



1 equipment releases uncontrolled high velocity flow of fluid which is hazardous to  
2 service personnel. Releasing such fluid to the environment is damaging to the  
3 environment resulting in expensive cleanup and loss of production. Repair costs  
4 are also high.

5 In all cases, retention of particulates contaminates surface  
6 equipment and the produced fluids and impairs the normal operation of the oil  
7 and gas gathering systems and process facilities. Therefore, desanding devices  
8 are required for removing sand from the fluid stream. Due to the nature of the  
9 gases handled, including pressure and toxicity, all vessels and pressure piping in  
10 desanding devices must be manufactured and approved by appropriate boiler  
11 and pressure vessel safety authorities.

12 In one existing system, a pressurized tank ("P-Tank") is placed on  
13 the wellsite and the well is allowed to produce fluid and particulates. The fluid  
14 stream is produced from a wellhead and into a P-Tank until sand production  
15 ceases. The large size of the P-Tank usually restricts the maximum operating  
16 pressure of the vessel to something in the order of 1,000 – 2,100 kPa. In the case  
17 of a gas well, this requires some pressure control to be placed on the well to  
18 protect the P-Tank. Further, for a gas well, a pressure reduction usually is  
19 associated with an increase in gas velocity which in turn makes sand-laden  
20 wellhead effluent much more abrasive and places the pressure controlling choke  
21 at risk of failure. Another problem associated with this type of desanding  
22 technique is that it is only a temporary solution. If the well continues to make  
23 sand, the solution becomes prohibitively expensive. In most situations with this  
24 kind of temporary solution, the gas vapors are not conserved and sold as a  
25 commercial product.

1 Another known system includes employing filters to remove  
2 particulates. A common design is to have a number of fiber-mesh filter bags  
3 placed inside a pressure vessel. The density of the filter bag fiber-mesh is  
4 matched to the anticipated size of the particulates. Filter bags are generally not  
5 effective in the removal of particulates in a multiphase condition. Usually  
6 multiphase flow in the oil and gas operations is unstable. Large slugs of fluid  
7 followed by a gas mist are common. In these cases, the fiber bags become a  
8 cause of pressure drop and often fail due to the liquid flow there through. Due to  
9 the high chance of failure, filter bags may not be trusted to remove particulates in  
10 critical applications or where the flow parameters of a well are unknown. An  
11 additional problem with filter bags in most jurisdictions is the cost associated with  
12 disposal. The fiber-mesh filter bags are considered to be contaminated with  
13 hydrocarbons and must be disposed of in accordance to local environmental  
14 regulation.

15 Hydrocyclone or cyclone devices are also known for separating  
16 particles from liquid mixture by exploiting the centripetal force. By injecting the  
17 liquid mixture into a vessel and spinning therein, heavy or large particles move  
18 outward towards the wall of the vessel due to the centripetal force, and spirally  
19 move down to the bottom of the vessel. Light components move towards the  
20 center of the vessel and may be discharged via an outlet. However, Hydrocyclone  
21 devices have difficulty in separating particulates from effluents with more than  
22 two phases, and have an associated pressure drop issue that is undesirable in  
23 many oilfield situations.

24 In Canadian Patent Number 2,433,741, issued February 3, 2004,  
25 and in Canadian Patent Number 2,407,554, issued June 20, 2006, both assigned

1 to the Applicant of the subject patent application, a desander is disclosed having  
2 an elongate, horizontal vessel with an inlet at one end and an outlet at the other  
3 end. The fluid inlet is adapted for connection to a fluid stream F, which typically  
4 comprises a variety of phases including gas G, some liquid L and entrained  
5 particulates P such as sand. The fluid stream F containing particulates P enters  
6 through the inlet end and is received by a freeboard portion. The freeboard area  
7 is set by a downcomer flow barrier, or a weir. Accordingly, the velocity of the fluid  
8 stream F slows to a point below the entrainment or elutriation velocity of at least a  
9 portion of the particulates P in the fluid stream. Given sufficient horizontal  
10 distance without interference, the particulates P eventually fall from the freeboard  
11 portion. Particulates P and liquids L accumulate over time in a belly portion under  
12 the freeboard portion, and the desanded fluid stream, typically liquid L and gas G,  
13 emanates from the fluid outlet.

14           The accumulated particulates in the vessel require periodical clean-  
15 out at sufficient intervals to ensure that the maximum accumulated depth does  
16 not encroach on the fluid outlet. However, for larger vessels, manual cleaning  
17 becomes difficult and time consuming.

18           Canadian Patent Application Number 2,799,278, filed on December  
19 19, 2012, and assigned to the Applicant, discloses a desander having a tilted  
20 vessel, however, this desander has a given particulate storage capacity that also  
21 requires periodic withdrawal from service and depressurization for removal of  
22 sand.

23           Therefore, there continues to exist the desire of further improving  
24 capacity, separation efficiency and the ease with which the vessel with can be  
25 cleaned.

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SUMMARY

It is an objective of this disclosure to provide a desanding device for removing particulates from a fluid stream.

According to one aspect, there is provided a desanding device for removing at least particulates from a multiple-phase fluid stream containing at least gas and entrained particulates. The desanding device comprises: a vessel forming a treatment chamber, the treatment chamber having a fluid inlet for receiving the fluid stream; a recovery chamber having a first upper port in fluid communication with an upper portion of the treatment chamber for receiving gas therefrom, a second lower port in fluid communication with a lower portion of treatment chamber, and a fluid outlet intermediate the first and second ports for discharging at least particulate-removed gas out of the treatment chamber.

In one embodiment, the recovery chamber is external to the vessel.

In another embodiment, the recovery chamber is a conduit and fluidly connected to the treatment chamber within the vessel at the first port and at the second port.

In another embodiment, the recovery chamber is located within the vessel and fluidly connected to the treatment chamber at the first port and at the second port.

In another embodiment, the treatment chamber further comprises a particulate drain for removing particulate from said treatment chamber.

In another embodiment, the fluid outlet is at an elevation lower than the fluid inlet.

1                    In another embodiment, the cross-sectional areas of the recovery  
2 chamber is much smaller than the cross-sectional area of the treatment chamber.

3                    In another embodiment, the fluid stream further comprises liquid,  
4 and wherein the recovery chamber receives liquid through the second port.

5                    In another embodiment, the fluid stream further comprises liquid,  
6 and wherein a liquid interface is formed in the recovery chamber and treatment  
7 chamber at the elevation of the fluid outlet.

8                    In another embodiment, the treatment chamber further comprises a  
9 flow barrier between the fluid inlet and the first port for directing the fluid stream  
10 thereabout.

11                   In another embodiment, a first portion of the recovery chamber is  
12 external to the vessel and a second portion of the recovery chamber is located  
13 within the vessel.

14                   According to another aspect, there is provided a method of  
15 removing at least particulates from a multiple-phase fluid stream containing at  
16 least gas and entrained particulates. The method comprises: establishing a  
17 treatment chamber; establishing a first channel between the treatment chamber  
18 and a fluid outlet for directing particulate-removed gas from the treatment  
19 chamber to the fluid outlet through the first channel; establishing a second  
20 channel between the treatment chamber and the fluid outlet; injecting said fluid  
21 stream into the treatment chamber to allow at least a substantial amount of the  
22 entrained particulates fall out of the fluid stream and move into a lower portion of  
23 the treatment chamber; and discharging the particulate-removed gas via the fluid  
24 outlet.

1           In one embodiment, the method further comprises: discharging  
2 particulates accumulated in the lower portion of the treatment chamber via a  
3 particulate drain.

4           In another embodiment, the fluid stream also comprises fluid, and  
5 the method further comprises: directing liquid from the treatment chamber to the  
6 fluid outlet through the second channel.

7           In one embodiment, said establishing a treatment chamber further  
8 comprises: establishing the treatment chamber in a vessel.

9           In one embodiment, said establishing a first channel further  
10 comprises: establishing the first channel in a first conduit external to the vessel.

11           In one embodiment, said establishing a second channel further  
12 comprises: establishing the second channel in a second conduit external to the  
13 vessel.

14           In one embodiment, said first conduit and second conduit are a first  
15 portion and a second portion of a same conduit.

16           In one embodiment, said establishing a first channel further  
17 comprises: establishing the first channel in the vessel, said first channel being  
18 separated from the treatment chamber.

19           In one embodiment, said establishing a second channel further  
20 comprises: establishing the second channel in the vessel, said second channel  
21 being separated from the treatment chamber.

22           In one embodiment, the first and second channels are separated  
23 from the treatment chamber by a baffle.

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1 vessel and a conduit received in the vessel for forming a recovery chamber, and  
2 defining a treatment chamber between the vessel and the conduit, the recovery  
3 chamber having a gas and a liquid channel in fluid communication with the  
4 treatment chamber;

5           Figure 9 is a perspective view of a desanding device according to  
6 an alternative embodiment, the desanding device comprising an inclined, conical  
7 shaped vessel forming a treatment chamber, and an inclined conduit forming a  
8 recovery chamber;

9           Figure 10 is a cross-sectional view of a desanding device according  
10 to an alternative embodiment, the desanding device comprising a vertically  
11 oriented vessel and a vertically oriented conduit extending from the top wall of the  
12 vessel to the bottom wall thereof, the conduit forming a recovery chamber and  
13 defining a treatment chamber between the vessel and the conduit;

14           Figure 11 is a cross-sectional view of a desanding device according  
15 to an alternative embodiment, the desanding device comprising a vertically  
16 oriented vessel and a vertically oriented conduit extending from a location  
17 proximate the top wall of the vessel to a location proximate the bottom wall  
18 thereof, the conduit forming a recovery chamber and defining a treatment  
19 chamber between the vessel and the conduit;

20           Figure 12 is a cross-sectional view of a desanding device according  
21 to an alternative embodiment, the desanding device is similar to that of Fig. 11  
22 except that an intake end or opening of the fluid outlet is received in the conduit;

23           Figure 13 is a cross-sectional view of a desanding device according  
24 to an alternative embodiment, the desanding device comprising a vertically  
25 oriented vessel and a vertically oriented baffle in the vessel dividing the vessel

1 into a treatment chamber and a recovery chamber in fluid communication with  
2 each other;

3           Figure 14 is a cross-sectional view of a desanding device according  
4 to an alternative embodiment, the desanding device is similar to that of Fig. 12  
5 except that the vessel comprises a tapering, conical shaped lower portion;

6           Figure 15 is a cross-sectional side view of a desanding device  
7 according to an alternative embodiment, the desanding device is similar to that of  
8 Fig. 14 except that the fluid inlet is oriented generally horizontally and tangential  
9 to the side wall of the vessel;

10           Figure 16 is a cross-sectional top view of the desanding device of  
11 Fig. 15;

12           Figure 17 is a cross-sectional view of a desanding device according  
13 to an alternative embodiment, the desanding device comprising a conical shaped  
14 vessel and a vertically oriented conduit extending from the top wall of the vessel  
15 to the bottom wall thereof, the conduit forming a recovery chamber and defining a  
16 treatment chamber between the vessel and the conduit; and

17           Figure 18 is a cross-sectional view of a desanding device according  
18 to an alternative embodiment, the desanding device comprising a vertically  
19 oriented treatment vessel having a fluid inlet and a vertically oriented recovery  
20 tank having a fluid outlet, the treatment vessel being in fluid communication with  
21 the recovery tank via a gas conduit and a liquid conduit.

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1 DETAILED DESCRIPTION

2 A desanding device is typically inserted between, or as a  
3 replacement for, existing piping such as connecting piping coupled to a wellhead  
4 and downstream equipment such as piping, valves, chokes, multiphase  
5 separators and other downstream equipment. As will be described in more detail  
6 later, the desanding device comprises a vessel having a treatment chamber that  
7 comprises a fluid inlet, and a recovery chamber that comprises a fluid outlet. The  
8 treatment and recovery chambers are in fluid communication by an upper port  
9 and a lower port. The treatment chamber receives a multiple-phase fluid stream  
10 F therein and separates particulates from gas. Particulates and any liquid are  
11 collected in the treatment chamber. Particulate-free gas communicates with the  
12 recovery chamber via the upper port for recovery and is discharged at the fluid  
13 outlet. Particulate-free liquid, if any, communicates with the recovery chamber  
14 via the lower port for recovery and is discharged with the gas at the fluid outlet. A  
15 liquid interface, if any, will form at the elevation of the fluid outlet as particulate-  
16 free liquid is carried with the gas stream to downstream equipment. As the  
17 recovery chamber and treatment chamber are in fluid communication via the  
18 lower port, the liquid interface also forms in the treatment chamber. The liquid  
19 interfaces are at substantially the same elevation given the hydraulics of the  
20 chambers. The recovery chamber comprises a gas channel connected to the  
21 first upper port, and a liquid channel connected to the second lower port,  
22 converging at the fluid outlet.

23 The desanding device receives, via the fluid inlet, a multiphase fluid  
24 stream F from the wellhead, and injects the fluid stream F into the treatment  
25 chamber. Herein, in this embodiment, the multiphase fluid F typically comprises

1 a variety of phases including gas G, some liquid L such as water and/or oil, and  
2 entrained particulates P such as sand.

3           The fluid stream F injected into the treatment chamber is directed to  
4 go along a downward path therein. Because of gravity, particulates P and liquid L  
5 fall out of the fluid stream F into the lower portion of the treatment chamber, so  
6 called an accumulator portion. As the lower portion of the treatment chamber has  
7 an inclination angle greater than the angle of repose of a bank of wet particulates,  
8 particulates P migrate from the treatment chamber down into a particulate  
9 collection structure. Liquid L is accumulated in the lower portion of the treatment  
10 chamber and particulates settle therefrom towards the particulate collection  
11 structure. The particulate-free liquid enters the liquid channel of the recovery  
12 chamber via the lower port.

13           Gas G traverses the upper portion of the treatment chamber, so  
14 called a freeboard portion, and enters the gas channel via the first upper port or  
15 gas port. As the liquid and gas channels are merged or converge at the fluid  
16 outlet, liquid and gas are recombined at the fluid outlet and are discharged to  
17 downstream equipment. The accumulator portion is separated from the  
18 freeboard portion by a freeboard interface referred to in industry as a gas/liquid  
19 interface, being an interface between gas G and liquid L.

20           Compared to prior art desanders such as the that disclosed in  
21 Canadian Patent Application Number 2,799,278, the embodiment's disclosed  
22 herein have advantages including requiring less horizontal operational space and  
23 the provision of a large accumulator portion for reduced accumulator or storage  
24 velocities for enhanced settling therein and increased particulate storage as  
25 necessary.

1                   With reference to Figs. 1 and 2, in one embodiment, a desanding  
2 device 100 is presented for separating multiphase fluid stream injected therein.  
3 The desanding device 100 comprises a vessel 102 for receiving a multiphase  
4 fluid stream F. In this embodiment, the vessel 102 is an inclined, elongated  
5 cylindrical container with a volume sufficient for removing particulates from the  
6 fluid injected therein. In particular, the vessel 102 comprises a cylindrical  
7 bounding wall terminated at opposing upper and lower end walls 110 and 112. A  
8 portion of the bounding wall forms a top wall 114 and a portion thereof forms a  
9 bottom wall 116. In other words, the vessel 102 is a cylindrical vessel having top  
10 and bottom heads, typically hemispherical for pressure service, or suitable flat  
11 heads.

12                   In this embodiment, the vessel 102 is inclined at a predefined angle  
13  $\alpha$  greater than the angle of repose of a bank of wet particulates. In one  
14 embodiment, the inclination angle  $\alpha$  is between about 25° and about 90°. In  
15 another embodiment, the inclination angle  $\alpha$  is between about 30° and about 90°.

16                   In this embodiment, the entire vessel 102 forms a treatment  
17 chamber 106 for removing particulates from the multiple-phase fluid stream F  
18 injected therein. The vessel 102 comprises a fluid inlet 118 adjacent its upper end  
19 wall 110 oriented in a direction generally along the longitudinal axis X-X for  
20 receiving the multiphase fluid stream F, and a particulate drain 120 in proximity  
21 with its lower end 112 coupling to a particulate collection structure 104. A  
22 recovery chamber 103 is provided external and adjacent the vessel 102. The  
23 vessel 102 also comprises a first upper opening or port 122 and a second lower  
24 opening or port 124 along the top wall 114 for fluidly connecting with upper and  
25 lower ends 126, 128 respectively of the recovery chamber 103. The recovery

1 chamber is an elongated conduit 108 positioned above the vessel 102 and  
2 generally parallel thereto. Where vessel 102 is a pressure vessel, then conduit  
3 108, upper port 126 and lower port 128 are also pressure rated, such as using  
4 the appropriate pipe and fittings.

5           The recovery chamber's conduit 108 is in gas communication with  
6 the vessel 102 via the upper port 122 (denoted as the gas port) for gas G to pass  
7 through, and in liquid communication with the vessel 102 via the lower port 124  
8 (denoted as the liquid port) for liquid L to pass through. The conduit 108 further  
9 comprises a fluid outlet 132 located intermediate the upper and lower ports  
10 126,128 and, as shown, closer to the upper opening 126. The fluid outlet 132  
11 has an intake opening or port 138 for receiving particulate-free gas and liquid.

12           The opening 138 is an intake port of the fluid outlet 132, while the  
13 fluid outlet 132 may take any suitable shape, orientation and length as required.  
14 The elevation of the intake opening 138 of the fluid outlet 132 sets a gas/liquid  
15 interface in the recovery and treatment chambers 103,102. The intake port 138  
16 of the fluid outlet 132 defines a freeboard interface 142. The freeboard interface  
17 142 is described in greater detail below. As shown in Fig. 2, the intake port 138  
18 of the fluid outlet 132 is at an elevation below the gas port 122 and the discharge  
19 end 148 of the fluid inlet 118 but above the liquid port 124.

20           The intake port 138 of the fluid outlet 132 divides the recovery  
21 chamber 103 into an upper, gas channel 134 from the gas port 122 of the conduit  
22 108 to the intake port 138 of the fluid outlet 132, and a lower, liquid channel 136  
23 from the liquid port 124 of the conduit 108 to the intake port 138 of the fluid outlet  
24 132. Both channels 134 and 136 are in fluid communication with the treatment  
25 chamber 106, which is the entirety of vessel 102 in this embodiment, via the gas

1 port 122 and liquid port 124, respectively. The gas and liquid channels 134 and  
2 136 converge at the intake port 138 of the fluid outlet 132, are contiguous and in  
3 fluid communication.

4 As shown in Fig. 2, the treatment chamber 106 comprises therein a  
5 flow barrier or downcomer 130 laterally intermediate the fluid inlet 118 and the  
6 gas port 122, extending from the upper end wall 110 downwardly along the  
7 longitudinal axis X-X to a location vertically intermediate the gas port 122 of the  
8 treatment chamber 106 and the intake port 138 of the fluid outlet 132. The axis X-  
9 X extends generally from the top wall 114 to the bottom wall 116. The  
10 downcomer 130 may be a flat plate, a curved plate or the like that has a length  
11 and width sufficient for blocking direct access from the fluid inlet 118 to the gas  
12 port 122. Herein laterally refers to spacing perpendicular from the longitudinal  
13 axis X-X of the treatment chamber 106.

14 The intake port 138 of the fluid outlet 132 defines a freeboard  
15 interface 142 horizontally extending therefrom and across both the conduit 108  
16 and the treatment chamber 106. The freeboard interface 142 partitions the  
17 treatment chamber 106 into a freeboard portion 144 formed thereabove and an  
18 accumulator portion 146 formed therebelow. The intake port 138 of the fluid outlet  
19 132 is positioned at a location below the discharge end 148 of the fluid inlet 118,  
20 the fluid inlet 118 being directed into the freeboard portion 144.

21 As described above, the treatment chamber 106 comprises a  
22 particulate drain 120 in proximity with its lower end 112 coupling to a particulate  
23 collection structure 104. In this embodiment, the particulate collection structure  
24 104 comprises a sand accumulation chamber 174 sandwiched between an inlet

1 valve 172 and a discharge valve 176. Here, the inlet and discharge valves 172  
2 and 176 are rated for sand slurry service.

3 The inlet valve 172 is connected to the particulate drain 120 on top  
4 thereof and to the sand accumulation chamber 174 therebelow, and the sand  
5 accumulation chamber 174 is in turn connected to the discharge valve 176  
6 therebelow. The particulate collection structure 104 also comprises a particulate  
7 detector 178, e.g., an ultrasonic sand detector, to detect particulate accumulation  
8 in the sand accumulation chamber 174.

9 As will be described in more detail later, the inlet valve 172 may be  
10 set to the open position and the discharge valve 176 set to the closed position in  
11 normal operation to allow the sand accumulation chamber 174 to collect  
12 particulates and liquid from the particulate drain 120.

13 Conventional pressure safety valves and other gas phase related  
14 devices and instrumentation (not shown) may be reliably installed on the vessel  
15 102.

16 Although not shown in the figures, the vessel 102 is supported by  
17 supporting structure to maintain the vessel 102 in its tilted orientation. In some  
18 use scenarios, the desanding device 100 is set up at an oil and gas well site. The  
19 connective piping of the fluid inlet 118 is connected to a wellhead, and the fluid  
20 outlet 132 is connected to downstream equipment.

21 In operation, the multiphase fluid stream F is injected from the  
22 wellhead through the fluid inlet 118 into the treatment chamber 106 downwardly  
23 at the angle  $\alpha$ . As the fluid inlet 118 has a cross-section area smaller than that of  
24 the treatment chamber 106, the velocity of the fluid in the treatment chamber 106  
25 is reduced comparing to that in the fluid inlet 118.

1 Under the influence of gravity, particulates P and liquid L in the fluid  
2 flow fall towards the bottom of the treatment chamber 106 via a trajectory path  
3 150. The trajectory for dropping particulates P and the liquid L is governed by the  
4 fluid properties and the geometry of the treatment chamber 106. Once the  
5 particulates P and liquid L have dropped into the accumulator portion 146, they  
6 remain separated from the active flow stream and form a wet sand bank 152 on  
7 the bottom wall 116 of the treatment chamber 106. Such a sand bank 152 is  
8 unstable as the slope of the bottom wall 116 of the treatment chamber 106,  
9 defined by the inclination angle  $\alpha$ , is steeper than the angle of repose of the wet  
10 sand bank. Therefore, particulates P and liquid L migrate towards the particulate  
11 collection structure 104. To aid in automated removal, the particulates P fall  
12 through the open inlet valve 172 into the sand accumulation chamber 174, as  
13 indicated by the arrow 154.

14 After start of operation, liquid L accumulates in the accumulate  
15 portion 146, and liquid L and particulates P removed from the fluid stream  
16 continue to accumulate therein. Particulates can be periodically removed,  
17 however at steady state, liquids accumulate until they reach the fluid outlet 132.  
18 Thus, in cases that the fluid stream F contains more liquid L than particulates P, a  
19 liquid surface of the accumulated liquid L rises upward towards and forms the  
20 freeboard interface 142.

21 As the inflow of liquid L exceeds removal with accumulated  
22 particulates P, the liquid interface would continue to grow higher but for the fluid  
23 outlet 132. Liquid L accumulates in both the treatment chamber and the recovery  
24 chamber, hydraulically balanced through lower port 128. Particulate laden liquid  
25 dominates in the treatment chamber 102 and particulate-free liquid dominants in

1 the recovery chamber 103. Liquid L from the treatment chamber 102 enters the  
2 liquid channel 136, and moves upwardly towards the fluid outlet 132, as indicated  
3 by the arrow 156.

4 Gas G, having been relieved of any particulates therein, traverses  
5 the freeboard portion 144, and enters the gas channel 134 via the upper gas port  
6 122 of the treatment chamber 106. Gas G moves down the gas channel 134  
7 towards the fluid outlet 132 as indicated by the arrow 158, and is discharged from  
8 the fluid outlet 132 while particulates P and liquid L continue to accumulate in the  
9 accumulator portion 146.

10 Those skilled in the art appreciate that, before the liquid surface  
11 reaches the liquid port 124, gas G may also enter the liquid channel 136 from the  
12 liquid port 124. Moreover, before the steady state, i.e., before a liquid surface  
13 grows to the freeboard interface 142, gas G may also enters the liquid channel  
14 136 from the gas port 122 via the gas channel 134.

15 As stated, at a steady state, the level of the liquid surface grows to  
16 the freeboard interface 142, formed at the intake port 138 of the fluid outlet 132.  
17 As liquid inflow continues to exceed liquid associated with particulates P collected  
18 at the collection structure 104, incoming oil and other liquids are re-entrained with  
19 the gas G exiting at the fluid outlet 132. Such a steady state operations last as  
20 long as accumulated particulates are removed, or sufficient accumulate storage  
21 volume is provided, so as maintain collected particulates free from the lower  
22 liquid port 124. Blockage of the lower port 124 of the recovery chamber 103  
23 signals desanding failure, resulting in particulates being recovered at the fluid  
24 outlet 132, endangering the integrity of the downstream equipment and requiring  
25 a manual service cleaning cycle. Such desanding failure is prevented by

1 automatically, continuously or periodically removing accumulated particulates  
2 from the particulate collection structure 104.

3 In cases that the fluid stream contains significant fraction of  
4 particulates, particulates accumulate quickly. Desanding would be quickly  
5 compromised if the accumulated particulates reach and plug the liquid port 124.  
6 Such an occurrence is prevented by removing accumulated particulates from the  
7 particulate collection structure 104.

8 The removal of accumulated particulates can be conducted  
9 continuously or periodically with the treatment chamber 106 remaining  
10 pressurized and in operation. In one embodiment, valves 172 and 176 are  
11 controlled manually by an operator or automatically with a timer or an ultrasonic  
12 sand detector to periodically open and close. Typically, an interlock is used to  
13 prevent the inlet and discharge valves from being open at the same time. In  
14 particular, the valve 172, between the treatment chamber 106 and the sand  
15 accumulation chamber 174 is normally open except at the time of particulate  
16 removal, allowing particulates to fall into the sand accumulation chamber 174.  
17 The discharge valve 176 is normally closed except at the time of particulate  
18 removal.

19 To remove particulates while maintaining the desanding device 100  
20 in operation, the valve 172 is first closed. Valve 176 is then opened allowing the  
21 particulates contained in the sand accumulation chamber 174 to exit. After  
22 removing particulates from the sand accumulation chamber 174, valve 176 is  
23 closed and valve 172 is then reopened to allow particulates in the treatment  
24 chamber 106 to migrate into the sand accumulation chamber 174. Persons  
25 skilled in the art appreciate that the treatment chamber 106 has sufficient space

1 to store particulates therein during the particulates-removing process, and the  
2 volume of the sand accumulation chamber 174 is sufficiently large to discharge  
3 enough particulates within a cleaning cycle so as not to cause a backup of  
4 particulates into valve 172 thereby preventing the valve to close. Both valves 172  
5 and 176 are required to have service rated for abrasive slurries.

6 As an alternate, substantially continuous removal could be  
7 accomplished in a mass balance scenario with an automatic bleed down solids  
8 and some liquid as come in using flow of solids level control. Alternatively,  
9 periodic opening of a control valve, such as valve 172, could be performed  
10 manually, such controlled by visual inspection of the fraction of particulates in the  
11 blowdown while the valve is open, and closing once the flow is predominately  
12 liquid L. In such scenarios, valve 172 can be left open or cycled open and closed.  
13 Accordingly, valve 176 is opened only for a short period of time, or pulsed,  
14 sufficient to allow the volume of the sand accumulation chamber 174 to be  
15 evacuated, and closed again before the liquid inventory thereabove is exhausted.

16 Persons skilled in the art appreciate that various alternative  
17 embodiments are readily available. For example, the gas and liquid channels 134  
18 and 136 may be formed in various ways according to various alternative  
19 embodiments.

20 With reference to Figs. 3 and 4 a desanding device 200, according  
21 to an alternative embodiment, is similar to the desanding device 100 of Figs. 1  
22 and 2, wherein the entire vessel 102 forms a treatment chamber 106. However,  
23 the recovery chamber 103, having the liquid and gas channels 136 and 134, in  
24 this embodiment is made of two conduits, which, together with the vessel 102,  
25 form a generally triangular structure relative to the vessel 102, the gas channel

1 134 sloping somewhat to the fluid outlet 132, whilst the liquid channel 136 being  
2 substantially vertical.

3           In this embodiment, the liquid channel 136 is formed by a vertically  
4 oriented conduit 214 extending upwardly from the liquid port 124. The conduit  
5 214 comprises an opening 138 near its upper end at a location lower than the  
6 gas port 122. A conduit 212 extends from the opening 138 upwardly at an  
7 inclination angle  $\beta$  to the gas port 122, forming the gas channel 134. The portion  
8 of the conduit 214 from the liquid port 124 to the opening 318 forms the liquid  
9 channel 136, and the portion of the conduit 214 from the opening 318 to the  
10 upper end thereof forms a fluid outlet 132, with the opening 138 acting as the  
11 intake port thereof. The gas and liquid channels 134 and 136 converge at the  
12 intake port 138 of the fluid outlet 132, and are in fluid communication therewith.

13           The intake port 138 of the fluid outlet 132 defines a freeboard  
14 interface 142 extending horizontally in the gas channel 134 and the treatment  
15 chamber 106. The freeboard interface 142 partitions the treatment chamber 106  
16 into a freeboard portion 144 thereabove and an accumulator portion 146  
17 therebelow.

18           Similar to the desanding device 100 of Figs. 1 and 2, the discharge  
19 end 148 of the fluid inlet 118 is at an elevation above the intake port 138 of the  
20 fluid outlet 132. Also, the treatment chamber 106 comprises therein a downcomer  
21 130 laterally intermediate the fluid inlet 118 and the gas port 122, extending from  
22 the upper end wall 110 downwardly along the longitudinal axis X-X to a location  
23 vertically intermediate the gas port 122 and the intake port 138 of the fluid outlet  
24 132. The downcomer 130 may be a flat plate, a curved plate or the like that has a  
25 length and width sufficient for blocking direct access from the fluid inlet 118 to the

1 gas port 122. The operation of the desanding device 200 is the same as that of  
2 the desanding device 100 of Figs. 1 and 2.

3 With reference to Figs. 5 to 7, a desanding device 300 is shown,  
4 according to another embodiment, the device 300 having a recovery chamber  
5 103 comprising a gas and a liquid channel 134 and 136 within the vessel 302. As  
6 the gas and liquid channels 134 and 136 are within the vessel 302, displacing  
7 treatment chamber volume, the vessel 302 has a larger cross-section than does  
8 the vessel 102 of Figs. 1 and 2 for achieving the same desanding throughput or  
9 capacity.

10 As can be seen, the desanding device 300 comprises a vessel 302  
11 similar to the vessel 102 of Figs. 1 and 2. The vessel 302 is an elongated  
12 cylindrical container inclined at a predefined inclination angle  $\alpha$  greater than the  
13 angle of repose of a bank of wet particulates. Similar to the vessel 102 of Figs. 1  
14 and 2, the vessel 302 comprises a top wall 114, a bottom wall 116, an upper end  
15 wall 110 and a lower end wall 112.

16 In this embodiment, the vessel 302 comprises therein a baffle 304  
17 extending from a position adjacent to the top end 110 of the vessel 302  
18 downwardly in a direction generally along the inclined longitudinal axis X-X to a  
19 position adjacent to the bottom end 112 thereof, and extending laterally from one  
20 side wall 308 of the vessel 302 to the other side wall 310 thereof (see Fig. 7).

21 The baffle 304 divides the vessel 302 to an upper portion 320  
22 thereabove and a lower portion 322 therebelow, the lower portion 322 having a  
23 cross-sectional area much larger than that of the upper portion 302. The upper  
24 and lower portions 320 and 322 are in fluid communication via an upper, gas port  
25 122, i.e., the gap between the baffle 304 and the upper end wall 110 of the vessel

1 302, and a lower, liquid port 124, i.e., the gap between the baffle 304 and the  
2 lower end 112 of the vessel 302.

3 The upper portion 320 of the vessel 302 comprises a fluid outlet  
4 132 on the top wall 114 near the upper end wall 110 with an intake port 138 at an  
5 elevation below the gas port 122 but above the liquid port 124.

6 The lower portion 322 of the vessel 302 comprises a fluid inlet 118  
7 at the upper end wall 110 of the vessel 302 oriented in a direction generally along  
8 the longitudinal axis X-X for receiving the multiphase fluid stream F. The fluid inlet  
9 118 comprises a discharge end 148 at an elevation above the intake port 138 of  
10 the fluid outlet 132.

11 The lower portion 322 of the vessel 302 forms a treatment chamber  
12 306. A gas channel 134 is formed in the upper portion 320 from gas port 122 to  
13 the intake port 138 of the fluid outlet 132. The gas channel 134 is in  
14 communication with the treatment chamber 306 via the gas port 122 generally for  
15 gas G to pass therethrough. A liquid channel 136 is formed in the upper portion  
16 320 from the liquid port 124 to the intake port 138 of the fluid outlet 132. The  
17 liquid channel 136 is in communication with the treatment chamber 306 via the  
18 liquid port 124 generally for liquid L to pass therethrough. The gas and liquid  
19 channels 134 and 136 converge at the intake port 138 of the fluid outlet 132, and  
20 are in fluid communication therewith.

21 The intake port 138 of the fluid outlet 132 defines a freeboard  
22 interface 142 extending horizontally in the gas channel 134 and the treatment  
23 chamber 306. The freeboard interface 142 partitions the treatment chamber 306  
24 into a freeboard portion 144 thereabove and an accumulator portion 146  
25 therebelow.

1                    Similar to the desanding device 100 of Figs. 1 and 2, the treatment  
2 chamber 306 of the desanding device 300 comprises therein a downcomer 130  
3 laterally intermediate the fluid inlet 118 and the gas port 122, extending from the  
4 upper end wall 110 downwardly along the longitudinal axis X-X to a location  
5 vertically intermediate the gas port 122 and the intake port 138 of the fluid outlet  
6 132. The downcomer 130 may be a flat plate, a curved plate or the like that has a  
7 length and width sufficient for blocking direct access from the fluid inlet 118 to the  
8 gas port 122. The operation of the desanding device 300 is the same as that of  
9 the desanding device 100 of Figs. 1 and 2.

10                    In an alternative embodiment, the baffle 304 extends from the top  
11 end wall 110 of the vessel 302 downwardly in a direction generally along the  
12 inclined axis X-X to the bottom end wall 112 thereof, and extending from one side  
13 wall 308 of the vessel 302 to the other side wall 310 thereof. The baffle 304  
14 comprising an upper hole adjacent to the upper end wall 110 of the vessel 302,  
15 forming the upper, gas port 122, and a lower hole adjacent to the lower end 112  
16 of the vessel 302, forming the lower, liquid port 124. Other aspects of the  
17 desanding device in this embodiment is the same as the desanding device 300 of  
18 Figs. 5 to 7.

19                    Fig. 8 shows a cross-sectional view of a desanding device 400  
20 according to yet another embodiment. Similar to the desanding devices described  
21 above, the desanding device 400 comprises an elongated vessel 502 inclined at  
22 a predefined angle  $\alpha$  greater than the angle of repose of a bank of wet  
23 particulates. The vessel 502 receives therein an elongated conduit 504 extending  
24 from the upper end wall 110 along the axis X-X of the vessel 502 to the lower end  
25 wall 112. The conduit 504 has a cross-sectional area much smaller than that of

1 the vessel 502, and comprises an upper, gas port 122 adjacent its upper end,  
2 and a lower, liquid port 124 adjacent its lower end. The conduit 504 further  
3 comprises a fluid outlet 508 coupling to a fluid outlet 132 of the vessel 502. The  
4 fluid outlet 508 comprise an intake port 138 on the conduit 504 at an elevation  
5 intermediate the gas and liquid ports 122 and 124, and below the discharge end  
6 148 of the fluid inlet 118.

7           The conduit 504 forms the recovery chamber 103 comprising the  
8 gas and liquid channels 134 and 136. In particular, the upper, gas channel 134 is  
9 formed by the portion of the conduit 504 from the gas port 122 to the intake port  
10 138 of the fluid outlet 508, and the liquid channel 136 is formed by the portion of  
11 the conduit 504 from the liquid port 124 to the intake port 138 of the fluid outlet  
12 508. The gas and liquid channels converge at the intake port 138 of the fluid  
13 outlet 508, and are in fluid communication therewith.

14           The conduit 504 also defines a treatment chamber 506 being the  
15 annulus between the vessel 502 and the conduit 504, i.e., the interior space of  
16 the vessel 502 outside the conduit 504. The treatment chamber 506 is in  
17 communication with the gas channel 134 via the gas port 122 and in  
18 communication with the liquid channel 136 via the liquid port 124.

19           The intake port 138 of the fluid outlet 508 defines a freeboard  
20 interface 142 horizontally extending therefrom and across the gas channel 134  
21 and the treatment chamber 506. The freeboard interface 142 partitions the  
22 treatment chamber 506 into a freeboard portion 144 thereabove and an  
23 accumulator portion 146 therebelow.

24           Similar to the desanding device 100 of Figs. 1 and 2, the treatment  
25 chamber 506 comprises therein a downcomer 130 laterally intermediate the fluid

1 inlet 118 and the gas port 122, extending from the upper end wall 110  
2 downwardly along the longitudinal axis X-X to a location vertically intermediate  
3 the gas port 122 and the intake port 138 of the fluid outlet 132. The downcomer  
4 130 may be a flat plate, a curved plate or the like that has a length and width  
5 sufficient for blocking direct access from the fluid inlet 118 to the gas port 122.  
6 The operation of the desanding device 400 is the same as that of the desanding  
7 device 100 of Figs. 1 and 2.

8           Although in above embodiments, the vessel is a cylindrical tube,  
9 those skilled in the art appreciate that the vessel may alternatively have a  
10 different shape such as a frustum or conical shape, a cubic shape or the like, in  
11 accordance with the particular design and pressure-resistance requirements.  
12 Fig. 9 shows a desanding device 500 that is the same as the desanding device  
13 100 of Figs. 1 and 2 except that the vessel 502 in this embodiment has a frustum  
14 shape with the lower end wall 112 larger than the upper end wall 110. Of course,  
15 those skilled in the art appreciate that, in an alternative embodiment, the vessel  
16 502 may have a frustum shape with the lower end wall thereof larger than the  
17 upper end wall thereof.

18           In some alternative embodiments, the vessel may be vertically  
19 oriented, i.e., having an inclination angle  $\alpha$  of  $90^\circ$ . For example, Fig. 10 shows a  
20 desanding device 600 according to one embodiment. In this example and the  
21 examples hereinafter, the particulate collection structure is not shown for the  
22 ease of illustration.

23           The desanding device 600 comprises a vertically oriented vessel  
24 602 receiving therein an also vertically oriented conduit 604 extending from the  
25 top wall 110 of the vessel 602 to the bottom wall 112 thereof. The conduit 604

1 has a cross-sectional area much smaller than that of the vessel 602, and  
2 comprises an upper, gas port 122 and a lower, liquid port 124. A fluid outlet 132  
3 extends downwardly into the vessel 602 from the top wall 110 thereof and  
4 couples to the conduit 604 at an intake port 138.

5           The conduit 604 forms the recovery chamber 103 comprising the  
6 gas and liquid channels 134 and 136. In particular, the upper, gas channel 134 is  
7 formed by the portion of the conduit 604 from the gas port 122 to the intake port  
8 138 of the fluid outlet 132, and the liquid channel 136 is formed by the portion of  
9 the conduit 604 from the liquid port 124 to the intake port 138 of the fluid outlet  
10 132. The gas and liquid channels converge at the intake port 138 of the fluid  
11 outlet 132, and are in fluid communication therewith.

12           The conduit 604 also defines a treatment chamber 606 being the  
13 annulus between the vessel 602 and the conduit 604, which is in communication  
14 with the gas channel 134 via the gas port 122 and in communication with the  
15 liquid channel 136 via the liquid port 124.

16           The intake port 138 of the fluid outlet 132 defines a freeboard  
17 interface 142. The treatment chamber 606 comprises a fluid inlet 118 extending  
18 downwardly from the top wall 110 of the vessel 602 with a discharge end 148  
19 above the intake port 138 of the fluid outlet 132.

20           In this embodiment, the treatment chamber 606 further comprises  
21 therein a downcomer 130 laterally intermediate the fluid inlet 118 and the gas  
22 port 122, extending from the upper end wall 110 downwardly to a location  
23 vertically intermediate the gas port 122 and the intake port 138 of the fluid outlet  
24 132. The downcomer 130 may be a flat plate, a curved plate or the like that has a

1 length and width sufficient for blocking direct access from the fluid inlet 118 to the  
2 gas port 122.

3           In some alternative embodiments, the vessel may not comprise a  
4 downcomer 130 for blocking direct access from the fluid inlet 118 to the gas port  
5 122. For example, Fig. 11 shows a desanding device 700 according to one  
6 embodiment. The desanding device 700 comprises a vertically oriented vessel  
7 702 receiving therein a vertically oriented conduit 704 extending from a location  
8 proximate the top wall 110 of the vessel 702 to a location proximate the bottom  
9 wall 112 thereof, forming the recovery chamber 103. The conduit 704 has a  
10 cross-sectional area much smaller than that of the vessel 702, and comprises an  
11 upper, gas port 122 and a lower, liquid port 124. A fluid outlet 132 extends from  
12 an intake port 138 on the conduit 704 radially outwardly to the side wall 708 of  
13 the vessel 700.

14           The intake port 138 of the fluid outlet 132 divides the conduit 704 or  
15 recovery chamber 103 into an upper, gas channel 134 from the gas port 122 of  
16 the conduit 704 to the intake port 138 of the fluid outlet 132, and a lower, liquid  
17 channel 136 from the liquid port 124 of the conduit 108 to the intake port 138 of  
18 the fluid outlet 132. The conduit 704 also defines a treatment chamber 706 being  
19 the annulus between the vessel 702 and the conduit 704.

20           Both channels 134 and 136 are in fluid communication with the  
21 treatment chamber 706 via the gas port 122 and liquid port 124, respectively. The  
22 gas and liquid channels 134 and 136 converge at the intake port 138 of the fluid  
23 outlet 132, and are in fluid communication therewith. The intake port 138 of the  
24 fluid outlet 132 defines a freeboard interface 142.

1           The treatment chamber 706 comprises a fluid inlet 118 extending  
2 downwardly from the top wall 110 of the vessel 702 with a discharge end 148  
3 above the intake port 138 of the fluid outlet 132. In this embodiment, the  
4 discharge end 148 is sufficiently spaced from the gas port 122 for preventing  
5 direct access from the fluid inlet 118 to the gas port 122. Therefore, the treatment  
6 chamber 706 does not comprise any downcomer laterally intermediate the fluid  
7 inlet 118 and the gas port 122.

8           Fig. 12 shows a desanding device 800 according to one  
9 embodiment. The desanding device 800 comprises a vertically oriented vessel  
10 802 receiving therein a vertically oriented conduit 804 extending from a location  
11 proximate the top wall 110 of the vessel 802 to a location proximate the bottom  
12 wall 112 thereof, forming the recovery chamber 103. The conduit 804 has a  
13 cross-sectional area much smaller than that of the vessel 702, and comprises an  
14 upper, gas port 122 and a lower, liquid port 124. A fluid outlet 132 extends from  
15 the top wall 110 of the vessel 700 downwardly into the conduit 804 such that an  
16 intake port 138 of the fluid outlet 132 is within the conduit 804. In this  
17 embodiment, the conduit 804 is laterally located approximate one side of the  
18 vessel 802.

19           The intake port 138 of the fluid outlet 132 divides the conduit 804 or  
20 the recovery chamber 103 into an upper, gas channel 134, which is the annulus  
21 between the conduit 804 and the fluid outlet 132 from the gas port 122 of the  
22 conduit 804 to the intake port 138 of the fluid outlet 132, and a lower, liquid  
23 channel 136 from the liquid port 124 of the conduit 108 to the intake port 138 of  
24 the fluid outlet 132. The conduit 804 also defines a treatment chamber 806 being  
25 the annulus between the vessel 802 and the conduit 804. Both channels 134 and

1 136 are in fluid communication with the treatment chamber 806 via the gas port  
2 122 and liquid port 124, respectively. The gas and liquid channels 134 and 136  
3 converge at the intake port 138 of the fluid outlet 132, and are in fluid  
4 communication therewith. The intake port 138 of the fluid outlet 132 defines a  
5 freeboard interface 142. Other aspects of the desanding device 800 are similar to  
6 the desanding device 700 of Fig. 11.

7           As shown in Fig. 13, in an alternative embodiment, the desanding  
8 device 900 comprises a vertically oriented vessel 902. A vertically oriented baffle  
9 904 extending from the top wall 110 of the vessel 902 to the bottom wall 112  
10 thereof divides the vessel 902 into a first portion 906 as the recovery chamber  
11 103 and a second portion 908 as the treatment chamber 908, the second portion  
12 908 having a cross-sectional area much larger than that of the first portion 906.  
13 The baffle 904 comprises an upper, gas port 122 and a lower, liquid port 124. A  
14 fluid inlet 118 extends downwardly from the top wall 110 of the vessel 902 into  
15 the second portion 908, and a fluid outlet 132 extends downwardly from the top  
16 wall 110 of the vessel 700 into the first portion 906. The intake port 138 of the  
17 fluid outlet 132 is at an elevation intermediate the gas port 122 and the liquid port  
18 124. The discharge end 148 of the fluid inlet 118 is at an elevation intermediate  
19 the gas port 122 and the intake port 138.

20           The intake port 138 of the fluid outlet 132 divides the first portion  
21 906 or the recovery chamber 103 into an upper, gas channel 134, which is the  
22 annulus between the first portion 906 and the fluid outlet 132 from the gas port  
23 122 of the baffle 904 to the intake port 138 of the fluid outlet 132, and a lower,  
24 liquid channel 136 from the liquid port 124 of the baffle 904 to the intake port 138  
25 of the fluid outlet 132. The second portion 908 forms a treatment chamber 908.

1 Both channels 134 and 136 are in fluid communication with the treatment  
2 chamber 908 via the gas port 122 and liquid port 124, respectively. The gas and  
3 liquid channels 134 and 136 converge at the intake port 138 of the fluid outlet  
4 132, and are in fluid communication therewith. The intake port 138 of the fluid  
5 outlet 132 defines a freeboard interface 142. Other aspects of the desanding  
6 device 800 are similar to the desanding device 300 of Figs. 5 and 6.

7           As described above, the vessel of the desanding device may have  
8 any suitable shape. For example, Fig. 14 shows a desanding device 1000 in an  
9 alternative embodiment. The desanding device 1000 is the same as the  
10 desanding device 800 of Fig. 12 except that, in this embodiment, the vessel 1002  
11 of the desanding device 1000 has a conical lower portion 1004 tapering  
12 downwardly to a bottom wall 112 of a diameter smaller than that of the rest part  
13 of the vessel 1002.

14           In above embodiments, the fluid inlet 118 is oriented generally  
15 parallel to the longitudinal axis of the vessel. However, in some alternative  
16 embodiments, the fluid inlet 118 may be oriented in other directions.

17           Figs. 15 and 16 show a desanding device 1100 in another  
18 embodiment. The desanding device 1100 is the same as the desanding device  
19 1000 of Fig. 14 except that, in this embodiment, the vessel 1002 of the desanding  
20 device 1100 comprises a fluid inlet 1118 on its side wall 1106. The fluid inlet 1118  
21 is oriented generally horizontally and comprises a discharge end 1120  
22 discharging a fluid stream into the vessel 1002 along a direction generally  
23 tangential to the side wall 1106 thereof. In this embodiment, the fluid outlet 132  
24 and the conduit 804 are biased from the horizontal center of the vessel 1002.

1 However, those skilled in the art appreciate that the fluid outlet 132 and the  
2 conduit 804 may alternatively be concentric with the vessel 1002.

3 Fig. 17 shows a desanding device 1200 in another embodiment.  
4 The desanding device 1200 is the same as the desanding device 600 of Fig. 10  
5 except that, in this embodiment, the vessel 1202 has a frustum shape with the  
6 top wall 100 larger than the bottom wall 112, and that the fluid inlet 1218 is  
7 oriented towards the side wall 1204 of the vessel 1202. In this embodiment, the  
8 side wall 1204 has an angle  $\alpha$  with respect to a horizontal plane that is greater  
9 than the angle of repose of a bank of wet particulates. A disadvantage of the  
10 desanding device 1200 is that the fluid stream F discharged from the fluid inlet  
11 1218 impinges the side wall 1204, causing erosion thereto.

12 Fig. 18 shows a desanding device 1300 according to an alternative  
13 embodiment. As shown, the desanding device 1300 comprises a vertically  
14 oriented treatment vessel 1302 receiving a fluid inlet 118 extending downwardly  
15 from the top wall 110 of the vessel 1302. The desanding device 1300 also  
16 comprises a vertically oriented recovery tank 1304 receiving a fluid outlet 132  
17 extending downwardly from the top wall 1310 of the tank 1304. The vessel 1302  
18 and the tank 1304 are in fluid communication via an upper conduit 1306 and a  
19 lower conduit 1308, which forms the gas port 122 and liquid port 124,  
20 respectively. The intake port 138 of the fluid outlet 132 is at an elevation  
21 intermediate the gas port 122 and the liquid port 124. The discharge end 148 of  
22 the fluid inlet 118 is at an elevation intermediate the gas port 122 and the intake  
23 port 138.

24 The entire vessel 1302 forms a treatment chamber 1312. The  
25 intake port 138 of the fluid outlet 132 divides the tank 1304 into an upper, gas

1 channel 134, which is the annulus between the tank 1304 and the fluid outlet 132  
2 from the gas port 122 to the intake port 138 of the fluid outlet 132, and a lower,  
3 liquid channel 136 from the liquid port 124 to the intake port 138 of the fluid outlet  
4 132. Both channels 134 and 136 are in fluid communication with the treatment  
5 chamber 1312 via the gas port 122 and liquid port 124, respectively. The gas and  
6 liquid channels 134 and 136 converge at the intake port 138 of the fluid outlet  
7 132, and are in fluid communication therewith. The intake port 138 of the fluid  
8 outlet 132 defines a freeboard interface 142. Other aspects of the desanding  
9 device 800 are similar to the desanding devices described above.

10 In above embodiments, the discharge end 148 of the fluid inlet 118  
11 is above the freeboard interface 142 defined by the intake port 138 of the fluid  
12 outlet 132. In an alternative embodiment, the discharge end 148 of the fluid inlet  
13 118 is below the freeboard interface 142. The disadvantage of the desanding  
14 device in this embodiment is that, the liquid level may grow above the discharge  
15 end 148 of the fluid inlet 118, and when it occurs, the fluid stream is injected into  
16 the treatment chamber under the liquid surface, and may cause greater  
17 turbulence than injecting the fluid stream above the liquid surface.

18 Those skilled in the art appreciate that the particulate collection  
19 structure 104 may alternatively comprise different components. For example, in  
20 an alternative embodiment, the particulate collection structure 104 may be a sand  
21 sump having a normally-closed valve, a blind, or quick access port or the like,  
22 coupled to the particulate drain 120, which is closed when the desanding device  
23 is in operation, and is open for cleaning out particulates accumulated in the  
24 accumulator portion 146.

1           In an alternative embodiment, the fluid inlet comprises a nozzle,  
2 such as a replaceable nozzle as set forth in Applicant's Canadian Patent Number  
3 2,535,215 issued May 8, 2008, the content of which is incorporated herein by  
4 reference in its entirety.

5           In another embodiment, the fluid inlet 118 comprises a nozzle  
6 having a horizontally oriented injection end for connecting to a wellhead, and an  
7 inclined discharge end 148 oriented in a direction generally along the inclined  
8 axis X-X, such as a nozzle as set forth in Applicant's Canadian Patent Application  
9 Number 2,799,278 filed on December 19, 2012, the content of which is  
10 incorporated herein by reference in its entirety.

11           In some other embodiments, an inlet nozzle having a diverting wall  
12 at the discharge end 148 may be used. The detail of such inlet nozzle is  
13 disclosed in Applicant's Canadian Patent Application Number 2,836,437, filed in  
14 December 16, 2013, the content of which is incorporated herein by reference in  
15 its entirety.

16           The desanding devices described in this disclosure generally exploit  
17 the effect of gravity to separate particulates from the multiphase fluid stream  
18 injected into a vessel having a limited size, which provide significant advantage  
19 for use in oil and gas sites that offer limited operational space.

20           In above embodiments, the multiple-phase fluid stream comprises  
21 liquid L. In some alternative embodiments, the multiple-phase fluid stream does  
22 not comprise liquid L. In these embodiment, both the gas channel 134 and the  
23 liquid channel 136 are used for directing gas G from the vessel to the fluid  
24 outlet 132.

1           In above embodiments, the gas and liquid channels are physically  
2 separated from the treatment chamber by one or more walls. In some  
3 embodiments described above, the gas and liquid channels are external to the  
4 vessel while in other embodiments described above, the gas and liquid channels  
5 are received in the vessel. In embodiments that the gas and liquid channels 134  
6 and 136 are within the vessel, e.g., in embodiments of Figs. 5-7, 8, and 10-17, it  
7 is preferable to design the desanding device in such a way that the treatment  
8 chamber has a cross-sectional area much larger than the cross-sectional areas  
9 of the gas and liquid channels, respectively. The advantage of such a design is  
10 that, for a vessel with a limited cross-sectional area, smaller cross-sectional  
11 areas of the gas and liquid channels result in a larger cross-sectional area of the  
12 treatment chamber, which means that the fluid stream injected into the treatment  
13 chamber experiences greater velocity slow-down, giving rise to better desanding  
14 result. Moreover, with smaller cross-sectional areas of the gas and liquid  
15 channels, more interior space of the vessel is used as the treatment chamber,  
16 improving the desanding capacity.

17           Those skilled in the art appreciate that, in some alternative  
18 embodiments, one of the gas and liquid channels may be outside the vessel and  
19 the other of the gas and liquid channels may be received in the vessel.

20           Those skilled in the art appreciate that, the desanding device may  
21 be made of suitable material, such as steel or the like, with specifications  
22 satisfying relevant safety code requirement. Also, in embodiments that the  
23 desanding device is used for removing particulates from high-pressure fluid  
24 streams, the shape of the vessel may also be modified to meet relevant safety

1 requirements. For example, the upper and lower ends of the vessel may be of a  
2 semi-spherical shape to provide higher pressure resistance.

3

4

1                   **THE EMBODIMENTS OF THE INVENTION FOR WHICH AN**  
2 **EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS**  
3 **FOLLOWS:**  
4

5                   1.       A desanding device for removing at least particulates from a  
6 multiple-phase fluid stream containing at least gas and entrained particulates, the  
7 desanding device comprising:

8                   a vessel forming a treatment chamber, the treatment chamber  
9 having a fluid inlet for receiving the fluid stream;

10                  a recovery chamber having

11                         a first upper port in fluid communication with an upper portion  
12 of the treatment chamber for receiving gas therefrom,

13                         a second lower port in fluid communication with a lower  
14 portion of treatment chamber, and

15                         a fluid outlet intermediate the first and second ports for  
16 discharging at least particulate-removed gas out of the treatment chamber.  
17

18                  2.       The desanding device of claim 1 wherein the recovery  
19 chamber is external to the vessel.  
20

21                  3.       The desanding device of claim 1 or 2 wherein the recovery  
22 chamber is a conduit and fluidly connected to the treatment chamber within the  
23 vessel at the first port and at the second port.  
24

1                   4.     The desanding device of claim 1 wherein the recovery  
2 chamber is located within the vessel and fluidly connected to the treatment  
3 chamber at the first port and at the second port.

4

5                   5.     The desanding device of any one of claims 1 to 4 wherein  
6 the treatment chamber further comprises a particulate drain for removing  
7 particulate from said treatment chamber.

8

9                   6.     The desanding device of any one of claims 1 to 5 wherein  
10 the fluid outlet is at an elevation lower than the fluid inlet.

11

12                   7.     The desanding device of any one of claims 1 to 6 wherein  
13 the cross-sectional areas of the recovery chamber is much smaller than the  
14 cross-sectional area of the treatment chamber.

15

16                   8.     The desanding device of any one of claims 1 to 7 wherein  
17 the fluid stream further comprises liquid, and wherein the recovery chamber  
18 receives liquid through the second port.

19

20                   9.     The desanding device of any one of claims 1 to 8 wherein  
21 the fluid stream further comprises liquid, and wherein a liquid interface is formed  
22 in the recovery chamber and treatment chamber at the elevation of the fluid  
23 outlet.

24

1                   10.    The desanding device of any one of claims 1 to 9 wherein  
2 the treatment chamber further comprises a flow barrier between the fluid inlet and  
3 the first port for directing the fluid stream thereabout.

4

5                   11.    The desanding device of claim 1 wherein a first portion of the  
6 recovery chamber is external to the vessel and a second portion of the recovery  
7 chamber is located within the vessel.

8

9                   12.    A method of removing at least particulates from a multiple-  
10 phase fluid stream containing at least gas and entrained particulates, the method  
11 comprising:

12                         establishing a treatment chamber;

13                         establishing a first channel between the treatment chamber and a  
14 fluid outlet for directing particulate-removed gas from the treatment chamber to  
15 the fluid outlet through the first channel;

16                         establishing a second channel between the treatment chamber and  
17 the fluid outlet;

18                         injecting said fluid stream into the treatment chamber to allow at  
19 least a substantial amount of the entrained particulates fall out of the fluid stream  
20 and move into a lower portion of the treatment chamber; and

21                         discharging the particulate-removed gas via the fluid outlet.

22

23                   13.    The method of claim 12 further comprising:

24                         discharging particulates accumulated in the lower portion of the  
25 treatment chamber via a particulate drain.

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14. The method of claim 12 or 13 wherein the fluid stream also comprises fluid, and wherein the method further comprises:  
directing liquid from the treatment chamber to the fluid outlet through the second channel.

15. The method of any one of claims 12 to 14 wherein said establishing a treatment chamber further comprises:  
establishing the treatment chamber in a vessel.

16. The method of claim 15 wherein said establishing a first channel further comprises:  
establishing the first channel in a first conduit external to the vessel.

17. The method of claim 16 wherein said establishing a second channel further comprises:  
establishing the second channel in a second conduit external to the vessel.

18. The method of claim 17 wherein said first conduit and second conduit are a first portion and a second portion of a same conduit.

1                    19.    The method of claim 15 wherein said establishing a first  
2 channel further comprises:

3                    establishing the first channel in the vessel, said first channel being  
4 separated from the treatment chamber.

5

6                    20.    The method of claim 19 wherein said establishing a second  
7 channel further comprises:

8                    establishing the second channel in the vessel, said second channel  
9 being separated from the treatment chamber.

10

11                    21.    The method of claim 20 wherein the first and second  
12 channels are separated from the treatment chamber by a baffle.

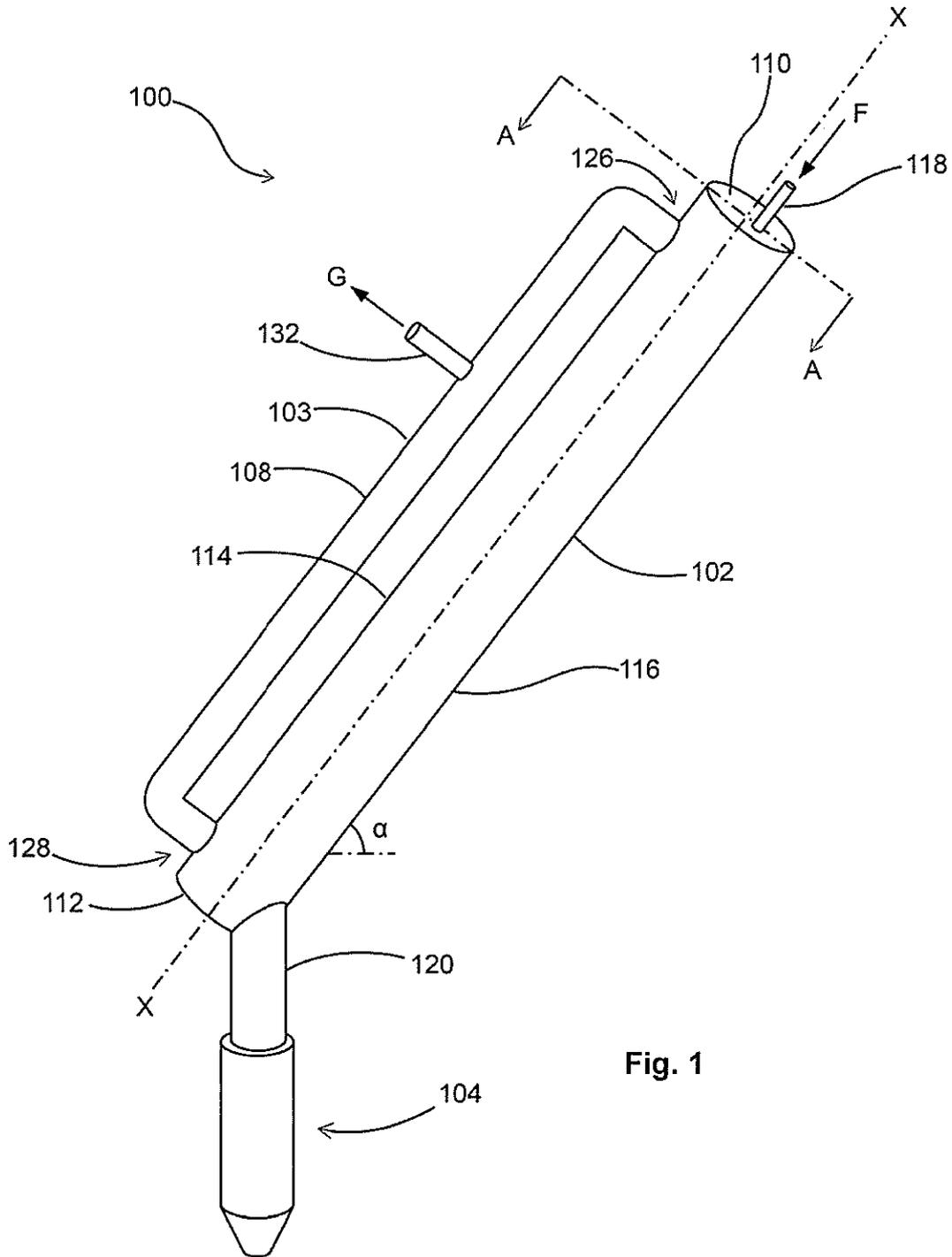
## **ABSTRACT**

1

2 An apparatus and method for removing particulates from a multiple-phase fluid  
3 stream is disclosed. The apparatus comprises a treatment chamber having a fluid  
4 inlet for receiving the multiple-phase fluid stream. The apparatus also comprises  
5 a recovery chamber having a gas channel and a liquid channel in fluid  
6 communication with the treatment chamber at a gas and a liquid port,  
7 respectively. The gas and liquid channels converge at an intake port of a fluid  
8 outlet for discharging particulate-removed gas and liquid.

9

10



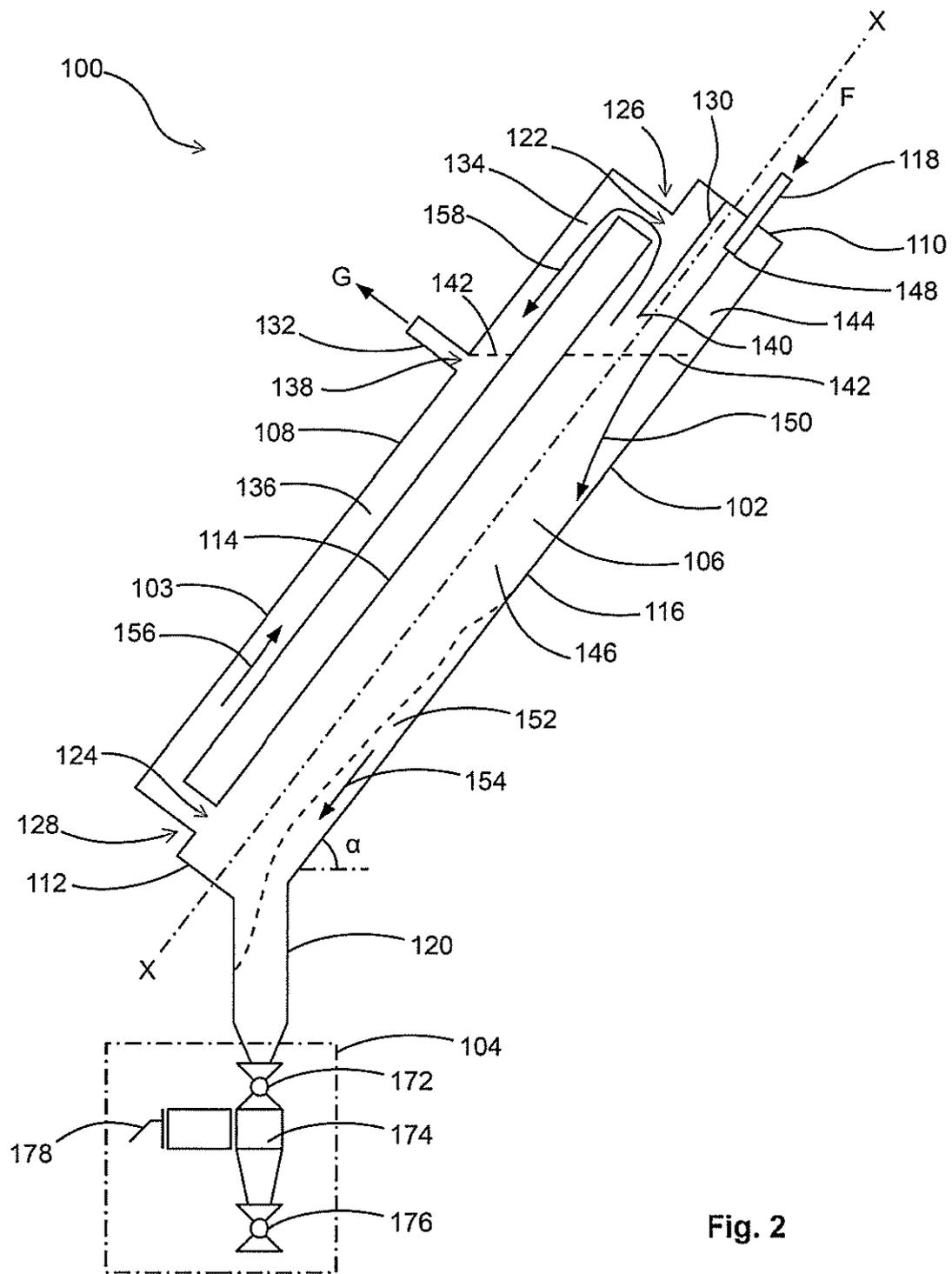


Fig. 2

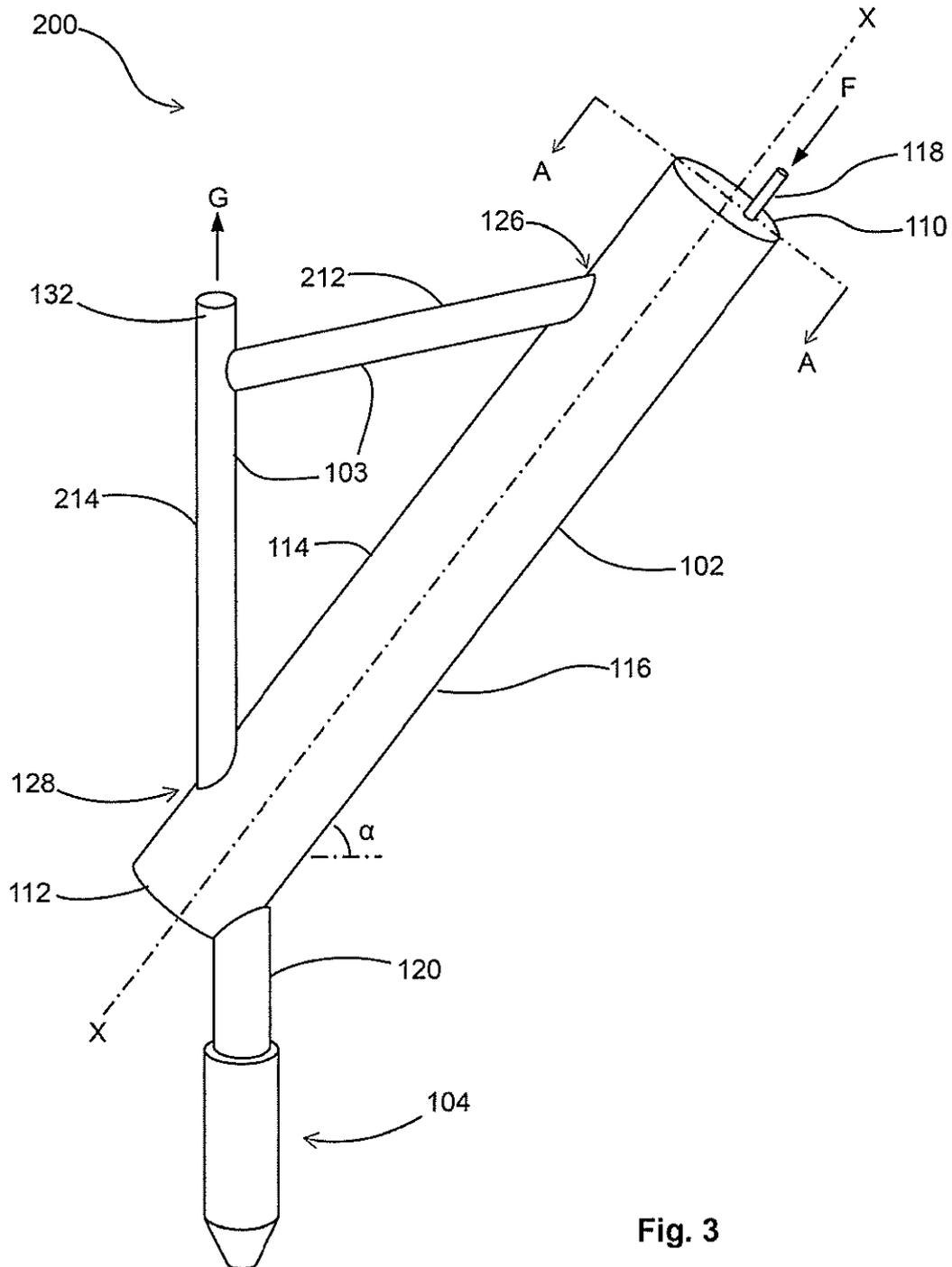


Fig. 3



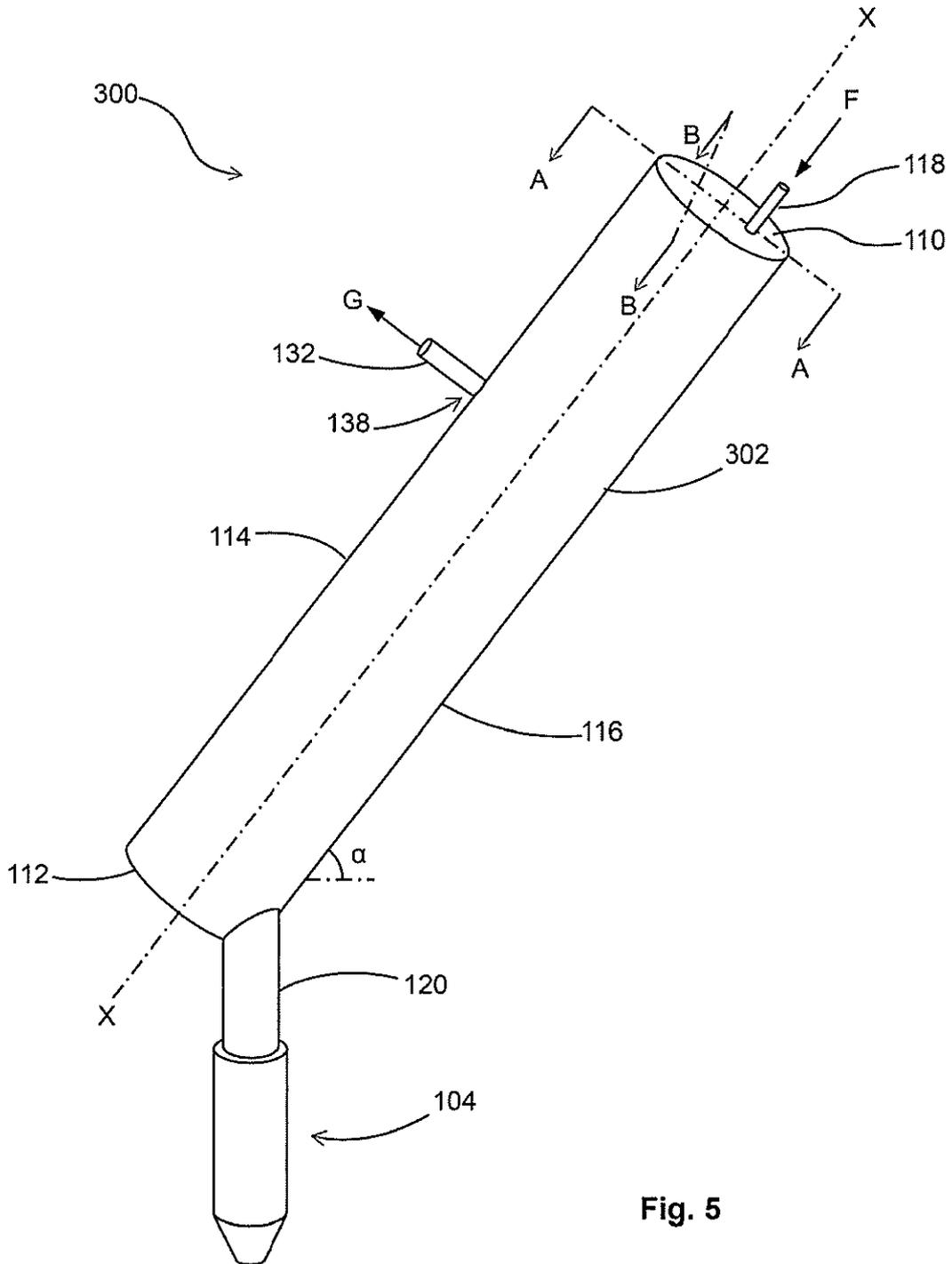


Fig. 5

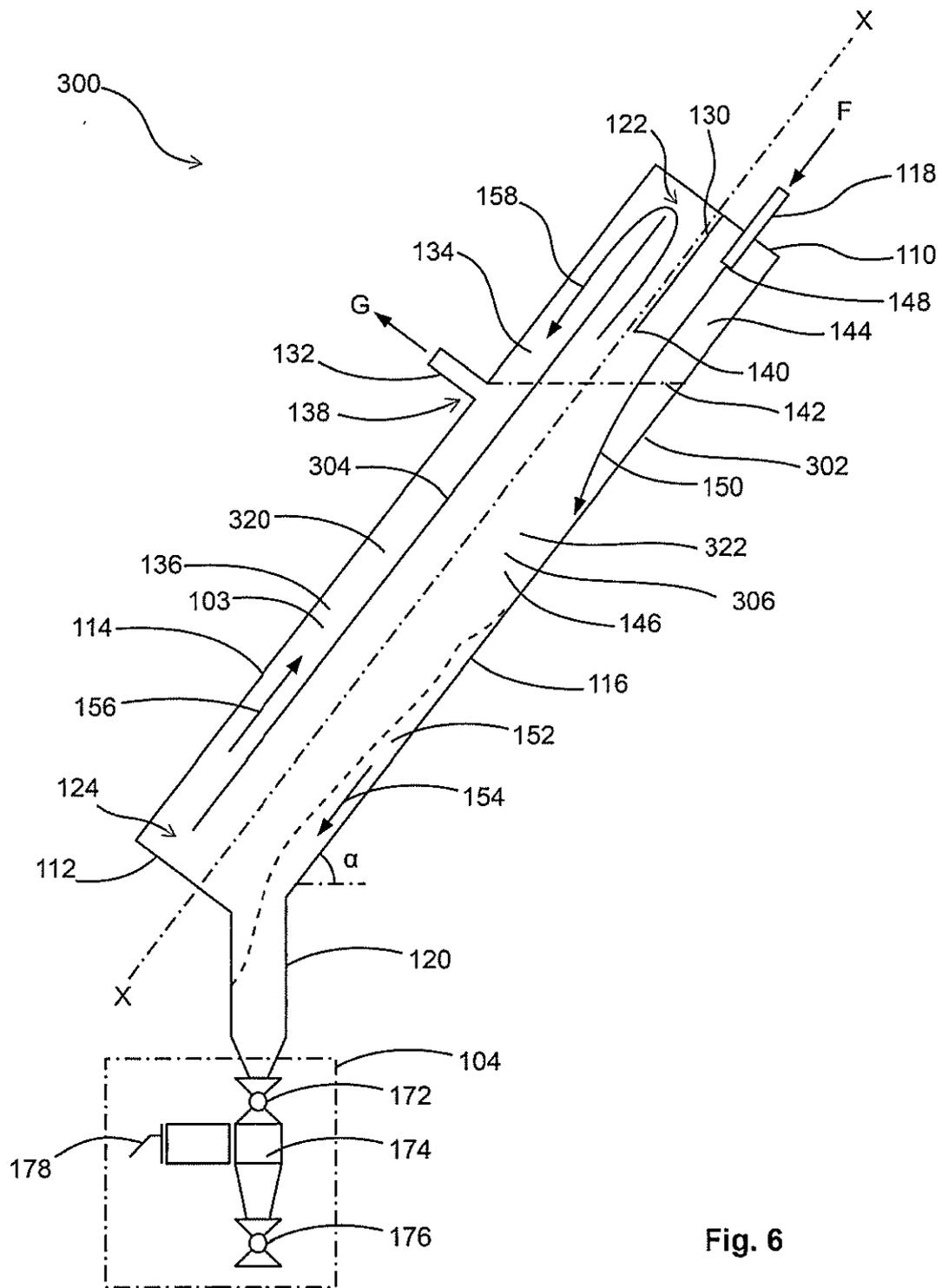


Fig. 6

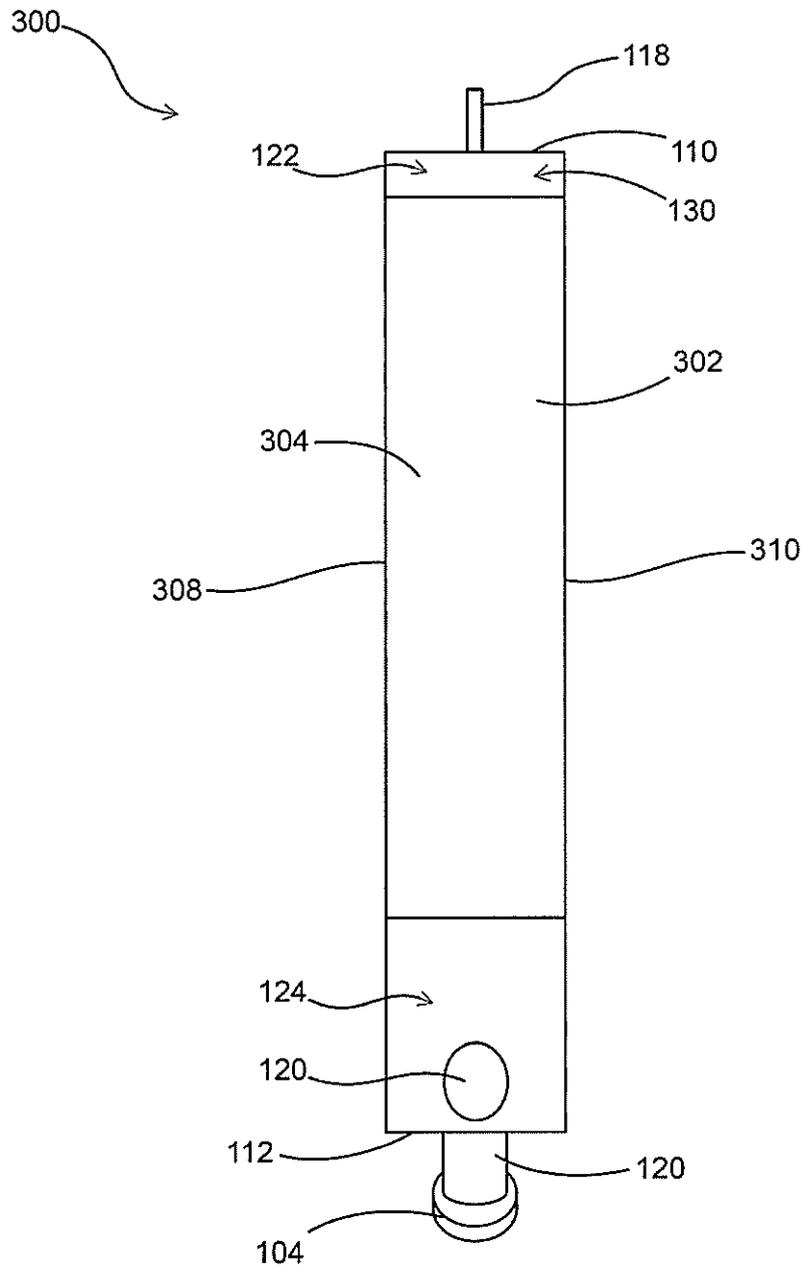


Fig. 7

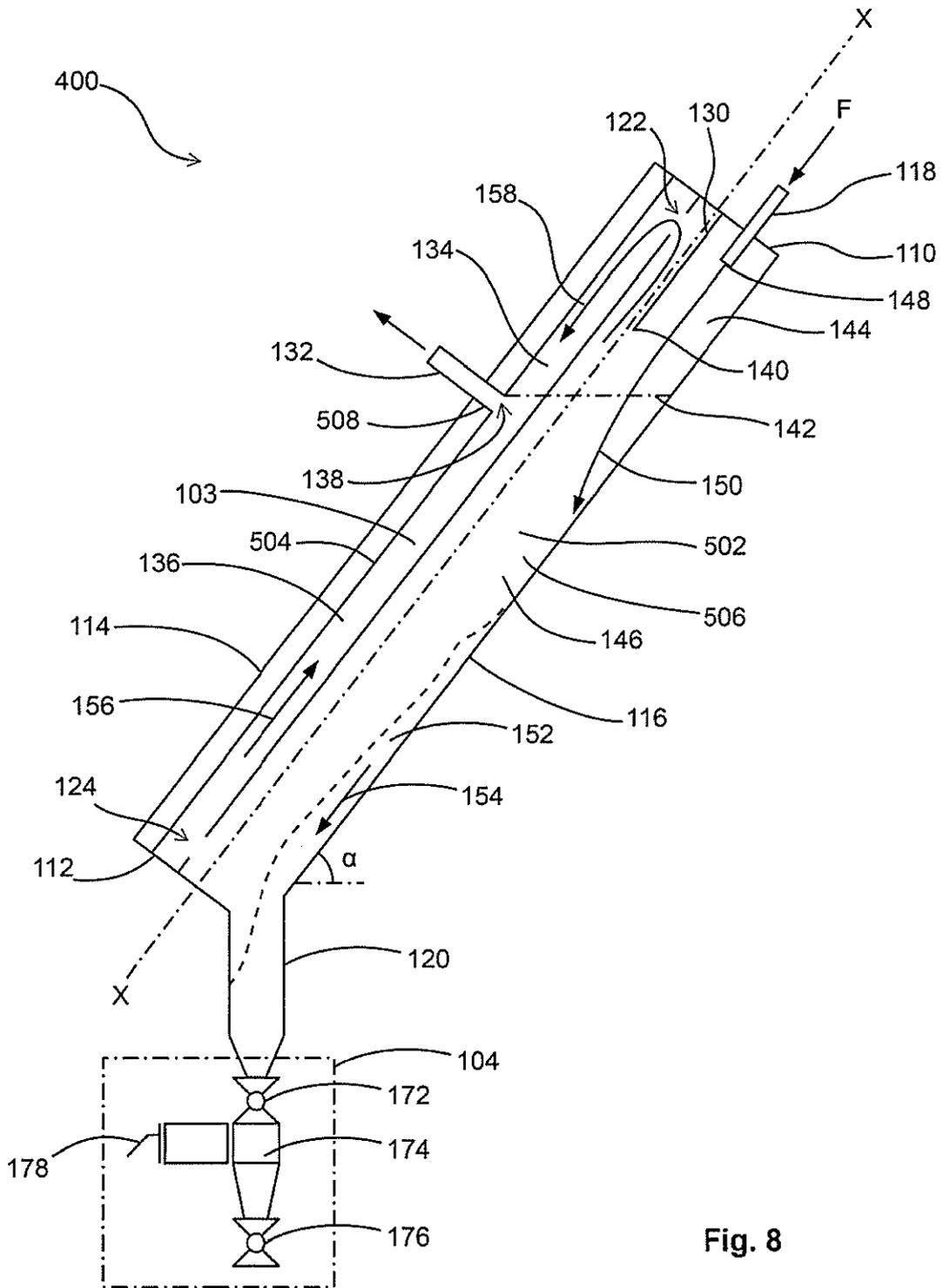


Fig. 8

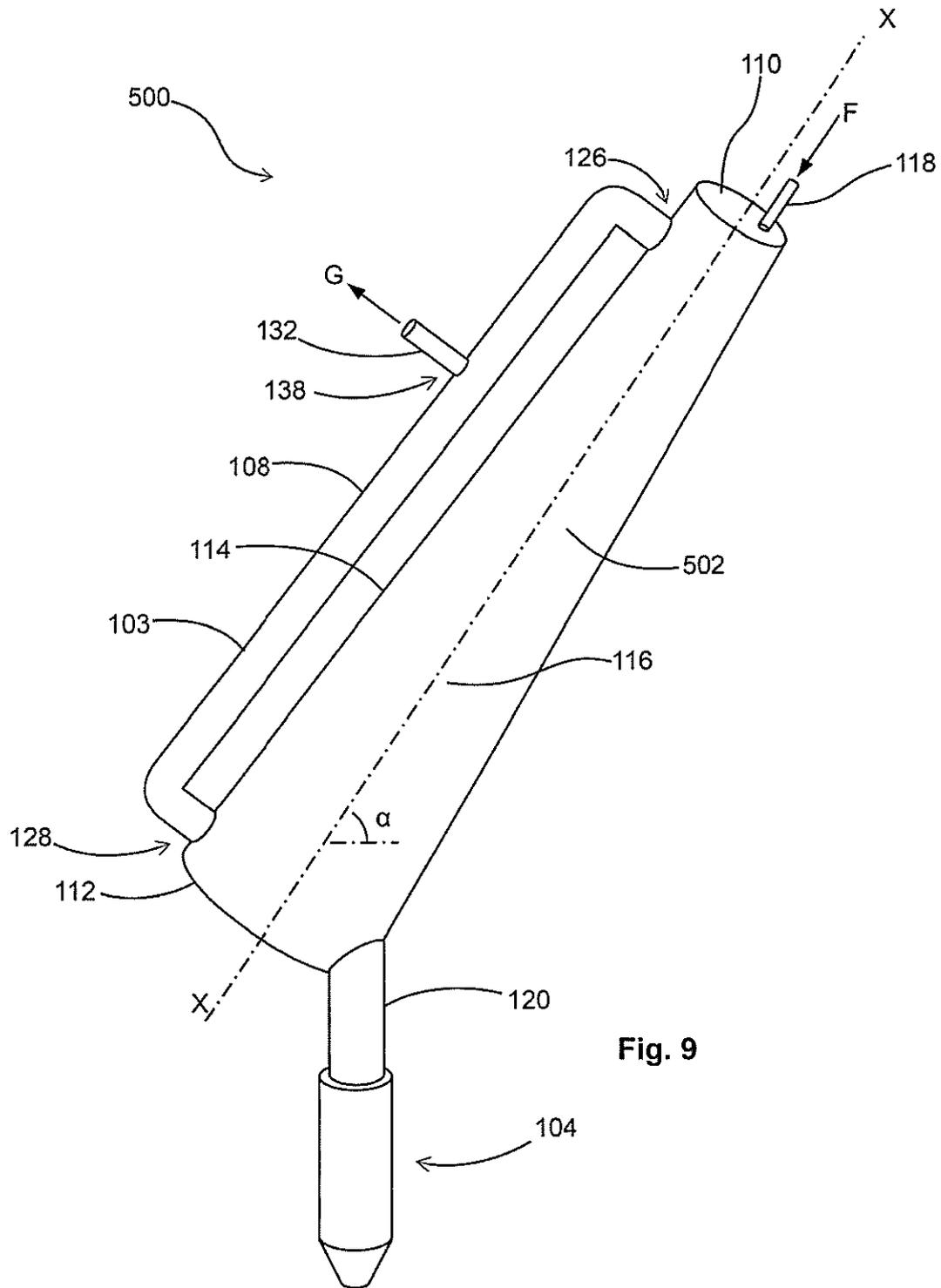


Fig. 9



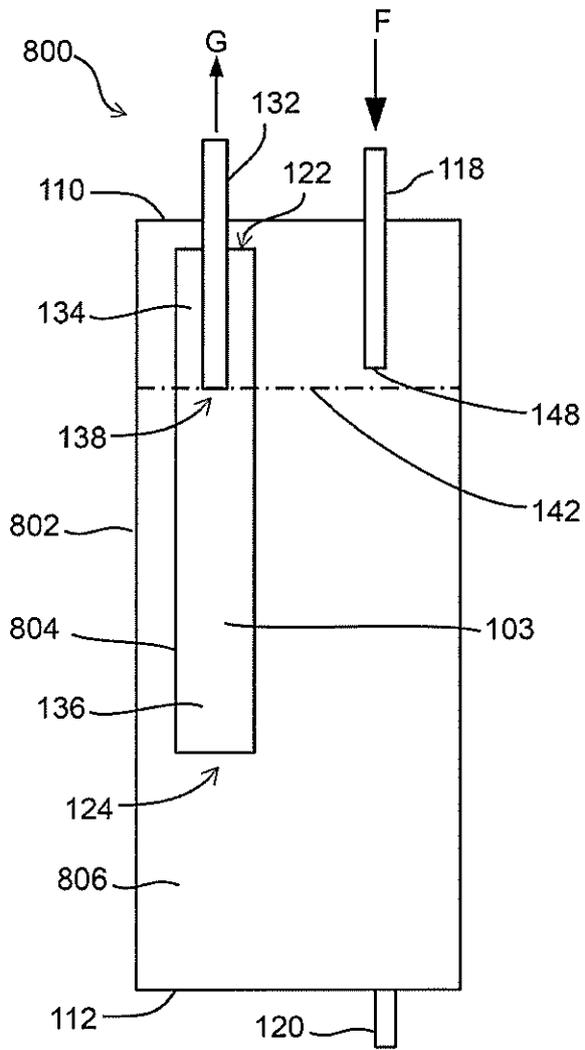


Fig. 12

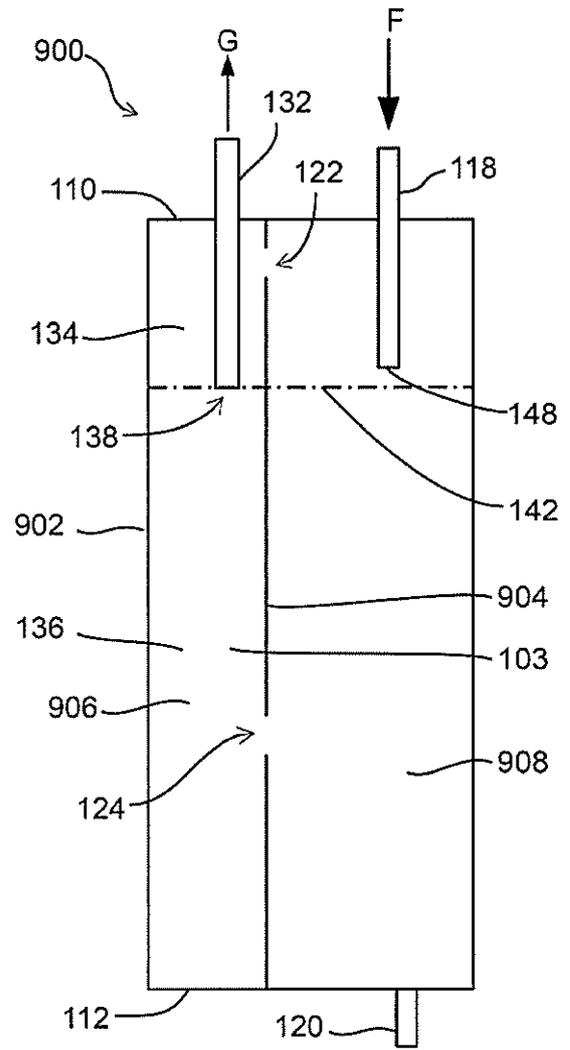


Fig. 13

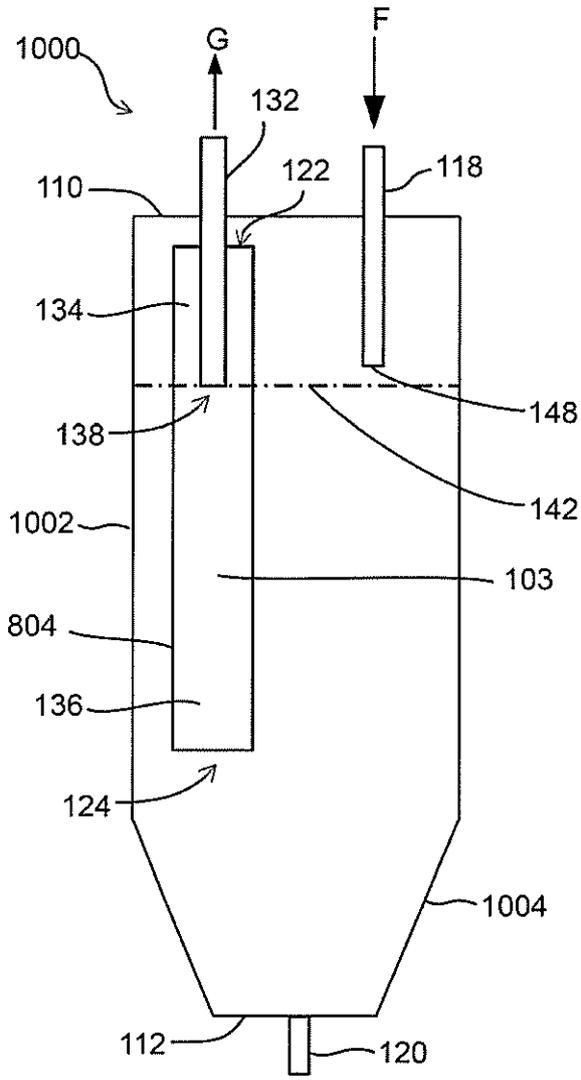


Fig. 14

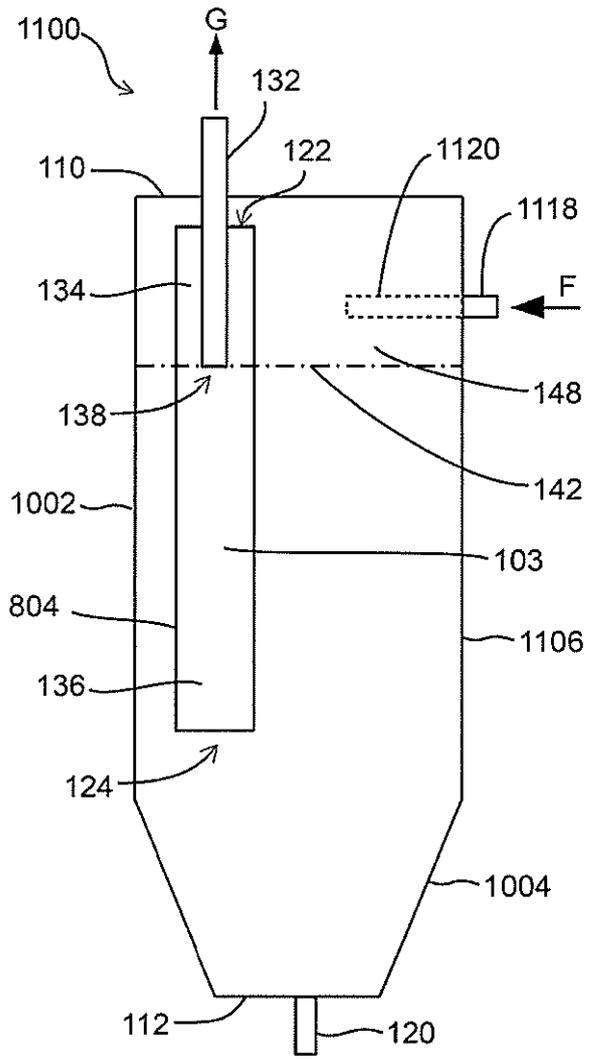


Fig. 15

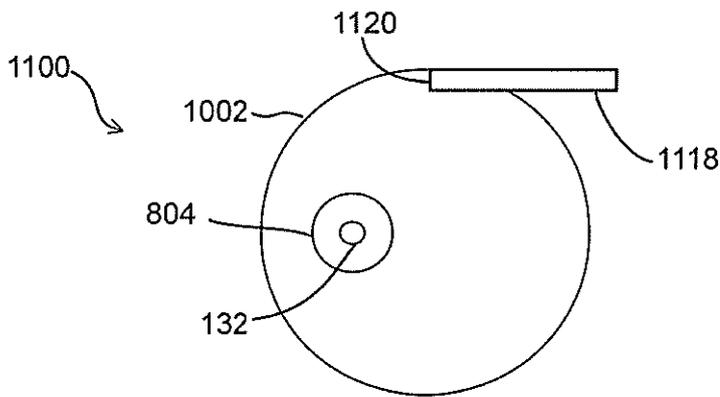


Fig. 16

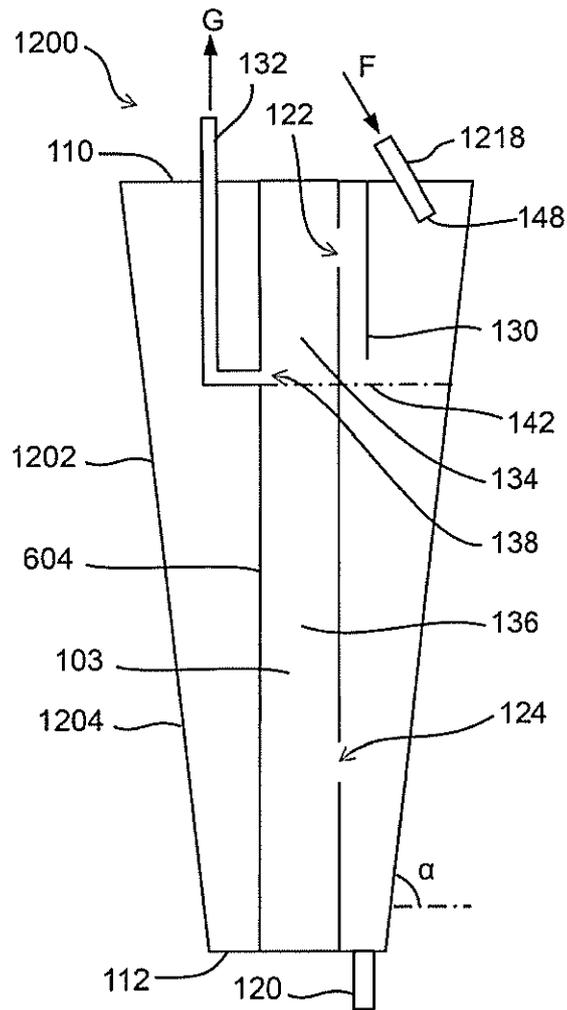
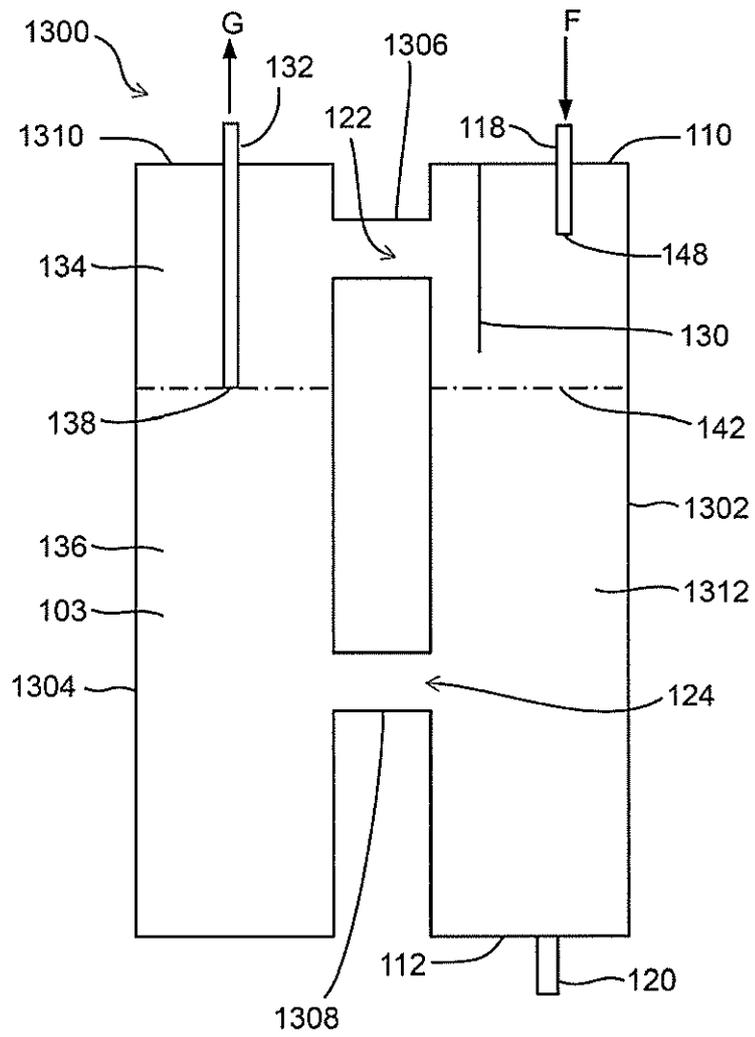


Fig. 17



**Fig. 18**