let-down apertures 38 perpendicular to the flow, more solids may tend to discharge through the first pressure let-down aperture 38. In such a scenario, a bulk of the solids may be separated from the main flashing flow, meaning that fewer solids would be accelerated in the location where solvent flashing will be more dominant which would be expected to exist at the remaining pressure let-down apertures 38 downstream of the first pressure let-down aperture 38. Thus, detrimental effects due to any pre-flashing that may occur proximate to downstream pressure let-down apertures 38 may be reduced due to lower solids content in the slurry at those downstream locations within the distributor. It should be noted that such effects also depend on feed composition and operating conditions of the TSRU.

[00201] In some implementations, the wall 40 of the distributor adapter 36 has a curvature that follows the curvature of the tubular portion 34, as illustrated for instance in Figs 2 and 19-23. A curvature in the wall 40 of the distributor adapter 36 that follows the curvature of the tubular portion 34 can facilitate avoiding sharp transitions or step changes from the adapter wall 40 to the side wall 46 of the distributor body 34, which in turn can contribute to avoid solids-induced nucleation in applications where the feed material includes solids, as is the case for solvent diluted tailings, and/or avoid modifying the flow pattern of the feed stream flowing in the feed passage 48. Step changes can lead to localized turbulence which can increase velocities of the multiphase stream leading to a higher risk of erosion. Step changes can also limit pressure available for flow through the slots which can lead to pre-flashing.

[00202] In some implementations, the succession of the side wall 46 of the distributor body 34 and of the wall 40 of the distributor adapter 36 is substantially continuous, or flat, for instance as shown in Figs, 2, 19B, 20B and 23. When the wall 40 of the distributor adapter 36 includes a portion that abuts against the outside surface of the side wall 46 of the distributor body 34, the transition from the side wall 46 of the distributor body 34 to the wall 40 of the distributor adapter 36 can include a step change,

for instance as shown in Fig 9, to account for the thickness of the wall 40 of the distributor adapter 36. In implementations such as shown in Figs 19B and 20B, the transition from the side wall 46 of the distributor body 34 to the wall 40 of the distributor adapter 36 can be continuous.

[00203] When the pressure let-down apertures 38 are configured as slots, the slots can have a curvature that follows the curvature of the wall 40 of the distributor adapter 36, as also illustrated for instance in Figs 19-23. Curved slots that follow the curvature of the wall 40 of the distributor adapter 36 can facilitate longer slot geometries, providing a thinner sheet-type spray and enhancing dissipation of the flow in multiple directions (e.g., downward and sideways), reducing fluid velocity and risk of erosion within the separation vessel. In addition, slots that follow the curvature of the tubular portion 34 can have consistent edges and throat wall orientations for enhanced flow consistency along the entire slot length.

[00204] In some implementations, the dimensions of the distributor adapter 36 can be determined according to various factors, such as the desired sizing of the pressure let-down apertures 38 to obtain a given type of spray, and the maintenance of the structural integrity of the distributor assembly 21. For instance, when the pressure let-down apertures 38 are shaped as slots, the width W_a of the distributor adapter 36 can be such that it terminates below or close to the mid-point of the tubular portion 42. In other implementations, for instance if the pressure let-down apertures 38 are circular or are provided horizontally relative to the flow direction such as shown in Figs 6 and 7, the width of the distributor adapter 36 can be smaller than when the pressure let-down apertures 38 are configured as slots.

[00205] Referring now to Figs 24-27, each pressure let-down aperture 38 of the distributor adapter 36 can have characteristics and structural features to promote desired flow and spray effects. The pressure let-down aperture 38 is formed in the wall 40 of the distributor adapter 36, which has a wall thickness W_a , and have a throat 92 being defined by throat walls 94 that have throat wall length L_t substantially corresponding to W_a . The pressure let-down apertures 38 also have a leading edge 96 and a trailing edge 98. The pressure let-down apertures 38 can be manufactured and designed such that the edges 96, 98 and the throat walls 94 do not promote flashing within the throat 92 but only once expelled beyond the downstream edge 98. In some implementations, the

throat walls 94 can be substantially straight and parallel to each other to form a throat 92 that has a constant cross-section in the outlet flow direction, such as shown in Figs 24-26. In other implementations, the throat 92 can have a tapered shape where the outlet is wider than the inlet. However, various shapes and configurations of the throat are also possible. In some implementations, the leading edge 96 of the pressure let-down apertures 38 can be smooth, or rounded, and the trailing edge 98 can be sharp, or generally square, as illustrated in Fig 25. The leading edge 96 can be bevelled or chamfered, which can help to maintain a more consistent pressure drop across the aperture over the lifetime of the distributor adapter 36. Otherwise, the pressure drop can change over time as the leading edge experiences wear and changes shape and smoothness, which can reduce overall performance or efficiency of the process, for instance by increasing the flow through the pressure let-down apertures 38. In some implementations, the leading edge 96 of the pressure let-down apertures 38 can be smooth, or rounded, and the trailing edge 98 can be tapered, as illustrated in Fig 27.

[00206] Referring back to Figs 2 and 3, the pressure let-down apertures 38, the closed end portion 44 and the spacing between various components of the distributor assembly 21 can have certain geometries. For example, the spacing between the adjacent pressure let-down apertures 38 can be between 1.5 inches and 2.5 inches or between 1.75 inches and 2.25 inches; the pressure let-down apertures 38 can have a generally rectangular cross-section or a generally discorectangle cross-section; the width of each pressure let-down apertures 38 can be between about 0.75 inch and 1.25 inches or between 0.9 inch and 1.1 inches; the length of each pressure let-down aperture 38 can be between 4 inches and 10 inches, or between 8 inches and 9 inches; the distance between the farthest pressure let-down aperture 38 and the near vessel wall is between 40 inches and 80 inches; and the distance between the beginning of the closed end portion 44 and the last pressure let-down aperture 38 is between 3 and 7 inches or between 5 and 6 inches. In some implementations, the pressure let-down apertures 38 follow the curvature of the tubular portion 42, and extend along about 20% to about 50%, or about 35% to about 45%, of the circumference of the tubular portion 42. Such pressure let-down apertures 38 sizes and configurations can be particularly useful when the distributors are provided in an upper portion of the flashing chamber so that the tailings spray is directed downward.

[00207] Referring back to Figs 2-8, in some implementations, the closed end portion 44 of the distributor body 34 can include tapered walls 66 defining a flow redirection zone 68 to redirect a bypassed portion of the solvent diluted tailings back toward the pressure let-down apertures 38. The tapered walls 66 can have a variety of configurations. For instance, the tapered walls 66 can be curved internal surfaces that are generally continuous and smooth. The tapered walls 66 can define an ellipsoid cap, which can be generally spherical. In some implementations, the closed end portion 44 is formed as a generally rounded cap, which provides reduced “dead” zones and solvent pockets within the rounded cap space, thereby promoting enhanced solvent mixing and discouraging accumulation of solids within the volume of the distributor. In some implementations, the ellipsoid or round cap can be made out of a plate and welded to the distributor body 34.

[00208] In other implementations, and as shown in Figs 19A, 20A and 21A, the closed end portion 44 can be substantially straight or flat. An example of implementation where the distributor body 34 includes a straight or flat closed end portion 44 is when the distributor body 34 is a cast distributor body, since it may be easier to cast.

Replacement of the distributor adapter

[00209] As mentioned above, the distributor adapter 36 can be designed to be removable from the distributor assembly 21 to be replaced for maintenance or for other considerations. The replacement of the distributor adapter 36 can be appropriate for instance when the distributor adapter 36 has sustained a considerable amount of wear and eventually provides reduced performance. Replacing the distributor adapter 36 instead of the entire distributor assembly 21 can reduce equipment down-time and result in reduced material costs and faster turn-around time during shutdown. In some implementations, in a first stage of the process for recovering solvent from the solvent diluted tailings stream, the distributor assembly 21 can include a first distributor adapter 36, and in a second stage of the process when the first distributor adapter 36 has sustained considerable wear, the first distributor adapter 36 can be removed from the distributor assembly 21 and replaced by a second distributor adapter 36 that includes “newer” pressure let-down apertures 38.

[00210] In some implementations, it may be desirable to replace the distributor adapter 36 after the process has been proceeding for a certain period of time, for instance if

properties of the solvent diluted tailings stream have changed over this period of time and whether or not the distributor adapter 36 has sustained wear that would otherwise require replacement. In other words, as the distributor adapter 36 is configured to be removable from the distributor assembly 21, the characteristics of the distributor adapter 36 can be changed over the course of the process for recovering solvent from the solvent diluted tailings stream to adjust the distributor adapter 36, and more particularly the pressure let-down apertures 38, to such properties. For instance, the composition of the solvent diluted tailings stream can vary over time (e.g., solvent content) and it can be beneficial to modify characteristics of the distributor adapter 36 to take into account such changes in the composition and/or to obtain different spray and separation characteristics. For example, in a first stage of the process, the solvent content of the solvent diluted tailings stream can be relatively high, and the pressure let-down apertures 38 can be designed to obtain a flash atomization spray pattern or explosive flashing, where a fine spray is present immediately at or near the slot or aperture outlet. In a second stage of the process, for instance if the feed stream has a lower solvent content, the distributor adapter 36 can be removed and replaced by a distributor adapter 36 having pressure let-down apertures 38 configured so that the spray discharged from the distributor assembly 21 may have a spray pattern that includes a considerable jet region and a surrounding disintegration region. Thus, in the course of the operation, the distributor adapters 36 can be replaced with ones that has different structural, dimensional or material characteristics in order to modify the functionality in the separation process.

[00211] It is to be noted that the spray pattern and conditions can vary depending on the operating conditions of the separation vessel, particularly depending on the solvent and solids contents of the streams to be expelled via the distributor assembly 21. Feed pressures, vessel pressures and other operating parameters can be varied depending on incoming solvent and solids contents to promote flash atomization or sheet spray.

Additional characteristics of the distributor assembly

[00212] The distributor body 34 and distributor adapter 36 can include a coating layer provided to protect against erosion that can be caused by abrasive solid particles contained in the multiphase stream. For instance, one or both of the distributor body 34 and distributor adapter 36 can be made of carbon steel covered with an overlay of a

wear resistance material, such as a chromium carbide overlay or a tungsten carbide overlay. In some implementations, the distributor body 34 and the distributor adapter 36 can be made of a single material, *i.e.*, without being covered by a welded overlay, to reduce or eliminate variations and inconsistencies that can be inherent in some welded designs, which in turn can contribute to improve durability and performance of the distributor assembly 21. In some implementations, the distributor body 34 and the distributor adapter 36 can be made of different materials to take advantage of the properties of each of these materials for the respective purpose of the distributor body 34 and the distributor adapter 36. For instance, the distributor adapter 36 can be made of a high resistance wear material such as High Chrome White Iron (HCWI), Chrome White Iron (CWI), or chrome carbide, while the distributor body 34 can be made of a lesser resistance wear material such as carbon steel, with or without a welded overlay. In some implementations, the distributor adapter 36 can also be made of a base metal overlaid with a wear resistant material such as chromium carbide, boron carbide or tungsten carbide. In some implementations, both the distributor body 34 and the distributor adapter 36 can be made of HCWI or CWI. Given the multi-component design of the distributor assembly 21, each one of the distributor body 34 and distributor adapter 36 can be replaced in accordance with their own respective wear and failure rate. In some implementations, this approach can allow taking advantage of a longer lifespan for the distributor body 34 compared to that of the distributor adapter 36, and offer advantages of using adequate but sometimes costly materials for the distributor body 34 since the distributor body 34 does not necessarily require replacement and can be re-used even if the distributor adapter 36 shows signs of premature failure.

Additional TSRU implementations

[00213] Referring back to Fig 1, the TSRU can include two separation vessels that can operate in different modes. In one mode, one of the separation vessels can be operational so that the TSRU operates as a single stage unit. This mode can be beneficial when replacement of one or more distributor adapters 36 of the distributor assemblies 21 of the offline separation vessel is desired. Both of the separation vessels can thus be designed so that either one of the vessels can operate alone.

[00214] In some implementations, both separation vessels can be operational in series to provide a two-stage unit. With reference to Figs 1 and 31-34, the two-stage unit can

include the first stage separation vessel 14 and the second stage separation vessel 16. The first separation vessel 14 can include a first and a second distributor assemblies 21a, 21b, the first distributor assembly 21a being connected to a first retractable lance 100a, and the second distributor assembly 21b being connected to a second retractable lance 100b, as shown in Fig 33. In some implementations, the first distributor assembly 21a can be operational and positioned inside the first stage separation vessel 14, while the second distributor assembly 21b can be in stand-by, retracted out of the first stage separation vessel 14. Fig 31 illustrates an example of an implementation of a distributor assembly 21 connected to a retracted lance 100 shown in an operational configuration. Fig 32 illustrates an example of an implementation of a distributor assembly 21 connected to a retracted lance 100 shown in a retracted configuration. When the first stage separation vessel 14 has been in operation for a certain period of time and/or if it is determined that the first distributor assembly 21a no longer provides an expected level of performance due to wear, the stand-by distributor assembly 21b can be inserted inside the first stage separation vessel 14 and the first distributor assembly 21a can be retracted out of the first stage separation vessel 14. As the first distributor assembly 21a is retracted out, it can be subjected to maintenance, which can include replacing the corresponding distributor adapter 36 by a newer one or one that is in better condition than the distributor adapter 36 of the first distributor assembly 21a, *i.e.*, by a replacement distributor adapter. Advantageously, the maintenance on the first distributor assembly 21a can be performed while the first stage separation vessel 14 remains operational with the second distributor assembly 21b.

[00215] In some implementations, the second stage separation vessel 16 can also include a pair of distributor assemblies, which can be referred to as a third distributor assembly 21c and a fourth distributor assembly 21d. The third distributor assembly 21c can be connected to a third retractable lance 100c, and the fourth distributor assembly 21d can be connected to a fourth retractable lance 100d, as shown in Fig 34. As mentioned previously, the second stage separation vessel 16 is configured to receive the underflow 24 of the first stage separation vessel 14, and to introduce the tailings component 24 partially depleted of solvent into the second stage separation vessel 16 via one of the third and fourth distributor assembly 21c, 21d. In implementations where the first stage includes more than one separation vessel, there can be a corresponding number of pair of distributor assemblies supplying the second stage separation vessel

16. For instance, if there are three first stage separation vessels, there can be three pairs of distributor assemblies, as shown in Fig 34 as distributor assemblies 21e, 21f, 21g and 21h. Each distributor assembly can also be connected to a respective retractable lance 100. In some implementations, the third distributor assembly 21c can be operational and positioned inside the second stage separation vessel 16 and thus receive the tailings component 24, while the fourth distributor assembly 21d can be in stand-by, retracted out of the second stage separation vessel 16. Again, the maintenance on the third distributor assembly 21c can be performed while the second stage separation vessel 16 can remain operational with the fourth distributor assembly 21d.

[00216] In a further mode, the order of the two separation vessels can be reversed, such that the first stage separation vessel becomes the second stage vessel and the second stage vessel becomes the first stage vessel. Such operating modes are facilitated by the use of the distributor that has a design enabling interchangeable use in both first and second stages.

[00217] In some implementations, multiple distributor assemblies 21 can be provided in one or both of the separation vessels 14, 16 that are part of the TSRU. The distributor assemblies 21 can be provided at a same height within each separation vessel 14, 16 such that the end of each distributor assembly 21 is positioned in spaced relation with respect to a center vertical axis of the separation vessel. Alternatively, distributor assemblies 21 can be provided at different heights within the separation vessels, although care should be taken to position each distributor away from any high velocity spray from a nearby distributor assembly 21. The distributor assemblies 21 can also be substantially identical to each other. Alternatively, the distributor assemblies 21 can be different from each other in terms of length of the tubular portion 42 for positioning within the flashing chamber of the vessel and/or in terms of the pressure let-down aperture sizing. The number, the location and the design of the distributor assemblies 21 within the separation vessel can be provided according to the fluid dynamics, structural features, and operating conditions of the separation vessel. For instance, the distributor assembly arrangement and design in the first stage separation vessel 14 shown in Fig 1 may be different from that of the second separation vessel 16, due to the different composition of the feed streams and the different operating conditions of the two separation vessels. It is also noted that the distributor assemblies 21 can be oriented

horizontally within the vessels, which the pressure let-down apertures 38 oriented for downward discharge of the spray. Alternative orientations can also be used in conjunction with corresponding design of the separation vessel.

[00218] In some implementations, a method of operating a TSRU or a separation vessel including a flashing chamber is provided. The method can include a first phase and a second phase. In the first phase, a first stream of solvent diluted tailings is introduced into the flashing chamber through a distributor assembly 21 as described herein. During the first phase of the method, the distributor assembly 21 includes a first phase distributor adapter 36 having given characteristics, for instance in relation with the shape, size and number of the pressure let-down apertures. Flash solvent can be recovered from the flashing chamber as an overhead stream, while a solvent depleted tailings stream can be recovered from the flashing chamber as an underflow stream. While in the first phase, a property of the first stream of solvent diluted tailings is monitored. The property can be for instance a solvent content or a solids content of the solvent diluted tailings. Then, if the property of the first stream of solvent diluted tailings is below or above a given threshold or if the property of the first stream of solvent diluted tailings is outside a given interval, the first phase can be terminating and steps can be taken to replace the first distributor adapter 36 of the distributor assembly 21 by a second distributor adapter 36 coupled to the same distributor body 34 as during the first phase. Once it is determined that the first stream of solvent diluted tailings is below or above a given threshold or if the property of the first stream of solvent diluted tailings is outside a given interval, the solvent diluted tailings stream can be referred to as a second stream of solvent diluted tailing. The second distributor adapter 36 will be chosen so as to have pressure let-down apertures having characteristics that are adapted to the second stream of solvent diluted tailing such that performance of the TSRU or separation vessel can remain adequate and efficient.

[00219] As mentioned above, in some implementations, the property of the first stream of solvent diluted tailings that is monitored is the solvent content. During the first phase of the method, the solvent content of the first stream of solvent diluted tailings can be above a given threshold, and the pressure let-down apertures of the first phase distributor adapter 36 can be configured to enable explosion flashing of solvent upon introduction of the first solvent diluted tailings stream into the flashing chamber. Then, in the second phase of the method, if it is determined that the solvent content of the

second stream of solvent diluted tailings is now below the given threshold, the first phase distributor adapter 36 can be replaced by a second phase distributor adapter having pressure let-down slots that enable formation of fan-shaped streams upon introduction into the corresponding flashing chamber.

[00220] Several alternative implementations and examples have been described and illustrated herein. The implementations of the technology described above are intended to be exemplary only. A person of ordinary skill in the art would appreciate the features of the individual implementations, and the possible combinations and variations of the components. A person of ordinary skill in the art would further appreciate that any of the implementations could be provided in any combination with the other implementations disclosed herein. It is understood that the technology may be embodied in other specific forms without departing from the central characteristics thereof. The present implementations and examples, therefore, are to be considered in all respects as illustrative and not restrictive, and the technology is not to be limited to the details given herein. Accordingly, while the specific implementations have been illustrated and described, numerous modifications come to mind.

CLAIMS

1. A distributor assembly for introducing a multiphase feed into a separation vessel, the distributor assembly comprising:

a distributor body having a proximal end for receiving the multiphase feed and a distal end for introducing the multiphase feed to the separation vessel, the distributor body comprising:

at least one wall having an outer surface and an inner surface, the at least one wall defining a feed passage for receiving the multiphase feed;

a distributor body opening provided through the distributor body; and

a closed end portion at the distal end of the distributor body; and

a distributor adapter coupled to the distributor body and comprising:

a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the separation vessel for introducing the multiphase feed into the separation vessel;

wherein the distributor adapter comprises a material having a higher wear resistance than the distributor body.

2. The distributor assembly of claim 1, wherein the distributor adapter is removably engageable with the distributor body.

3. The distributor assembly of claim 1 or 2, wherein the distributor body opening is provided through the at least one wall of the distributor body.

4. The distributor assembly of any one of claims 1 to 3, wherein the distributor body opening is proximate to the distal end of the distributor body.
5. The distributor assembly of any one of claims 1 to 4, further comprising a seal between the distributor body opening and the distributor adapter.
6. The distributor assembly of claim 5, wherein the seal comprises an epoxy sealant.
7. The distributor assembly of any one of claims 1 to 6, wherein the distributor adapter wall comprises an adapter insert portion receivable into the distributor body opening and comprising the at least one pressure let-down aperture.
8. The distributor assembly of claim 7, wherein the adapter insert portion has a complimentary shape relative to the distributor body opening to fit therein.
9. The distributor assembly of claim 7 or 8, wherein the distributor body opening comprises an opening upstream edge and an opening downstream edge, and the adapter insert portion comprises an adapter upstream edge and an adapter downstream edge.
10. The distributor assembly of claim 9, wherein at least one of the opening upstream edge and the opening downstream edge is substantially perpendicular to a length of the distributor body.
11. The distributor assembly of claim 9, wherein at least one of the opening upstream edge and the opening downstream edge comprises a tapered opening edge, and a corresponding one of the adapter upstream edge and the adapter downstream edge comprises a tapered adapter edge.
12. The distributor assembly of claim 9, wherein a transition from the inner surface of the distributor body to the opening upstream edge forms an angle that is obtuse.
13. The distributor assembly of claim 9, wherein a transition from the inner surface of the distributor body to the opening downstream edge forms an angle that is obtuse.
14. The distributor assembly of claim 12 or 13, wherein the angle is about 45°.

15. The distributor assembly of claim 9, wherein at least one of the opening upstream edge and the opening downstream edge comprises an opening rabbeted edge and a corresponding one of the adapter upstream edge and the adapter downstream edge comprises an adapter rabbeted edge.

16. The distributor assembly of claim 11, wherein the distributor body opening and the adapter insert portion each have a smaller length in proximity of the outer surface of the at least one wall than in proximity of the inner surface of the at least one wall, when measured in a longitudinal direction.

17. The distributor assembly of any one of claims 9 to 16, wherein a portion of the distributor adapter wall is configured to overlay part of the outer surface of the at least one wall of the distributor body.

18. The distributor assembly of claim 17, wherein the distributor adapter is removably securable to the outer surface of the at least one wall of the distributor body distributor body via a fastener.

19. The distributor assembly of claim 15, wherein the adapter rabbeted edge of the distributor adapter is removably securable to the opening rabbeted edge of the distributor body opening via a fastener.

20. The distributor assembly of any one of claims 1 to 17, wherein the distributor assembly further comprises a retention member to removably secure the distributor adapter to the distributor body.

21. The distributor assembly of claim 20, wherein the retention member is provided over the outer surface of the at least one wall of the distributor body.

22. The distributor assembly of claim 20, wherein the retention member comprises:

at least two bands provided in a spaced-apart relationship over the outer surface of the at least one wall of the distributor body on each side of the distributor body opening and over part of the distributor adapter wall; and

a first series of retention member fasteners to connect each of the at least two bands to at least the distributor adapter wall.

23. The distributor assembly of claim 22, wherein the first series of retention member fasteners further connects each of the at least two bands to the at least one wall of the distributor body.

24. The distributor assembly of claim 23, wherein the retention member further comprises a second series of retention member fasteners to connect each of the at least two bands to the distributor adapter wall and to the at least one wall of the distributor body.

25. The distributor assembly of claim 20, wherein the retention member comprises:

at least two clamps provided in a spaced-apart relationship around the outer surface of the at least one wall of the distributor body on each side of the distributor body opening and over part of the distributor adapter wall, wherein each clamp comprises a flange at each end to tighten the clamp via at least one flange fastener.

26. The distributor assembly of claim 25, wherein the retention member further comprises a bracket extending between opposite clamps.

27. The distributor assembly of claim 25 or 26, wherein the retention member further comprises a first series of retention member fasteners to connect the at least two clamps to at least the distributor adapter wall.

28. The distributor assembly of claim 27, wherein the retention member further comprises a second series of retention member fasteners to connect the at least two clamps to the at least one wall of the distributor body.

29. The distributor assembly of any one of claims 1 to 28, wherein the distributor body and the distributor adapter are made of different materials.

30. The distributor assembly of claim 29, wherein the distributor adapter comprises High Chrome White Iron (HCWI).

31. The distributor assembly of claim 29, wherein the distributor adapter comprises chrome carbide.
32. The distributor assembly of any one of claims 1 to 31, wherein the distributor body is configured to extend from a side wall of the separation vessel into the separation vessel.
33. The distributor assembly of claim 32, wherein the distributor body is configured to have a substantially horizontal orientation within the separation vessel.
34. The distributor assembly of claim 33, wherein the distributor body is configured such that the feed passage has a substantially constant diameter along a length thereof.
35. The distributor assembly of any one of claims 1 to 34, wherein the inlet spray system comprises more than one distributor assembly.
36. The distributor assembly of any one of claims 1 to 35, wherein the distributor assembly comprises more than one distributor adapter coupled to the distributor body.
37. The distributor assembly of any one of claims 1 to 36, wherein the distributor body is a pipe section and the distributor adapter wall substantially follows a curvature of the pipe section.
38. The distributor assembly of any one of claims 1 to 37, wherein the distributor adapter is configured to introduce the multiphase feed downwardly into the separation vessel through the at least one pressure let-down aperture.
39. The distributor assembly of any one of claims 1 to 38, wherein the at least one pressure let-down aperture has a rectangular shape.
40. The distributor assembly of any one of claims 1 to 38, wherein the at least one pressure let-down aperture has a discorectangular shape.
41. The distributor assembly of any one of claims 1 to 40, wherein the at least one pressure let-down aperture is shaped as a pressure let-down slot.

42. The distributor assembly of any one of claims 37 to 41, wherein the at least one pressure let-down aperture has a transverse orientation with respect to a longitudinal axis of the distributor body.
43. The distributor assembly of any one of claims 37 to 42, wherein the at least one pressure let-down aperture comprises multiple pressure let-down apertures.
44. The distributor assembly of claim 43, wherein the multiple pressure let-down apertures are substantially identical to each other in shape and size.
45. The distributor assembly of claim 43 or 44, wherein the multiple pressure let-down apertures are spaced apart such that each pair of adjacent pressure let-down apertures defines a corresponding strip each having a substantially same width.
46. The distributor assembly of claim 45, wherein the strips have substantially the same wall thickness.
47. The distributor assembly of any one of claims 1 to 46, wherein the at least one pressure let-down aperture comprises a throat defined by throat walls, a leading edge, and a trailing edge.
48. The distributor assembly of claim 47, wherein the throat walls include smooth surfaces to inhibit cavitation within the throat.
49. The distributor assembly of claim 47 or 48, wherein the leading edge is smooth-edged, chamfered or tapered.
50. The distributor assembly of any one of claims 47 to 49, wherein the trailing edge is sharp or square.
51. The distributor assembly of any one of claims 43 to 50, wherein the multiple pressure let-down apertures comprise at least one downstream pressure let-down aperture positioned proximate to the distal end of the distributor body to facilitate expelling backflow of the multiphase feed from the closed end portion into the separation vessel.

52. The distributor assembly of claim any one of claims 1 to 51, wherein the distributor body is configured for connection to a retractable lance, and has an internal diameter that is substantially identical to that of the retractable lance.

53. The distributor assembly of any one of claims 1 to 52, wherein the distributor body comprises a tubular portion.

54. The distributor assembly of any one of claims 1 to 53, wherein the distributor assembly is for use in a Tailings Solvent Recovery Unit (TSRU) as the separation vessel.

55. The distributor assembly of any one of claims 1 to 54, wherein the distributor assembly is configured to receive a hydrocarbon-containing feed as the multiphase feed is.

56. The distributor assembly of claim 55, wherein the distributor assembly is configured to receive a bituminous feed as the hydrocarbon-containing feed.

57. The distributor assembly of claim 56, wherein the distributor assembly is configured to receive a solvent diluted tailings stream as the bituminous feed.

58. The distributor assembly of any one of claims 1 to 57, wherein the separation vessel comprises a flashing chamber.

59. The distributor assembly of any one of claims 1 to 57, wherein the separation vessel comprises:

a flashing chamber for receiving the multiphase feed and configured to enable vaporization of a volatile component of the multiphase feed;

a feed inlet line for supplying the multiphase feed to the flashing chamber;

a liquid outlet for withdrawing a liquid component from the flashing chamber;

a volatile component outlet for withdrawing a recovered volatile component from the flashing chamber; and

an inlet spray system fluidly connected to the feed inlet line for receiving the multiphase stream for spraying into the flashing chamber, the inlet spray system comprising the distributor assembly.

60. A tailings solvent recovery process for recovering a solvent from solvent diluted tailings, the process comprising:

introducing the solvent diluted tailings into a flashing chamber through a distributor assembly extending within the flashing chamber, the distributor assembly comprising:

a distributor body extending into the flashing chamber and comprising a tubular portion and a closed end portion, the tubular portion comprising:

a tubular wall having an outer surface and an inner surface, the tubular wall defining a feed passage for receiving the solvent diluted tailings; and

a distributor body opening provided through the tubular wall; and

a distributor adapter removably engageable with the distributor body and comprising:

a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the flashing chamber for introducing the solvent diluted tailings into the flashing chamber;

wherein the distributor adapter comprises a material having a higher wear resistance than the distributor body;

recovering flashed solvent from the flashing chamber as a solvent overhead stream;

recovering a solvent depleted tailings component from the flashing chamber as an underflow stream; and

removing the distributor adapter from the distributor assembly and replacing the distributor adapter by a replacement distributor adapter removably engageable with the distributor body.

61. The process of claim 60, wherein the tubular portion of the distributor body is connectable to a retractable lance.

62. The process of claim 61, further comprising displacing the retractable lance when the tubular portion of the distributor body is connected thereto from an operational configuration wherein the distributor assembly extends within the flashing chamber to a retracted configuration wherein the distributor assembly is out of the flashing chamber.

63. The process of claim 62, wherein the removing of the distributor adapter from the distributor assembly and the replacing of the distributor adapter by the replacement distributor adapter are performed when the retractable lance is in the retracted configuration.

64. The process of claim 62 or 63, wherein following the removing of the distributor adapter from the distributor assembly and the replacing of the distributor adapter by the replacement distributor adapter, the retractable lance is displaced back into the operational configuration.

65. The process of claim 64, wherein when the retractable lance is in the retracted configuration, the solvent diluted tailings is introduced into to the flashing chamber through a second distributor assembly extending within the flashing chamber, the second distributor assembly comprising a second distributor body and a second distributor adapter.

66. The process of claim 65, wherein the second distributor assembly is connectable to a second retractable lance displaceable from an operational configuration to a retractable configuration and vice versa.

67. The process of claim 66, wherein when the retractable lance is displaced back into the operational configuration, the second retractable lance is in the retracted configuration and the second distributor adapter is removed from the second distributor assembly and replaced by a second replacement distributor adapter removably engageable with the second distributor body.

68. The process of claim 67, wherein following the removing of the second distributor adapter from the second distributor assembly and the replacing of the second distributor adapter by the second replacement distributor adapter, the process further comprises displacing the retractable lance back into the operational configuration.

69. A method of operating a tailings solvent recovery unit (TSRU) for recovering solvent from solvent diluted tailings, the method comprising:

in a first phase, introducing a first stream of solvent diluted tailings to a flashing chamber through a distributor assembly extending within the flashing chamber, the distributor assembly comprising:

a distributor body extending into the flashing chamber and comprising a tubular portion and a closed end portion, the tubular portion comprising:

a tubular wall having an outer surface and an inner surface, the tubular wall defining a feed passage for receiving the solvent diluted tailings; and

a distributor body opening provided through the tubular wall; and

a first phase distributor adapter removably engageable with the distributor body and comprising:

a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage

and the flashing chamber for introducing the solvent diluted tailings into the flashing chamber;

wherein the distributor adapter comprises a material having a higher wear resistance than the distributor body;

recovering flashed solvent from the flashing chamber as a solvent overhead stream;

recovering a solvent depleted tailings component from the flashing chamber as an underflow stream;

monitoring a property of the first stream of solvent diluted tailings, wherein when the property of the first stream of solvent diluted tailings is above or below a given threshold, terminating the first phase, wherein terminating the first phase comprises:

replacing the first phase distributor adapter by a second phase distributor adapter removably engageable with the distributor body;
and

in a second phase, introducing a second stream of solvent diluted tailings to the flashing chamber via the distributor assembly having the second distributor adapter.

70. The method of claim 69, wherein the first phase further comprises selecting at least one of a shape, a number and a size of the at least one pressure let-down aperture for the second phase distributor adapter.

71. The method of claim 69 or 70, wherein the property is a solvent content of the first stream of solvent diluted tailings.

72. The method of claim 71, wherein the at least one pressure let-down aperture of the first phase distributor assembly is sized according to the solvent content exiting the at least one pressure let-down aperture.

73. The method of claim 71 or 72, wherein the at least one pressure let-down aperture of the second phase distributor assembly is sized according to the solvent content exiting the at least one pressure let-down aperture.

74. The method of any one of claims 71 to 73, wherein in the first phase, the solvent content of the first stream of solvent diluted tailings is above the given threshold, and the at least one pressure let-down aperture of the first phase distributor adapter are configured to enable explosion flashing of solvent upon introduction of the first solvent diluted tailings stream into the flashing chamber.

75. The method of any one of claims 71 to 74, wherein in the second phase, the solvent content of the second stream of solvent diluted tailings is below the given threshold, and the at least one pressure let-down aperture enables formation of fan-shaped streams upon introduction into the corresponding flashing chamber.

76. The method of any one of claims 69 to 75, wherein the tubular portion of the distributor body is connected to a retractable lance.

77. The method of claim 76, wherein terminating the first phase further comprises displacing the retractable lance from an operational configuration wherein the distributor assembly extends within the flashing chamber to a retracted configuration wherein the distributor assembly is out of the flashing chamber.

78. The method of claim 77, wherein replacing the first phase distributor adapter by the second phase distributor adapter is performed when the retractable lance is in the retracted configuration.

79. The method of claim 77 or 78, wherein following the replacing of the first phase distributor adapter by the second phase distributor adapter, the retractable lance is displaced back into the operational configuration.

80. A process for producing a bitumen product from oil sands, the process comprising:

mining oil sands ore to obtain mined oil sands ore;

crushing the mined oil sands ore in a mixing unit to form crushed ore;

subjecting the crushed ore to sizing and addition of process water to form an oil sands slurry;

supplying the oil sands slurry to a primary separation vessel (PSV) to separate the oil sands slurry and form a bitumen froth stream;

subjecting the bitumen froth stream to froth treatment to produce solvent diluted bitumen and solvent diluted tailings; and

recovering solvent from the solvent diluted bitumen to produce the bitumen product;

introducing the solvent diluted tailings into a flashing chamber of a flash vessel through a distributor assembly extending within the flashing chamber, the distributor assembly comprising:

- a distributor body extending into the flashing chamber and comprising a tubular portion and a closed end portion, the tubular portion comprising:

- a tubular wall having an outer surface and an inner surface, the tubular wall defining a feed passage for receiving the solvent diluted tailings;
 - and

- a distributor body opening provided through the tubular wall; and

- a distributor adapter removably engageable with the distributor body and comprising:

- a distributor adapter wall mounted to the distributor body and covering the distributor body opening; and

- at least one pressure let-down aperture defined through the distributor adapter wall to provide fluid communication between the feed passage and the flashing chamber for introducing the solvent diluted tailings into the flashing chamber;

wherein the distributor adapter comprises a material having a higher wear resistance than the distributor body;

recovering flashed solvent from the flashing chamber as a solvent overhead stream;

recovering a solvent depleted tailings component from the flashing chamber as an underflow stream; and

recycling at least a portion of the solvent overhead stream back into the bitumen froth to enable the froth treatment.

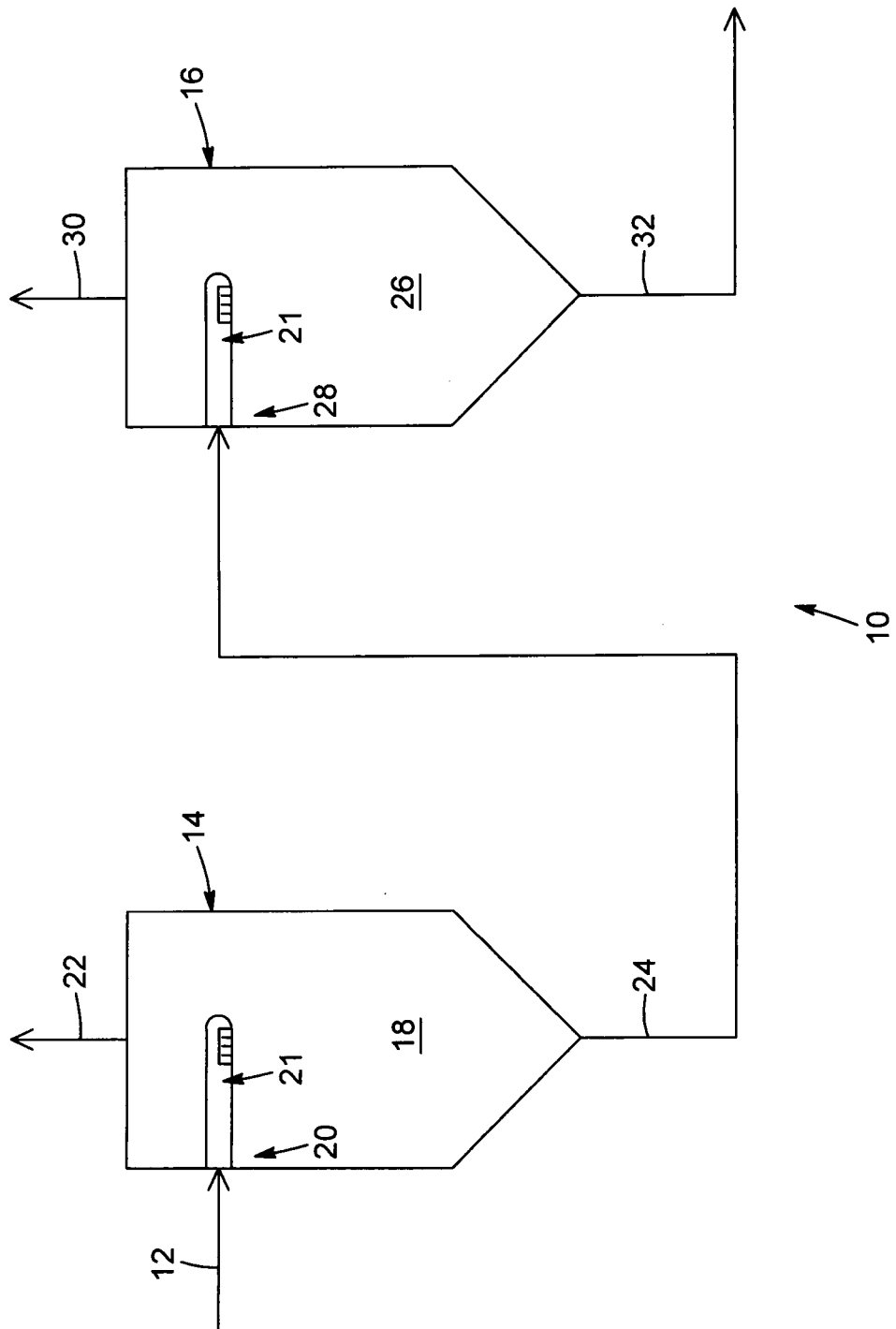
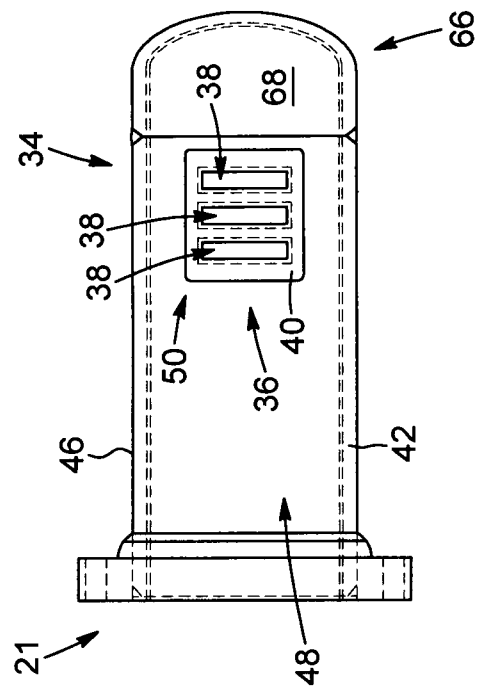
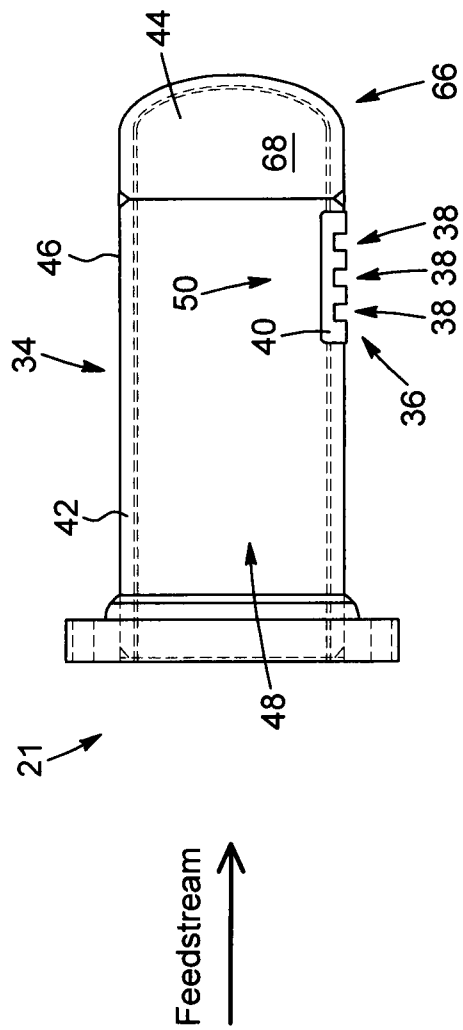


FIG. 1



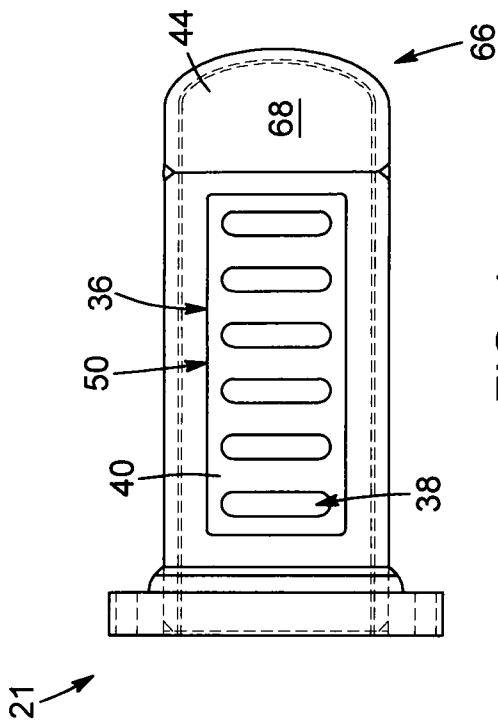


FIG. 4

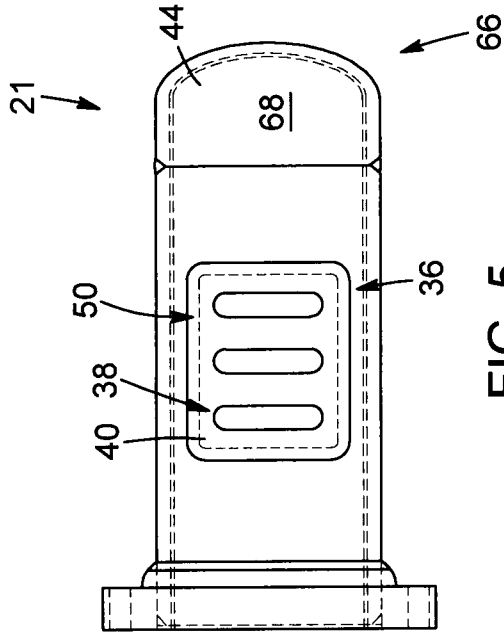


FIG. 5

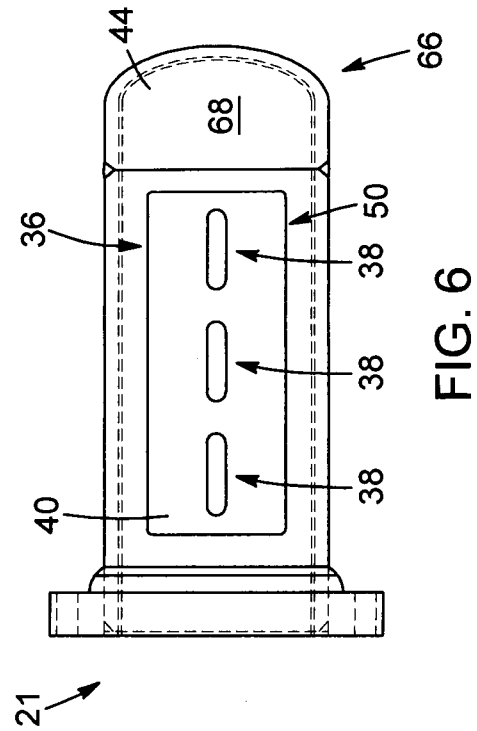


FIG. 6

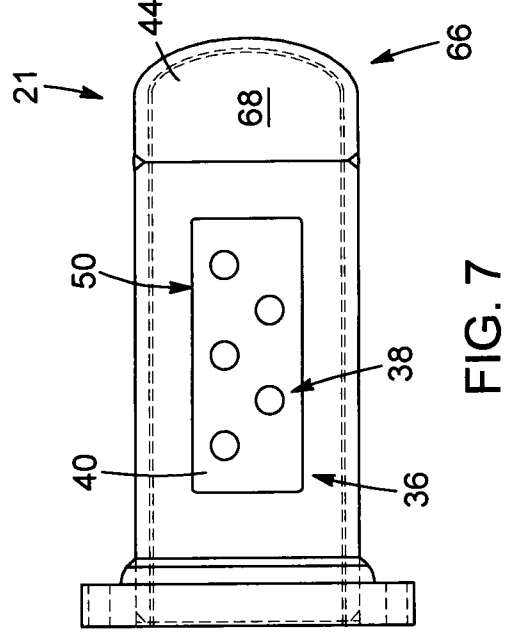


FIG. 7

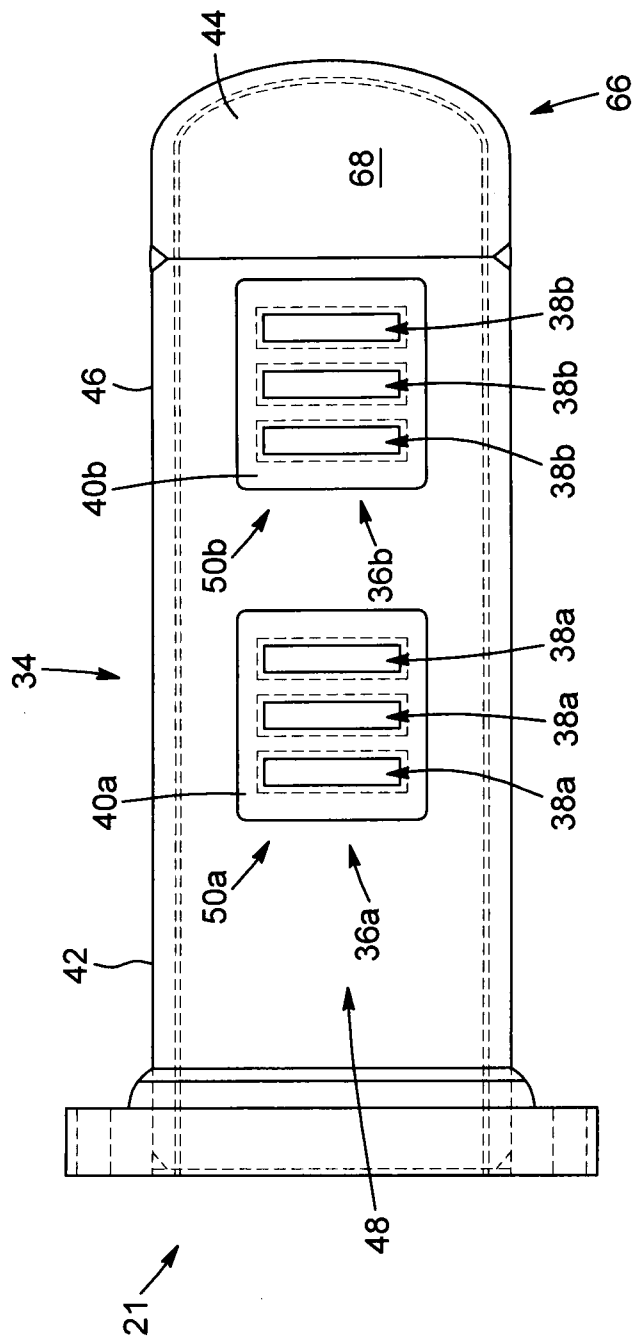


FIG. 8

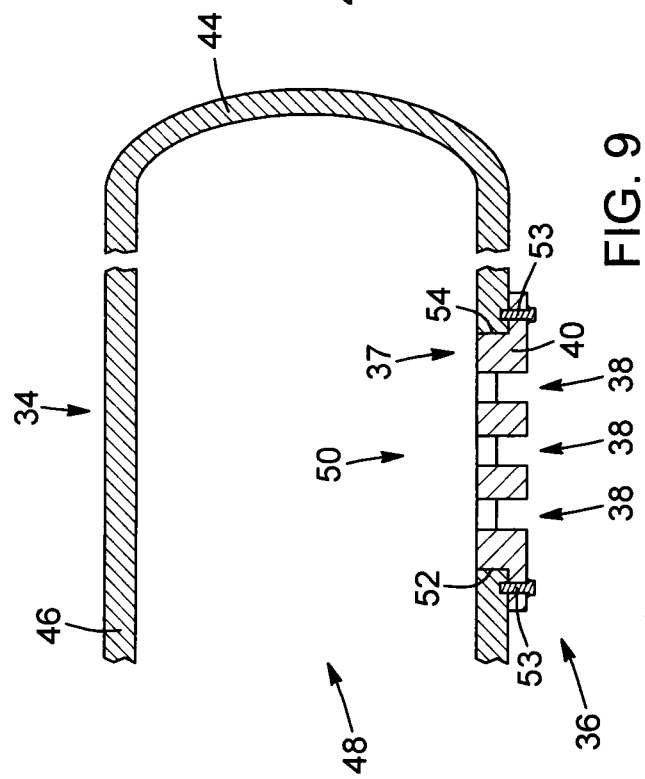


FIG. 9

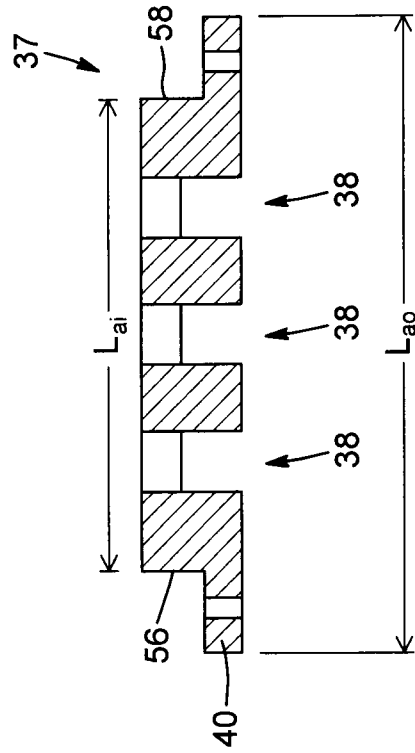


FIG. 10

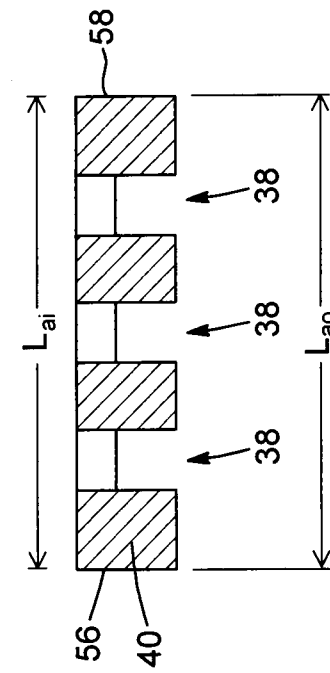


FIG. 12

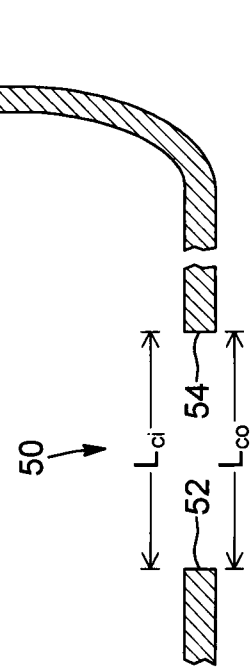


FIG. 11

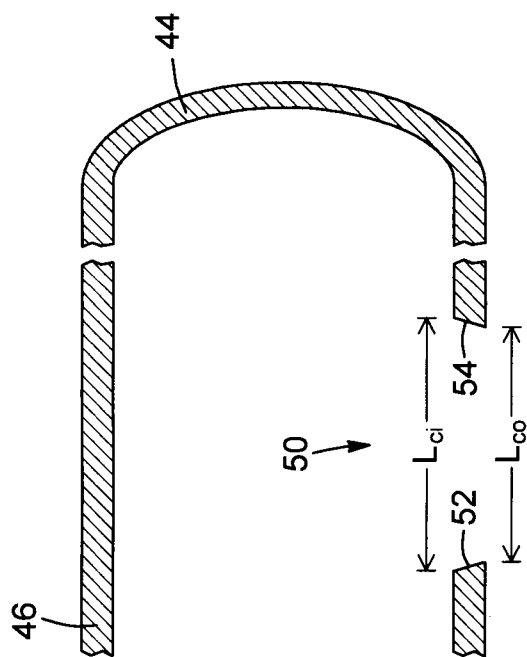


FIG. 13

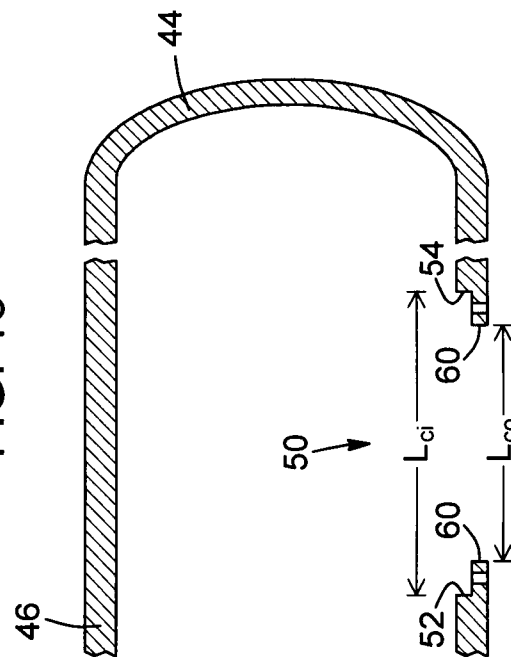


FIG. 15

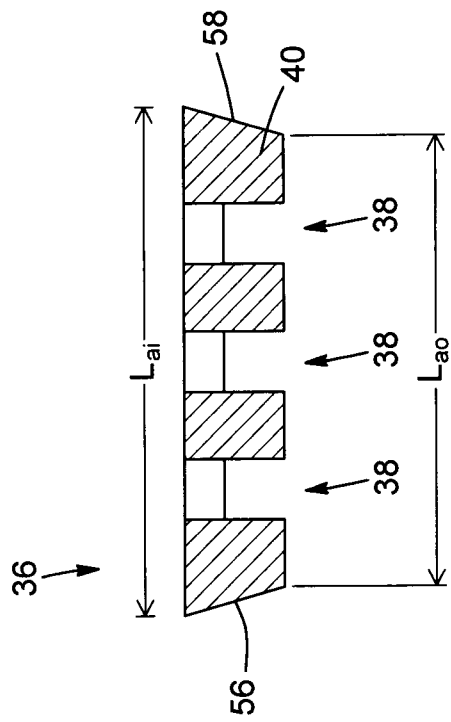


FIG. 14

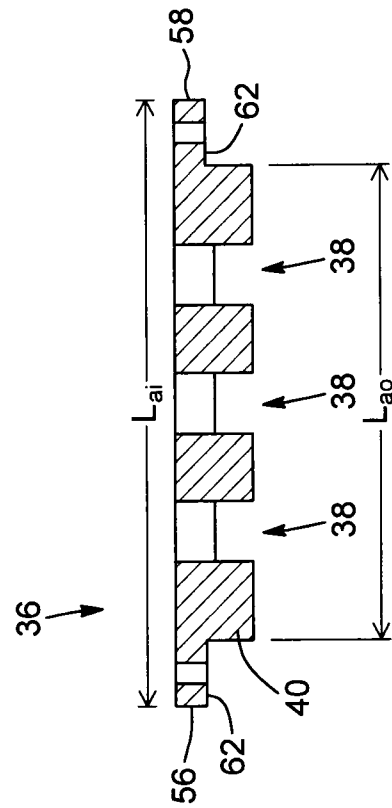


FIG. 16

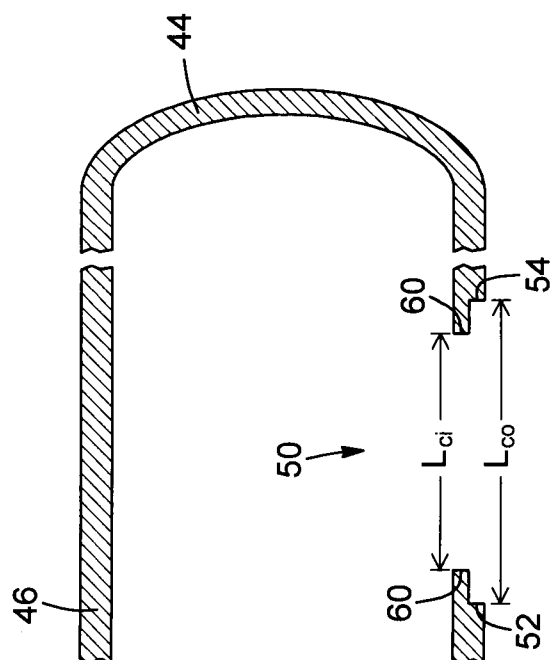


FIG. 17

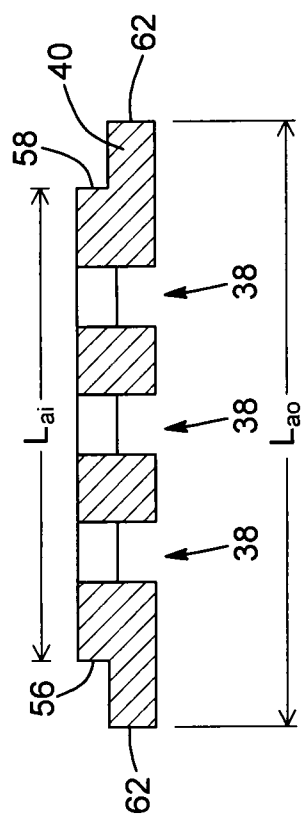


FIG. 18

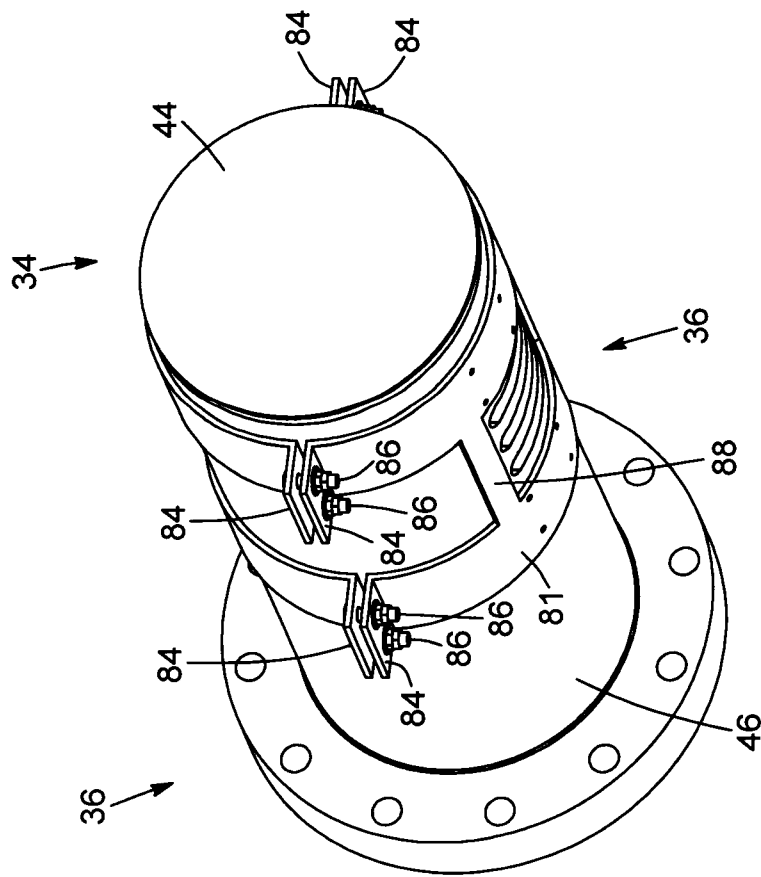


FIG. 19A

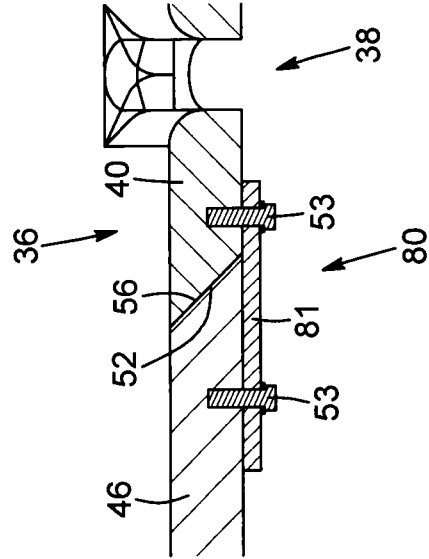


FIG. 19B

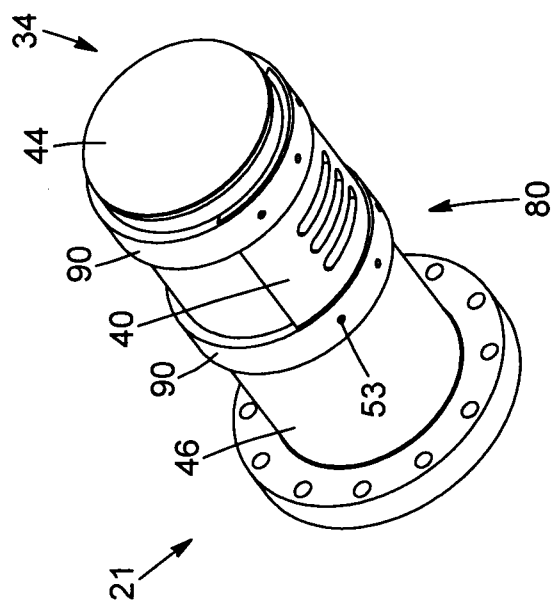


FIG. 21A

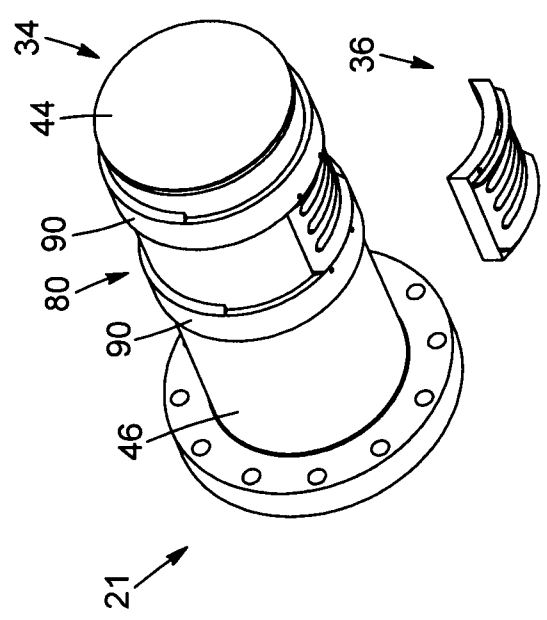


FIG. 20A

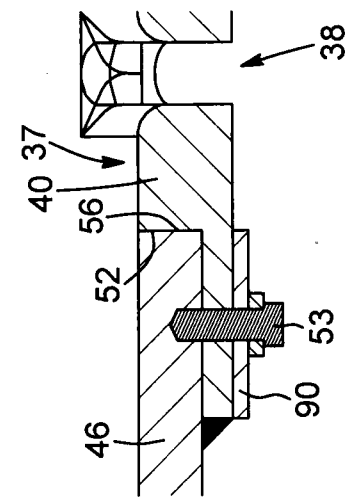


FIG. 21B

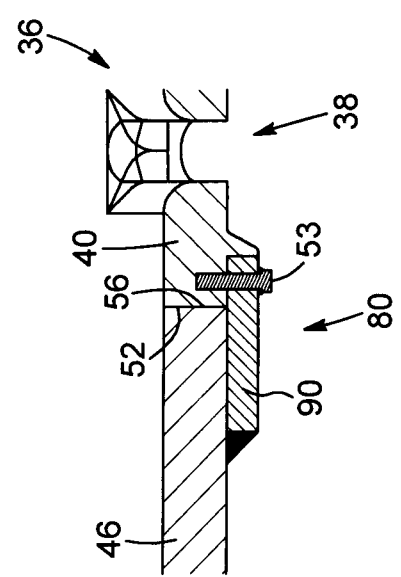


FIG. 20B

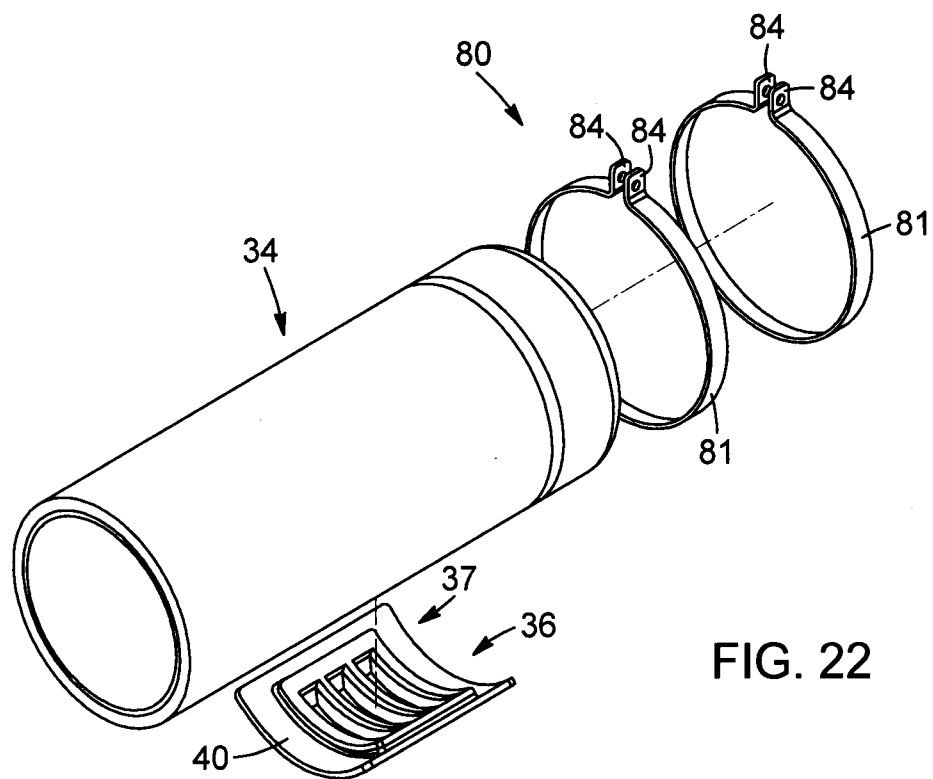


FIG. 22

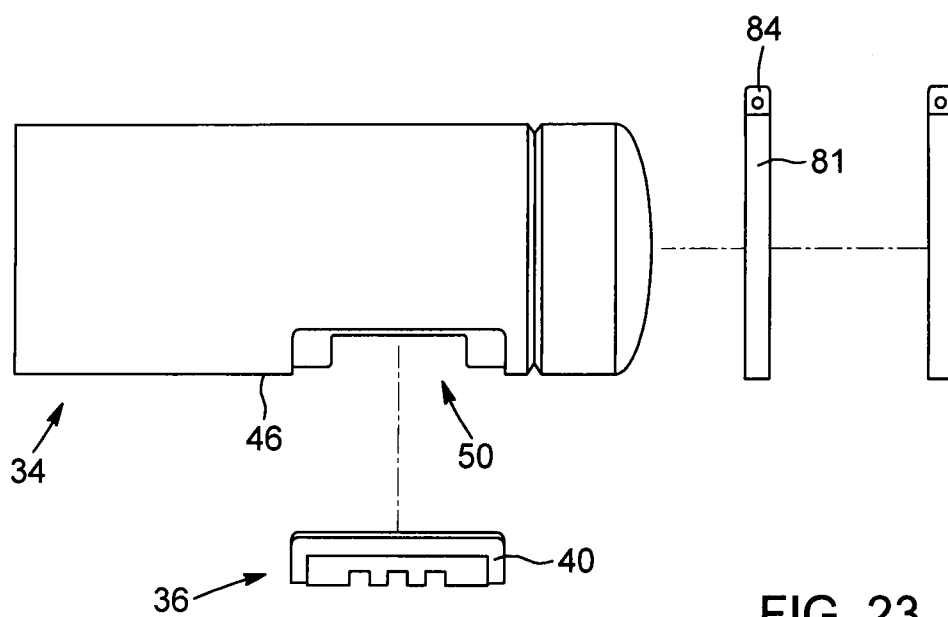


FIG. 23

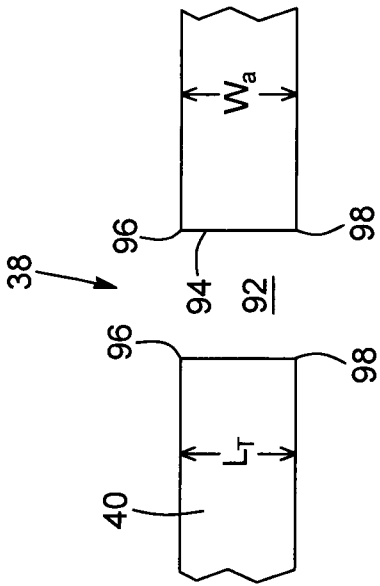


FIG. 24

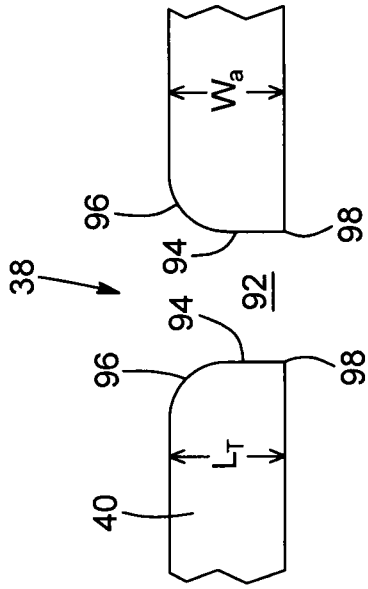


FIG. 25

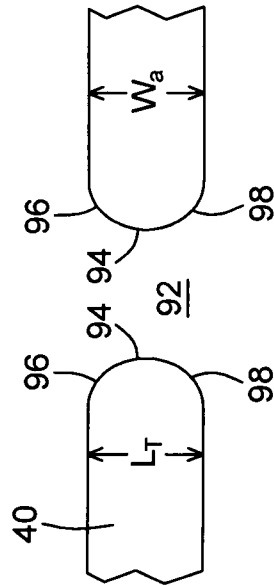


FIG. 26

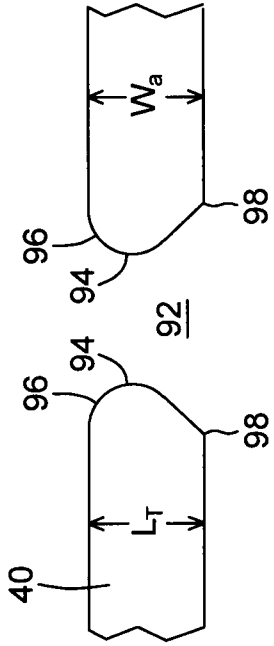


FIG. 27

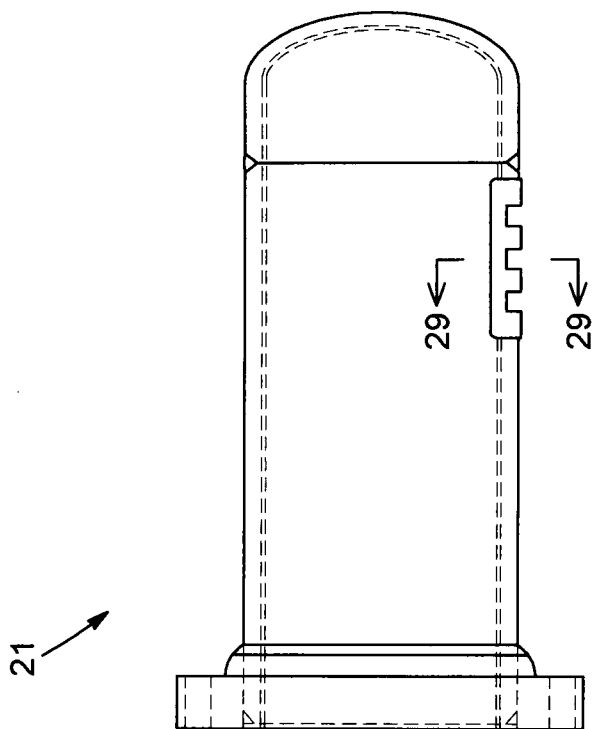


FIG. 28

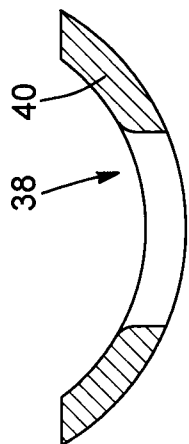


FIG. 29

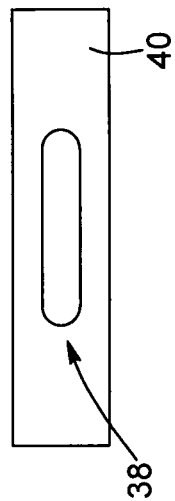


FIG. 30

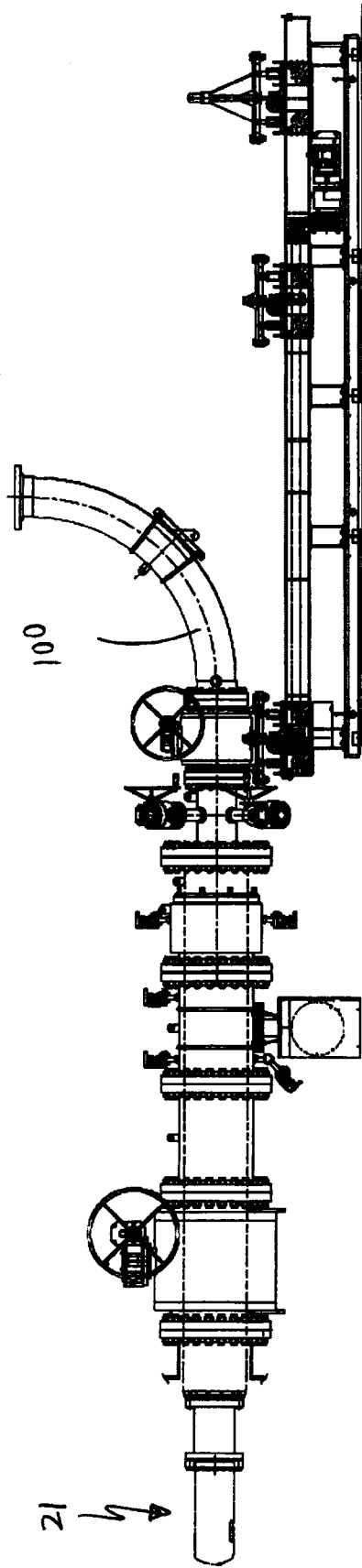


FIG. 31

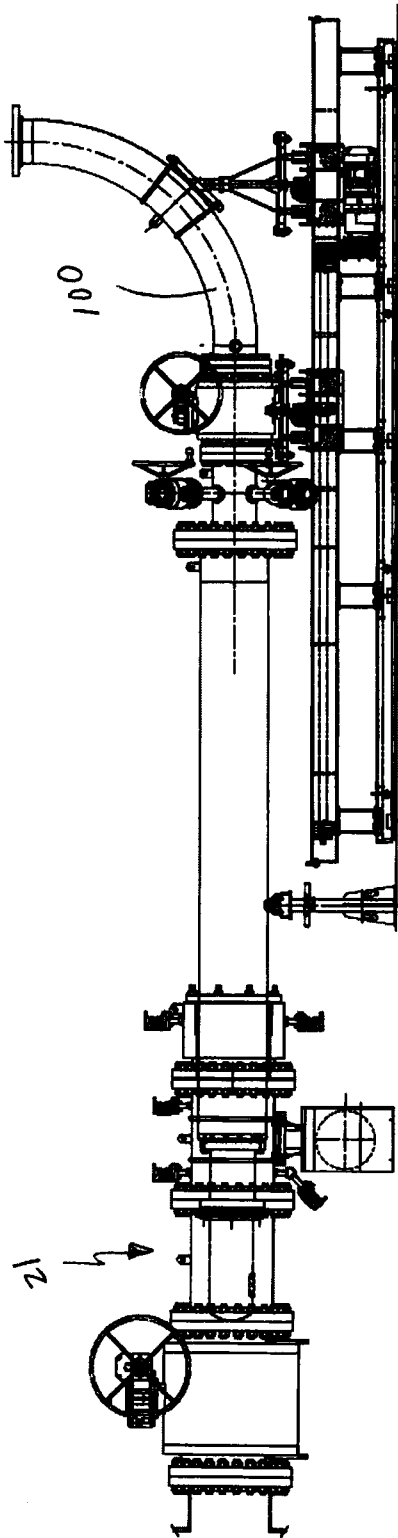


FIG. 32

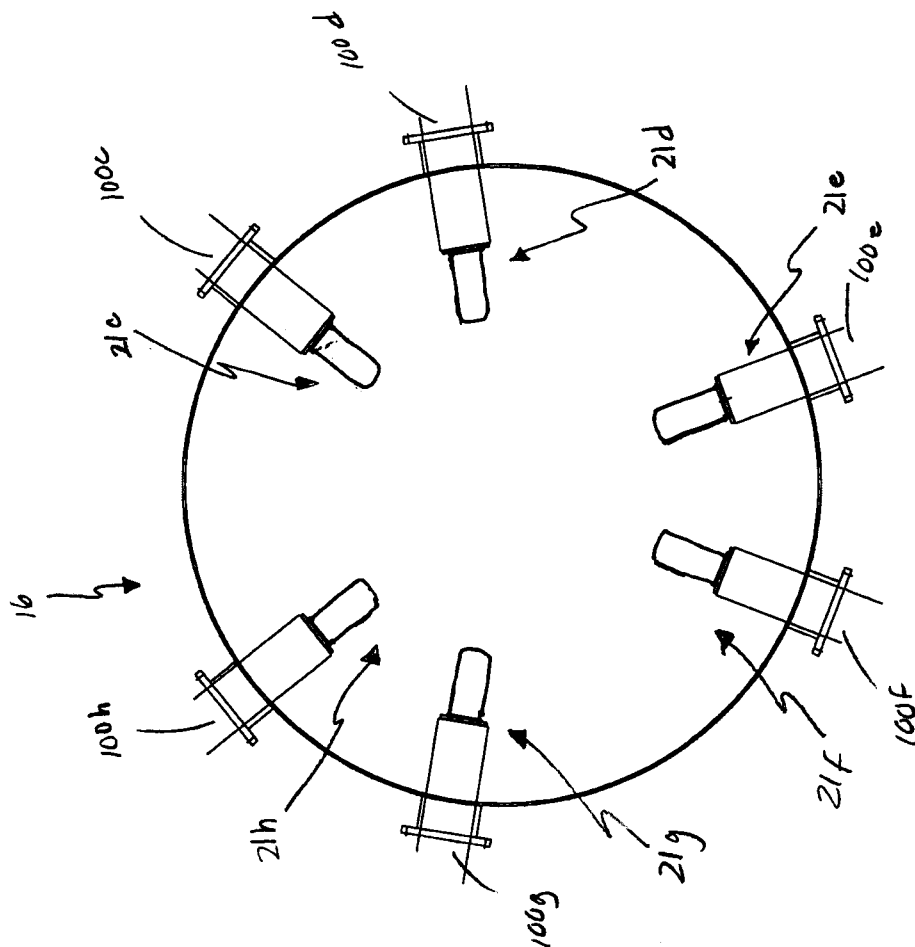


FIG. 33

FIG. 34

