US011338217B1

(12) **United States Patent**
Kremerman

(10) **Patent No.: US 11,338,217 B1**
(45) **Date of Patent: *May 24, 2022**

(54) **SHORT DISTILLATION HEAD WITH INTEGRATED COOLING SPIRAL**

(71) Applicant: **Elliot Kremerman**, Los Gatos, CA (US)

(72) Inventor: **Elliot Kremerman**, Los Gatos, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **17/207,925**

(22) Filed: **Mar. 22, 2021**

Related U.S. Application Data

(63) Continuation of application No. 17/019,432, filed on Sep. 14, 2020, now Pat. No. 10,987,607, which is a continuation-in-part of application No. 16/926,859, filed on Jul. 13, 2020, now Pat. No. 10,874,955.

(51) **Int. Cl.**
B01D 1/08 (2006.01)
B01D 5/00 (2006.01)

(52) **U.S. Cl.**
CPC ***B01D 1/08*** (2013.01); ***B01D 5/0006*** (2013.01); ***B01D 5/006*** (2013.01)

(58) **Field of Classification Search**
CPC B01D 1/08; B01D 5/0006; B01D 5/006
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,293,257	A *	8/1942	Gunn	B01D 3/42 137/262
2,427,142	A *	9/1947	Hornbacher	G01N 25/145 422/198
2,582,969	A *	1/1952	Dinsmore	B01L 3/569 165/142
3,020,211	A *	2/1962	Smith	B01D 1/225 202/205
3,334,966	A *	8/1967	Shepherd	C01B 6/10 423/294
3,340,157	A *	9/1967	Weiss	C02F 1/045 202/180
3,416,999	A *	12/1968	Shepherd	C01B 6/10 202/202
3,607,662	A *	9/1971	Glover	B01D 3/14 202/205
4,235,677	A *	11/1980	Karamian	C02F 1/045 202/202
4,437,937	A *	3/1984	McGraw	B01D 3/343 203/1
4,471,836	A *	9/1984	Hokanson	F28B 9/10 62/509

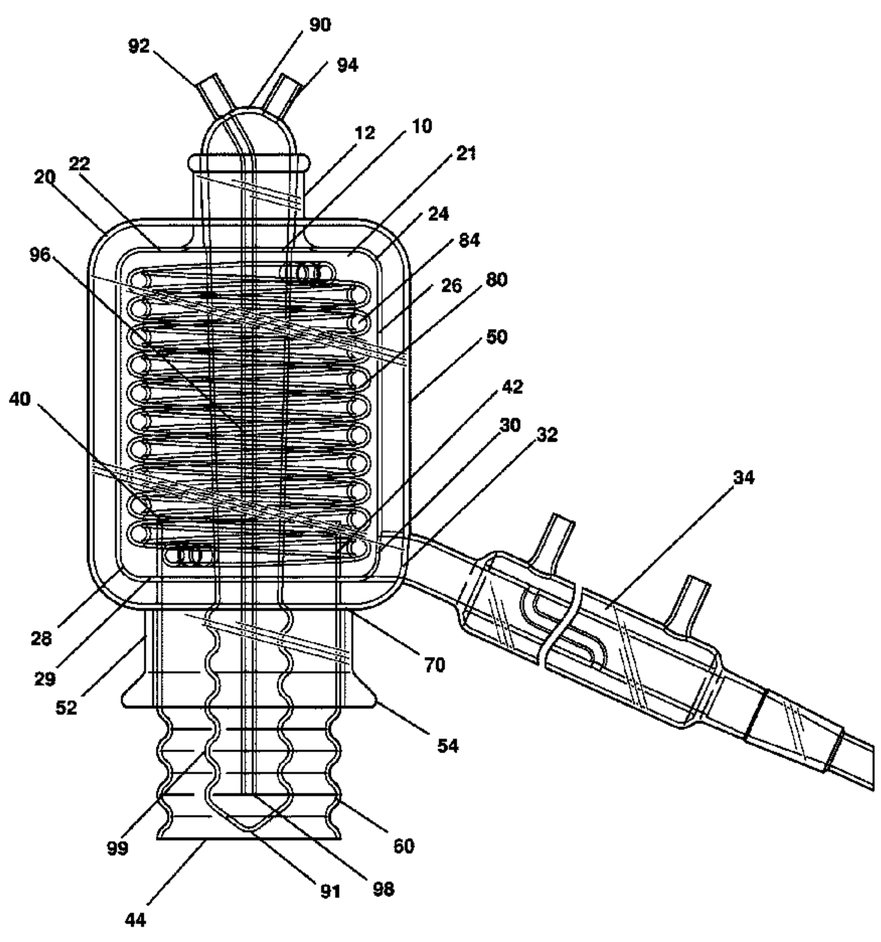
(Continued)

Primary Examiner — Jonathan Miller
(74) *Attorney, Agent, or Firm* — Michael J. Feigin, Esq.; Feigin and Fridman LLC

(57) **ABSTRACT**

A distillation apparatus has a cooling spiral surrounding at least a part of a vertical extent of a fraction collector in the disclosed technology. Connecting to and/or extending into an interior space of the fraction collector is an end of a vertically-extending passageway. This passageway is functionally connected at an other end to a lower-end entry portal. An outer cover substantially covers the cooling spiral, fraction collector, and a portion of the vertically-extending passageway, excepting for a top portal, a side exit portal, at least one cooling spiral intake, and at least one cooling spiral outtake.

8 Claims, 8 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

5,076,349	A *	12/1991	Kadono	B01D 5/009 165/104.19
5,885,313	A *	3/1999	Okamoto	B01D 3/4205 165/110
5,951,825	A *	9/1999	Land	B01D 5/0006 202/83
9,895,626	B2 *	2/2018	Kremerman	B01D 5/0063
10,029,188	B2 *	7/2018	Kremerman	B01D 1/222
10,279,281	B2 *	5/2019	Kremerman	B01D 5/009
10,406,451	B2 *	9/2019	Maibach	B01D 3/16
10,493,374	B2 *	12/2019	Wells	B01D 5/006
10,751,638	B2 *	8/2020	Maibach, Jr.	B01D 3/02
10,987,607	B2 *	4/2021	Kremerman	B01D 5/0006
2015/0367250	A1 *	12/2015	Alstin	B01D 11/0296 202/202
2018/0065060	A1 *	3/2018	Wells	B01D 3/02
2018/0290074	A1 *	10/2018	Kremerman	B01D 3/085
2019/0076752	A1 *	3/2019	Maibach	B01D 5/0003

* cited by examiner

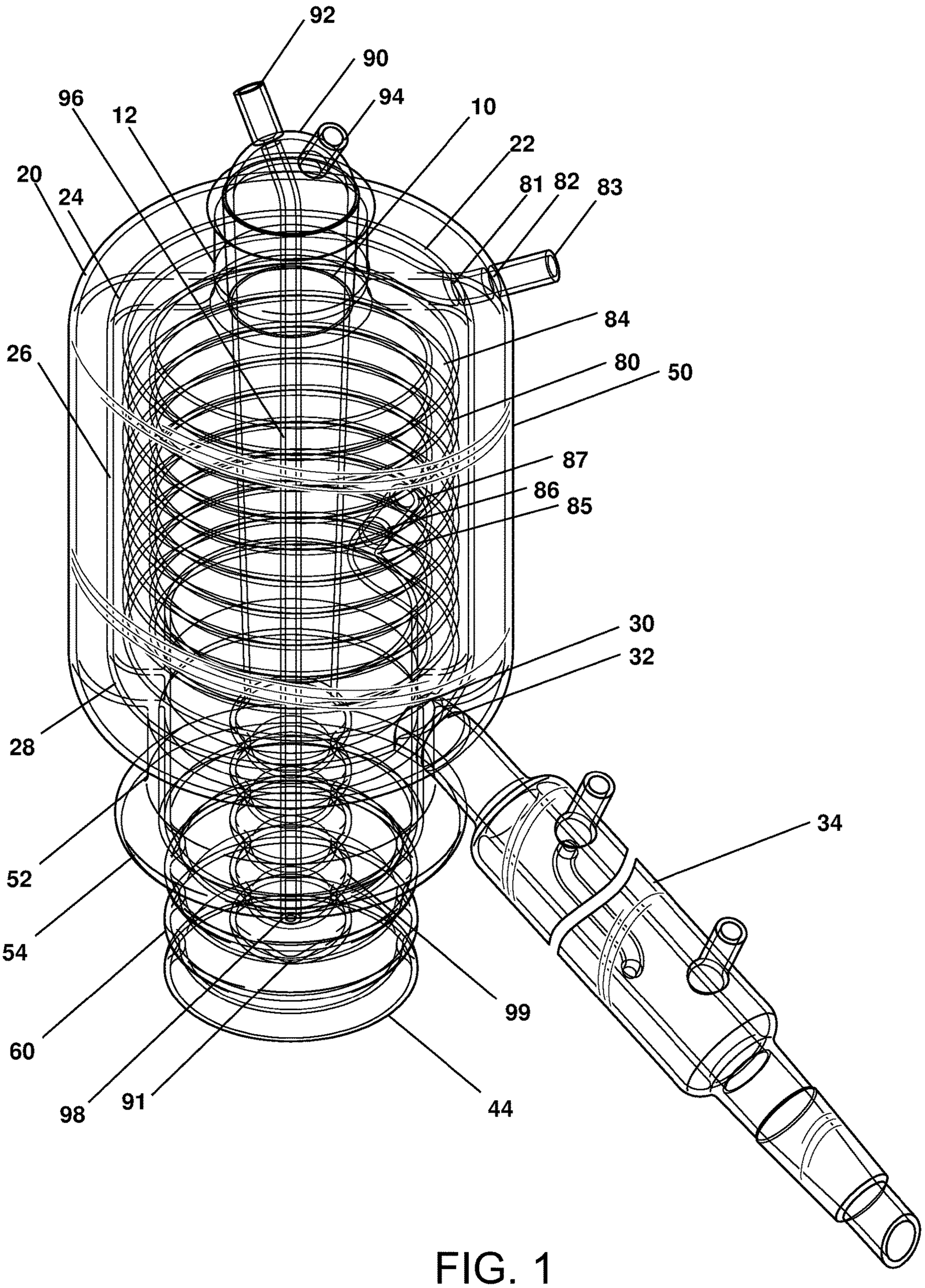

92
90
94
96
12
10
22
20
24
81
82
83
84
80
50
26
87
86
85
30
32
28
34
52
54
60
98
91
99
44

FIG. 1

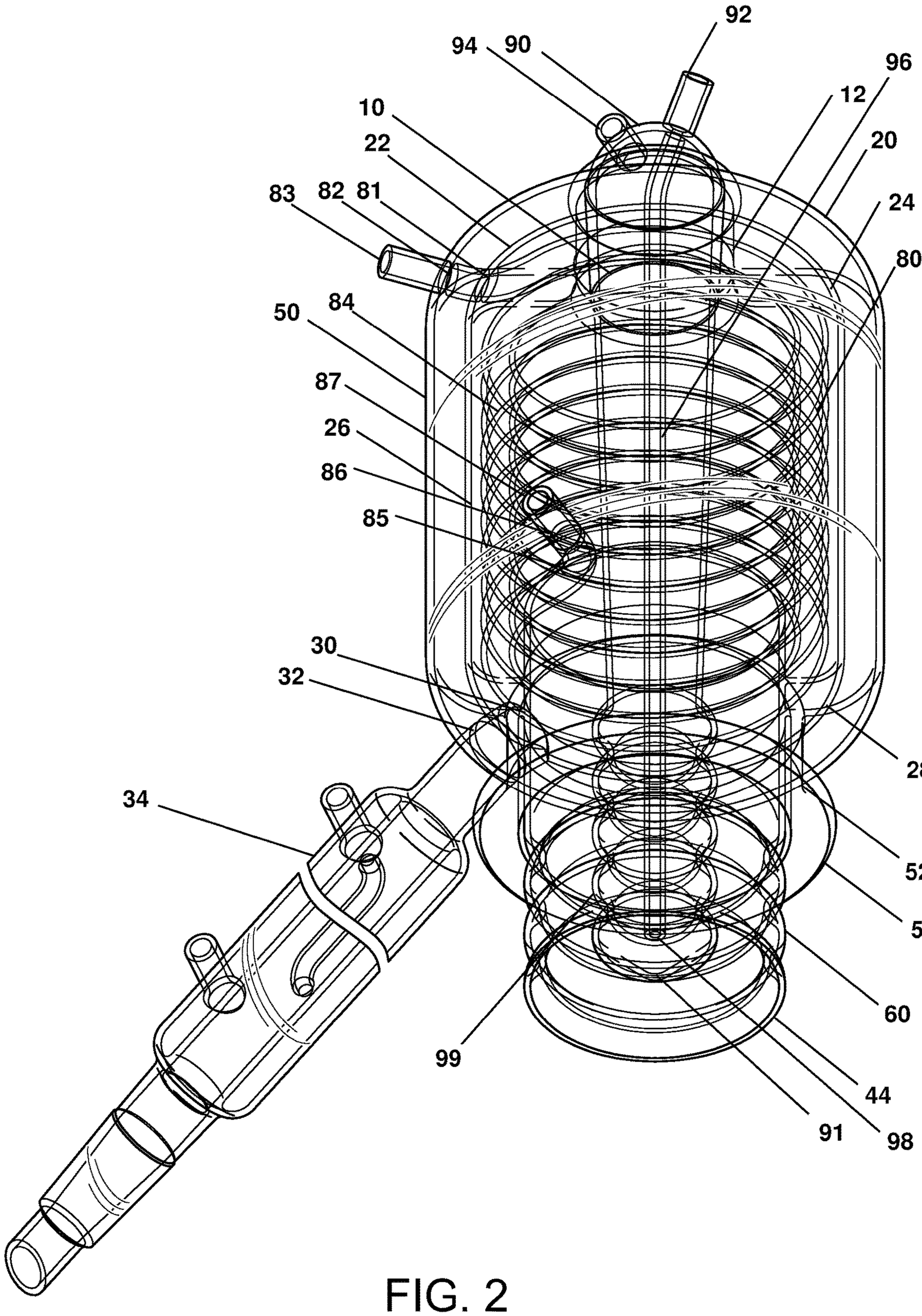

92
94
90
96
12
10
20
22
24
83
82
81
80
84
50
87
26
86
85
30
32
28
34
52
54
60
99
44
91
98

FIG. 2

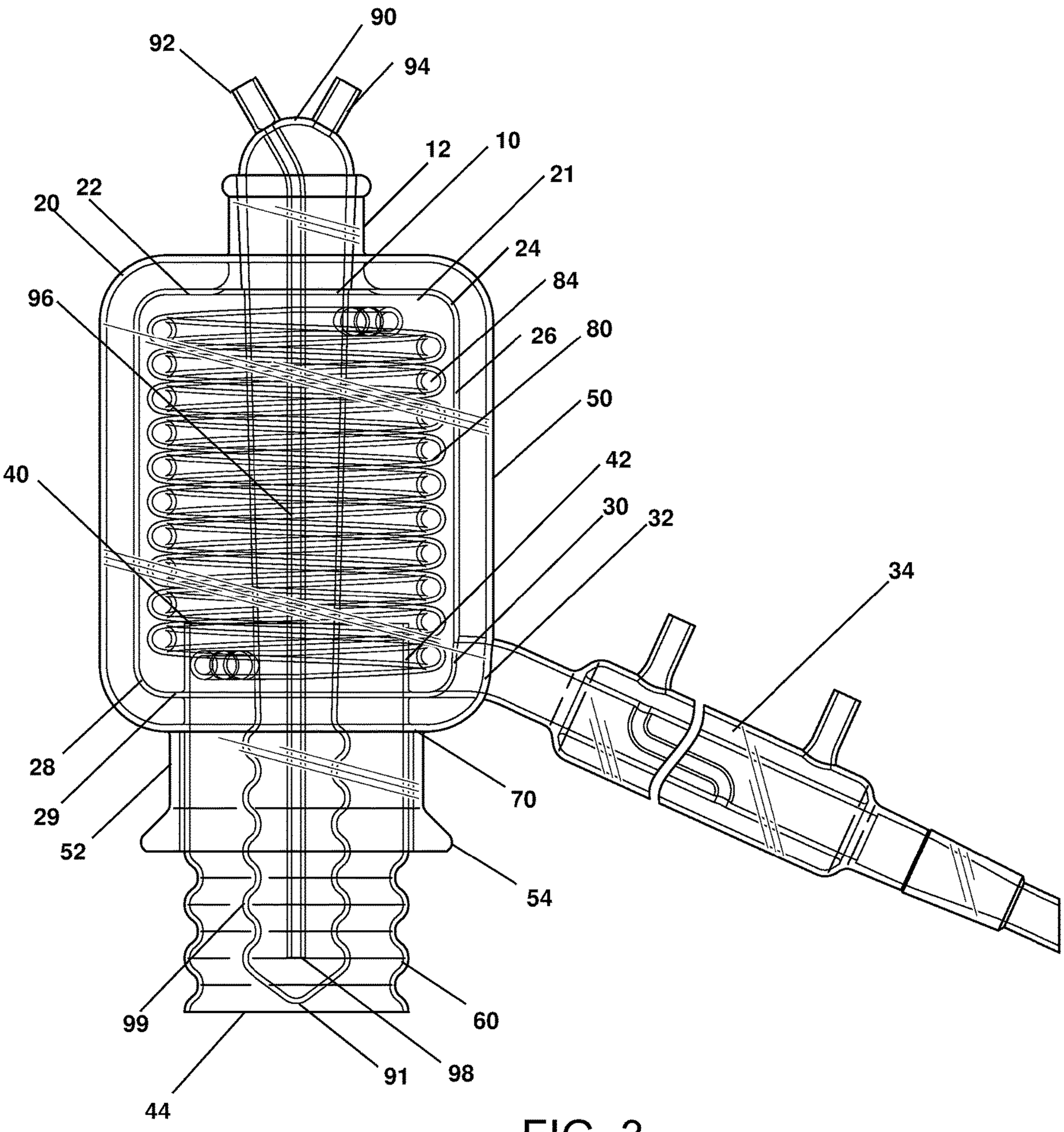

90
92
94
12
10
21
22
20
24
84
96
26
80
50
42
40
30
32
34
28
29
70
52
54
99
60
91
98
44

FIG. 3

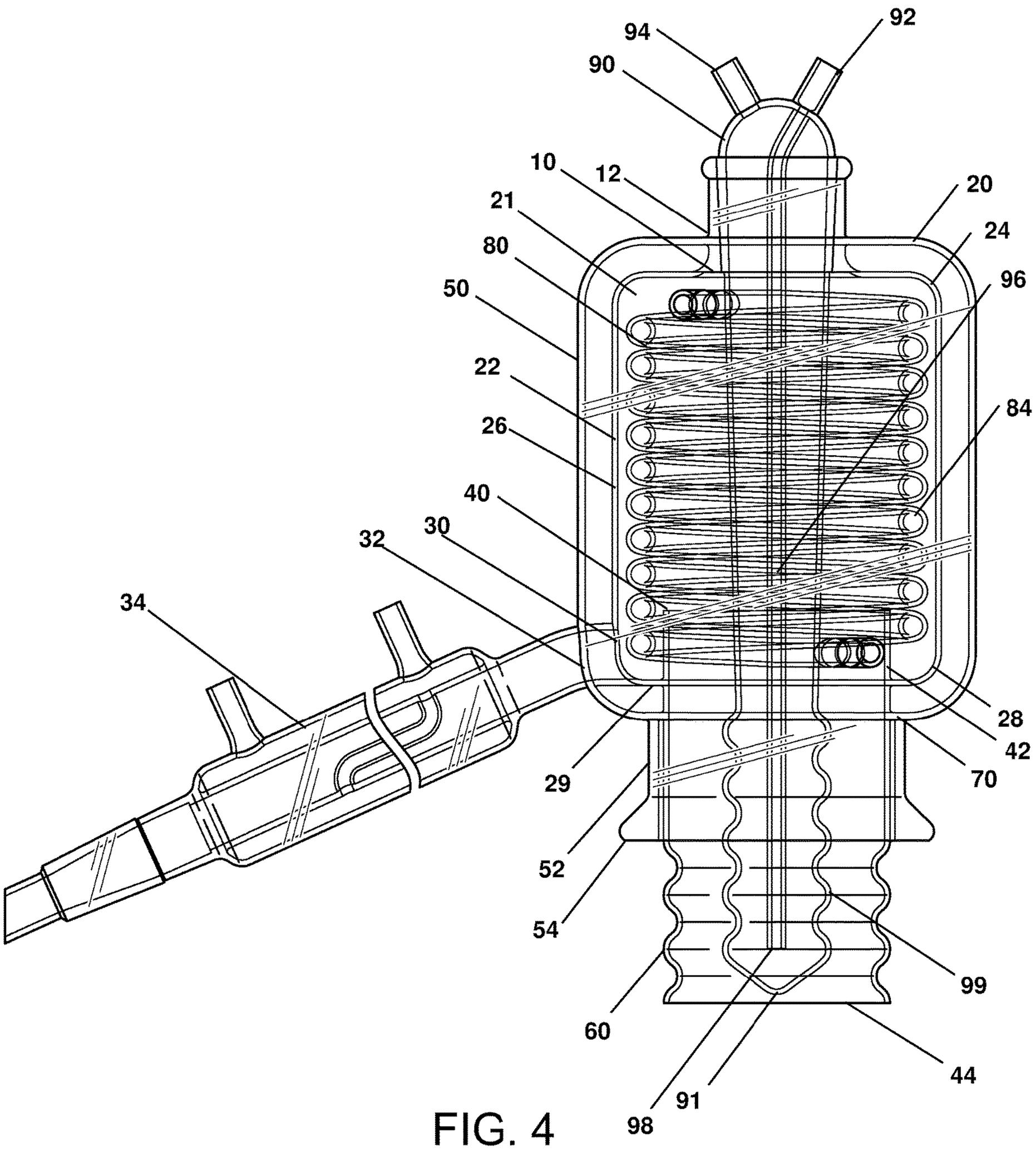

94
92
90
10
12
20
21
24
80
96
50
22
84
26
40
30
32
34
28
42
29
70
52
54
99
60
44
91
98

FIG. 4

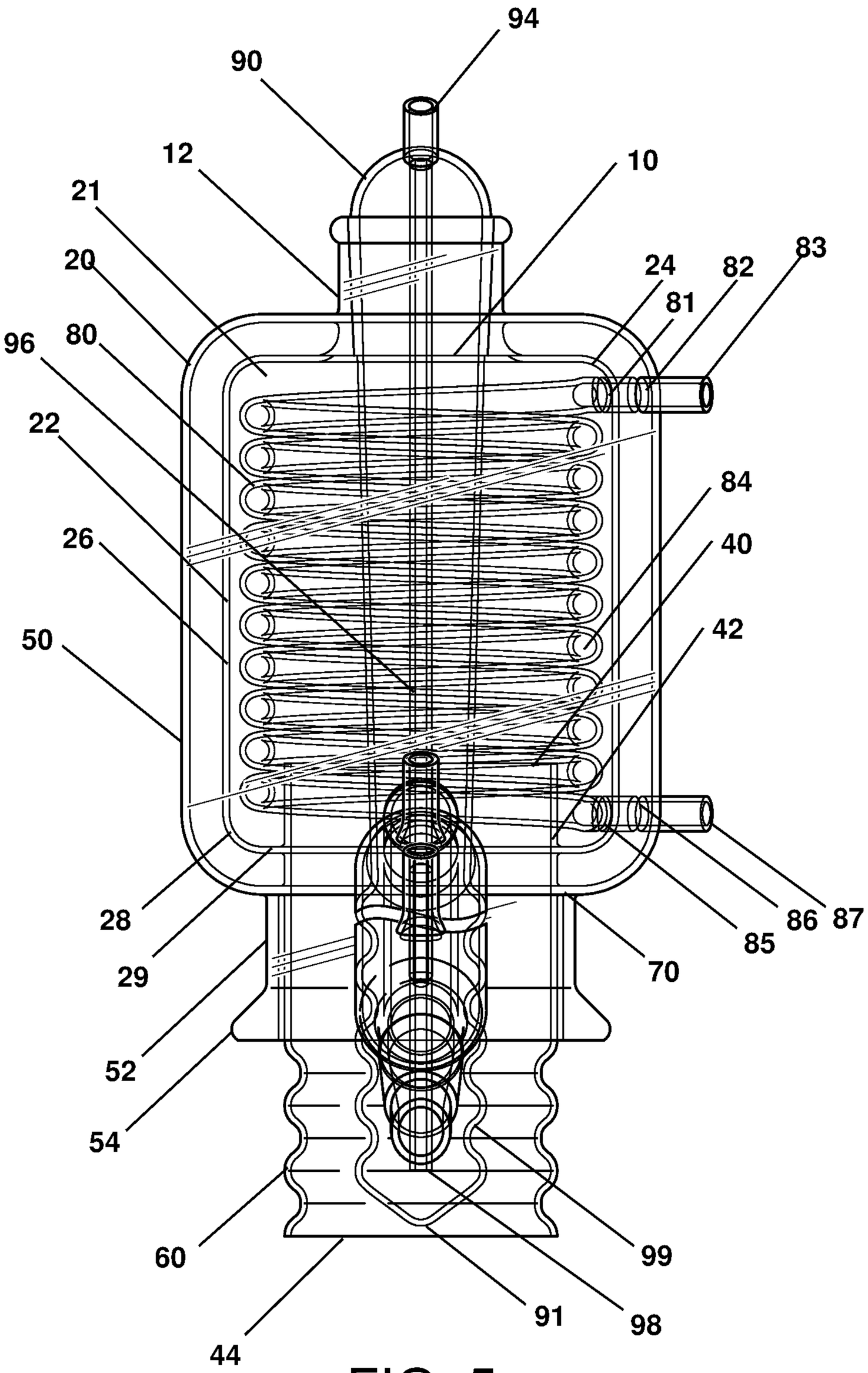

94
90
12
10
21
20
24
82
83
81
96
80
22
84
26
40
50
42
28
86
87
85
29
70
52
54
60
99
91
98
44

FIG. 5

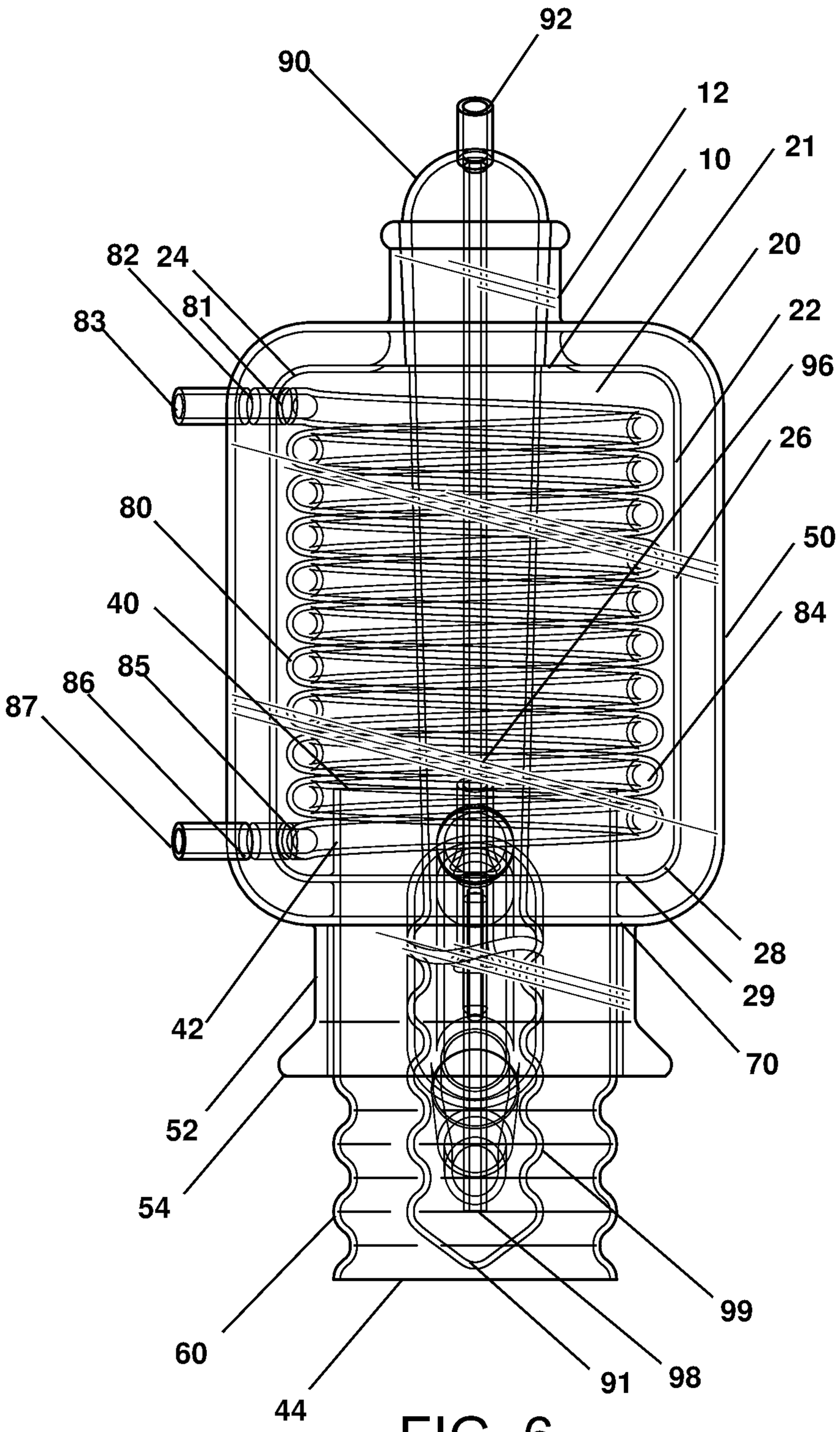

92
90
12
10
21
20
82
24
81
83
22
96
26
80
50
40
84
85
86
87
28
29
42
70
52
54
99
60
91
98
44

FIG. 6

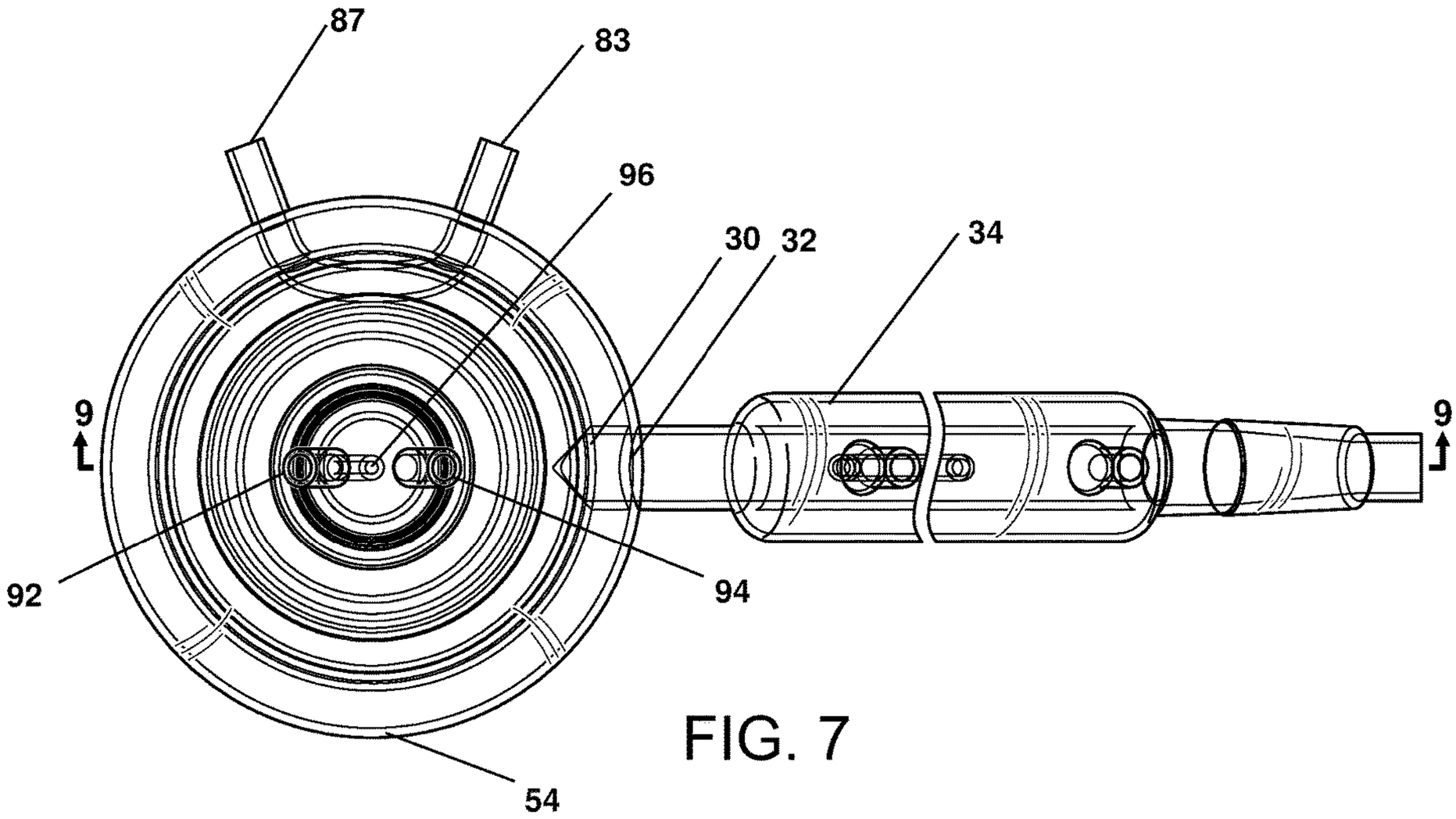


FIG. 7

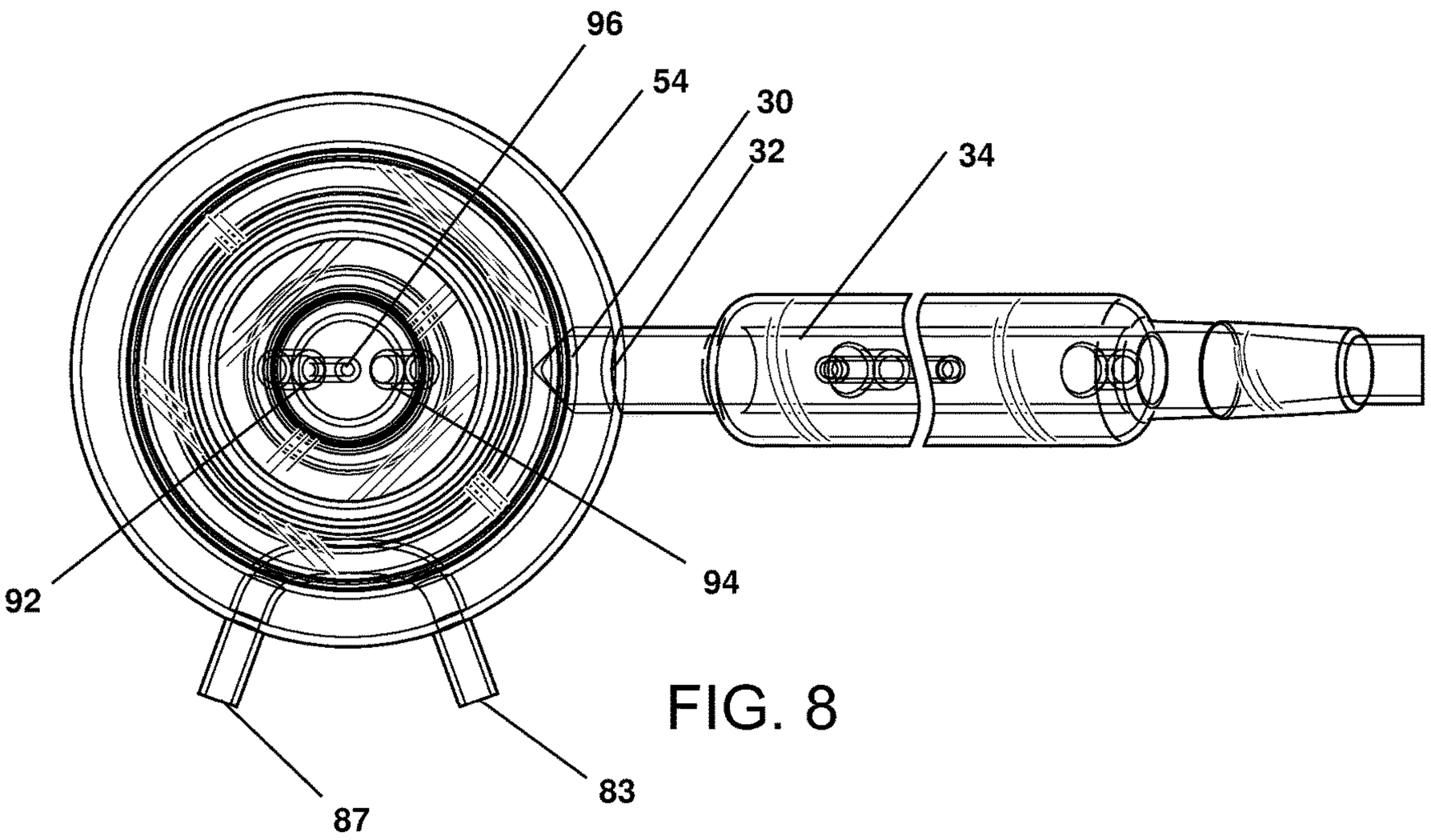


FIG. 8

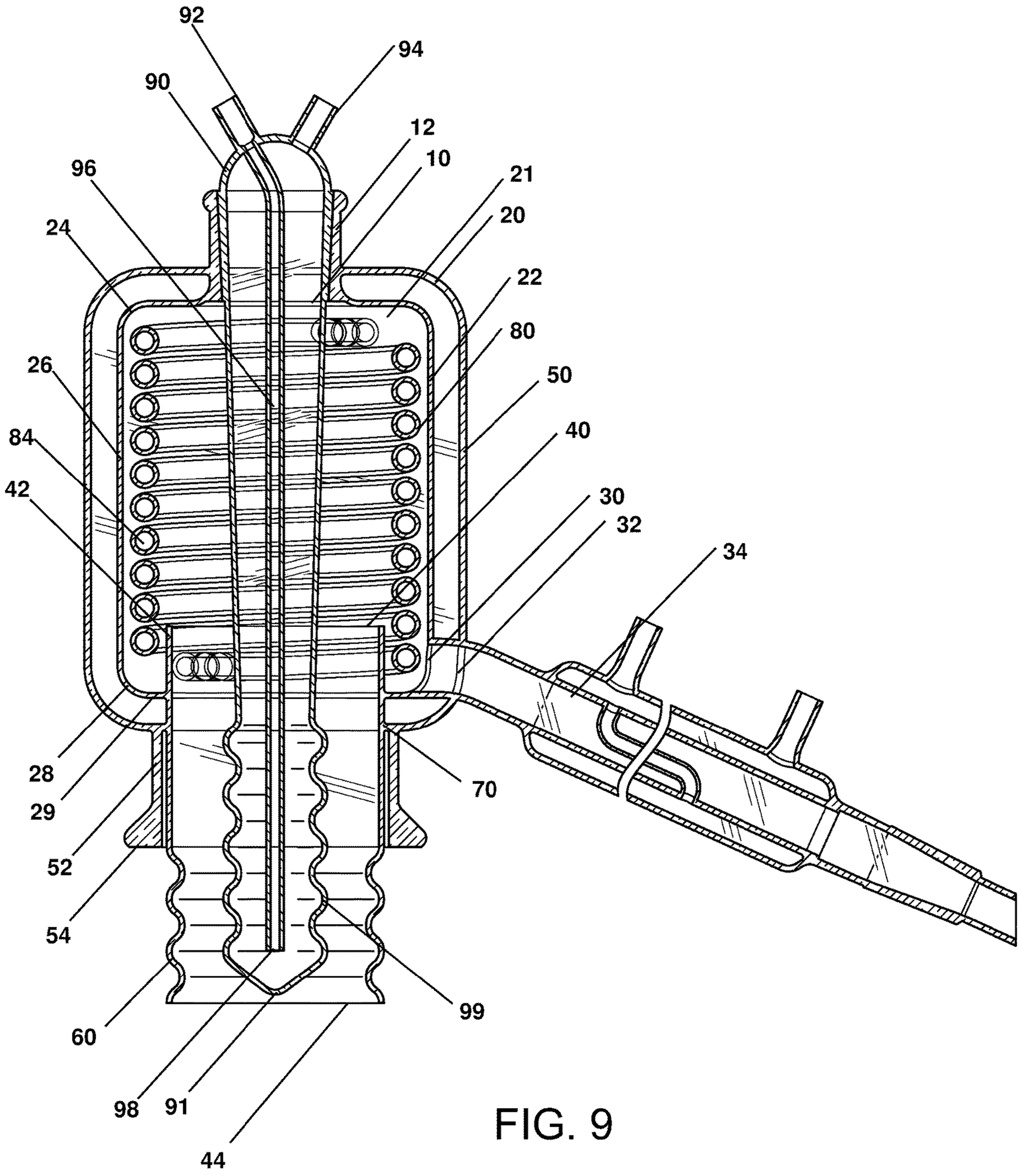

92
94
90
12
10
96
21
20
24
22
80
26
50
84
40
42
30
32
34
28
29
70
52
54
60
99
98
91
44

FIG. 9

SHORT DISTILLATION HEAD WITH INTEGRATED COOLING SPIRAL

FIELD OF THE DISCLOSED TECHNOLOGY

The disclosed technology relates generally to distillation and, more specifically, to a short path distillation head with an integrated cooling spiral.

BACKGROUND

Distillation or fractional distillation is carried out by heating a solid or liquid and removing gaseous vapors that are expelled therefrom. This is typically carried out by raising the temperature and boiling off fractions of the solid or liquid based on their differing boiling points. Separated compounds are removed from a distillation apparatus into an attached condenser in order to be converted from gas into a solid or liquid. Sometimes, however, the condensation process can be slow and/or less than precise when fractions have close boiling points and thus prevent the distillation from functioning at peak efficiency.

Therefore, there is therefore a need for a distillation system which separates fractions more precisely and faster without compromising the efficacy of the distillation.

SUMMARY OF THE DISCLOSED TECHNOLOGY

The disclosed technology is a distillation head and fraction collector with an in-built cooling spiral. This novel combination increases the speed and efficacy of the distillation process by adding a more rigorous step of cooling/condensation before the product exits the fraction collector.

A distillation apparatus of embodiments of the disclosed technology has a cooling spiral surrounded by at least a part of a vertical extent of a fraction collector. Connecting to and/or extending into an interior space of the fraction collector is an end of a vertically-extending passageway. This passageway is functionally connected at an other end to a lower-end entry portal. In this manner, the passageway for vapors can remain hot while a portion of the passageway is cooled. As such, only a portion of the vapors are rejected back down towards a lower entrance to the pathway while the hotter/quicker moving vapors continue onwards through the pathways while a desired fraction condenses and exits the device.

"Functionally connected" is defined as "having a continuous passageway for vapors or liquids to pass through." "Collector" is defined as "a device which is closed except for portals of entry or exit for gases or liquids, each portal being within a single side of a respective collector." "Fraction collector" is defined as "a device used to collect individual portions of mixtures separated through distillation, the separated portions being partially, substantially, or fully condensed therein". "Cooling spiral" is defined as "a spiraled hollow tube through which coolant, such as water or oil, flows such that a temperature of an area which surrounds the tube is lowered".

A "distillation apparatus" is defined as a device in which vapors of a solid, liquid, or combination solid and liquid product to be distilled move upwards therein before exiting therefrom such as into a distribution adapter or condenser. "Distillate" refers to, and is defined as, the vapor, liquid, or combination thereof which exits, by way of the fraction collector, from the distillation head and is ultimately fractionally distilled into component parts, each component part having different physical properties such as a different boiling point.

In some embodiments, an outer cover surrounds the fraction collector, the cooling spiral, and at least a majority of the vertically extending passageway. An intake and an outtake of the cooling spiral, in embodiments, can pass through the outer cover.

"Intake" is defined as "an area through which a substance or object, e.g. coolant, is brought into an area or part of a device". "Outtake" is defined as "an area through which a substance or object, e.g. coolant, is expelled from an area or part of a device".

The fraction collector, in various embodiments of the disclosed technology, has an outer wall with a curvilinear upper portion, a curvilinear lower portion, and a vertical middle portion. The vertical middle wall can form a unitary wall with the curvilinear upper portion and the curvilinear lower portion of the wall. In embodiments, the vertical middle portion may surround the cooling spiral. The intake and outtake of the cooling spiral, in some embodiments, pass through the outer wall of the fraction collector.

"Interior" is defined as "a mostly enclosed space and passageway designed for passage of gas, liquid and/or solid there-through". "Exterior" is defined as "outside of and relative to a mostly enclosed space.".

In some embodiments, the cooling spiral further comprises an interior space. This interior space is separate from a continuous passageway formed within the vertically extending passageway, the fraction collector, a side exit portal of the fraction collector, and a top portal of the fraction collector. The cooling spiral passageway is, in embodiments of the disclosed technology, separate from a passageway for gas (vapors) and liquid being distilled from a solid beneath the distillation apparatus.

The cooling spiral has, in some embodiments, an upper end, a spiral, and a lower end. The upper end terminates at a horizontal plane which is inline with the curvilinear upper portion, and the lower end terminates at a horizontal plane which is inline with curvilinear lower portion. The spiral is surrounded by, in embodiments, a majority of the vertical middle portion.

In embodiments, a hollow space exists between the vertical middle portion of the out wall of the fraction collector and between the cooling spiral. A first end of the cooling spiral, in some embodiments, terminates at the intake, while a second end terminates at the outtake.

The outer cover can directly surround an entirety of the vertical middle portion of the wall as well as the upper and the lower portions of the wall of the fraction collector. The vertical middle wall of the fraction collector surrounds the cooling spiral.

At least a majority of the cooling spiral is, in embodiments, above the side exit portal of the fraction collector.

The vertically extending passageway, in some embodiments, further has a top edge which extends into a part of the fraction collector which is surrounded by the lower portions and a portion of the middle portions of the wall of the fraction collector. This top edge may terminate inline with a part of the side exit portal which is below a top part of the side exit portal, and may be situated below a horizontal plane of a lowest edge of the cooling spiral.

"Inline" is defined as "sharing a horizontal or vertical plane therewith".

In various embodiments, the vertically extending passageway further has a lower collection region and a tube. A largest circumference of the lower collection region can be

wider than a largest circumference of the tube, and the largest circumference of the lower collection region can be substantially smaller than a largest horizontally-oriented circumference of the cooling spiral.

"Circumference" is defined as "measure of a length of a circular or ovoid enclosing boundary of a named part of the device described herein".

The cooling spiral intake is, in some embodiments of the disclosed technology, situated horizontally inline with the cooling spiral outtake. In other embodiments, all horizontal planes passing through the cooling spiral intake are above all horizontal planes passing through the cooling spiral outtake, and the cooling spiral outtake is horizontally inline with the side exit portal.

Described differently, a distillation apparatus of embodiments of the disclosed technology has a first continuous internal region extending from a bottom end of the apparatus to a side exit portal. A cooling spiral with a second continuous internal region, forming a separate interior space than the first continuous internal region, surrounds a portion of a vertical extent of the continuous internal region. In some embodiments, the first internal region may extend below the cooling spiral. The second continuous region lacks portals to the first continuous region, in various embodiments.

"Vertical extent" is defined as "a portion which has a vertical length throughout which its cross-sections are substantially identical".

The distillation apparatus further has, in various embodiments, an outer cover surrounding each of substantially an entirety of the first continuous internal region and the cooling spiral. The outer cover can have therein a top portal of the first continuous internal region. It can have therein an intake of the cooling spiral and/or an outtake of the cooling spiral. It can also have therein a side exit portal of the first continuous internal region. In some embodiments, a majority of horizontal planes passing through the side exit portal are below all horizontal planes passing through each of the intake and the outtake.

"Surrounding" is defined as "forming a unitary structure and covering and/or being contiguous with at least one point on every vertical or on every horizontal line on a thing being surrounded".

In various embodiments, the bottom section of the distillation tube has a narrower portion and a wider portion, with the narrower portion extending above a highest horizontal plane of the wider portion. The cooling spiral, in embodiments, has a lowest horizontal plane which is above the wider portion and which is above a majority of the narrower portion.

Put otherwise, a distillation has an internal glass section with a lower intake and a side outtake. A vertically-extending portion of the internal glass section is surrounded by a hollow glass spiral. A majority of the vertically-extending portion which is surrounded by the spiral is vertically above the side outtake, in embodiments.

A hollow distillation key is attached to the structure at a side and extends through a fraction collector and a bottom region of the internal glass section, and is spaced apart therefrom.

The distillation key, in embodiments, has two portals. A first portal extends into a substantially vertical hollow tube disposed within and extending through a majority of a vertical rise of the distillation key. A second portal opens into the hollow internal region of the distillation key.

The substantially vertical hollow tube, in embodiments, has a lowest extent which shares a horizontal plant with a region of the distillation apparatus adapted for placement within a boiling flask while a rest of the distillation apparatus exterior of the boiling flask.

The directional descriptors used in this disclosure, such as "top", "bottom", "vertical", "horizontal", "upper", "lower", "above", and "below" are relative to a typical direction of use with a heat source below the portion of the vertically-extending passageway substantially farthest from a top portal of the apparatus.

Any device or step to a method described in this disclosure can comprise, or consist of, that which it is a part of, or the parts which make up the device or step. The term "and/or" is inclusive of the items which it joins linguistically and each item by itself. Any element or described portion of the devices shown can be "substantially" as such, if used in the claims in this manner. Where used, "substantially" is defined as "within a 5% tolerance level thereof."

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a top and right side perspective view of a distillation apparatus of embodiments of the disclosed technology.

FIG. **2** shows a bottom and left side perspective view of the distillation apparatus of FIG. **1**.

FIG. **3** shows a right side elevation view of the distillation apparatus of FIG. **1**.

FIG. **4** shows a left side elevation view of the distillation apparatus of FIG. **1**.

FIG. **5** shows a front elevation view of the distillation apparatus of FIG. **1**.

FIG. **6** shows a back elevation view of the distillation apparatus of FIG. **1**.

FIG. **7** shows a top plan view of the distillation apparatus of FIG. **1**.

FIG. **8** shows a bottom plan view of the distillation apparatus of FIG. **1**.

FIG. **9** shows a vertical cross section of the distillation apparatus of FIG. **1**.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE DISCLOSED TECHNOLOGY

A distillation apparatus has a cooling spiral surrounding at least a part of a vertical extent of a fraction collector in the disclosed technology. Connecting to and/or extending into an interior space of the fraction collector is an end of a vertically-extending passageway. This passageway is functionally connected at an other end to a lower-end entry portal. An outer cover substantially covers the cooling spiral, fraction collector, and a portion of the vertically-extending passageway, excepting for a top portal, a side exit portal, at least one cooling spiral intake, and at least one cooling spiral outtake.

Embodiments of the disclosed technology will become more clear in view of the following discussion of the figures.

FIG. **1** shows a top and right side perspective view of a distillation apparatus of embodiments of the disclosed technology. FIG. **2** shows a bottom and left side perspective view of the distillation apparatus of FIG. **1**. Describing from roughly top to bottom for ease of reading, at the top, in some embodiments, a top portal **10** of the fraction collector **22** functionally connects/opens into a neck **12** in which is inserted a distillation key **90**. In other embodiments, the fraction collector **22** can be closed at a top side, neck **12** can be closed, or neck **12** can be open such that a stopper, thermometer, or other instrument may be inserted therein.

A cooling spiral **80** is partially or wholly surrounded by the fraction collector **22**. In other embodiments, the cooling spiral **80** is surrounded by different or additional segments of fraction collector **22** such as one or more of the upper curvilinear section **24** and lower curvilinear section **28**. In further embodiments, the cooling spiral **80** surrounds at least a portion of vertical tube **42**. In further embodiments, the cooling spiral **80** surrounded a part or substantially all of the fraction collector **22**. In some embodiments, at least a part of middle vertical extent **26** or any other part of the fraction collector or vertically extending tubes described herein, is, in embodiments of the disclosed technology, simultaneously a part of the cooling spiral **80**. In other embodiments, there exists a gap between the walls **24**, **26**, **28** of the fraction collector and between the cooling spiral **80**. In various embodiments, the interior space of the cooling spiral **80** is separate from an interior space **21** of the fraction collector **22** and the tube **42**.

In the embodiment shown, an intake tube **83** of the cooling spiral **80** connects to a portal **82** in an outer cover **20** and to a portal **81** in the wall of the fraction collector **22**. An outtake tube **87** of the cooling spiral **80** connects to a portal **86** in the outer cover **20** and to a portal **85** in the fraction collector **22**. In other embodiments, the cooling spiral **80** may be wholly exterior to the fraction collector **22**, and the intake tube **83** and the outtake tube **87** may connect only to, respectively, portals **82** and **86** in the outer cover **20**.

FIG. **3** shows a right side elevation view of the distillation apparatus of FIG. **1**. FIG. **4** shows a left side elevation view of the distillation apparatus of FIG. **1**. As shown in these figures, the fraction collector **22** has a bottom side **29** which can be a) angled, relative to the bottom of the device, and/or b) flat/horizontal relative to the bottom of the device. The bottom side **29** of the fraction collector **22** can have an opening there-in through which a tube **42** passes therein. The tube **42** extends vertically in some embodiments of the disclosed technology and has an opening at each of a top edge **40** and bottom edge **60**. The top edge **40** and opening into the fraction collector **22** is within a space circumscribed by (surrounded by or substantially surrounded by) the fraction collector. In this manner, vapors which extend above the vertical tube must condense before dropping to the bottom side **29** of the fraction collector which is in line with a side exit portal **30** which passes between the fraction collector **22** and condenser entry area **32** before entering a main body of the condenser **34** where the liquids are further cooled, such as by way of a cold water flow, or other coolant, around the path of the liquid passing through the condenser. Cold water is defined as water which has a temperature substantially equal to or below ambient room temperature. In other embodiments, the top edge **40** of vertical tube **42** terminates at a bottommost part of the lower curvilinear wall **28** and/or of a wall of fraction collector **22** rather than extending into fraction collector **22**.

In the embodiment shown, the fraction collector **22** has walls comprising an upper curvilinear section **24**, a middle vertical extent **26**, and a lower curvilinear section **28**. In other embodiments, there exist one or more additional wall segments with same or different shapes.

As shown in this embodiment, the condenser entry area **32** extends outward from the side exit portal **30** and at a downward angle relative to a horizontal plane. Condenser **34** is situated at a substantially identical downward angle as that of the condenser entry area **32**.

Also shown in this embodiment is that the intake tube and portals **83**, **82**, **81** are partially or completely horizontally inline with the upper curvilinear portion **24** of the walls of the fraction collector **22**. Further shown, the outtake tube and portals **87**, **86**, **85** are partially or completely horizontally inline with the lower curvilinear portion **28** of the walls of the fraction collector **22**.

FIG. **5** shows a front elevation view of the distillation apparatus of FIG. **1**. FIG. **6** shows a back elevation view of the distillation apparatus of FIG. **1**. As shown in these figures, the outer cover **20** has a wider region **50** which extends above and around the fraction collector **22**, a thinner region **52** which circumscribes a portion of the undulating region **60** of the tube **42**, and a flared region **54** which circumscribes a portion of the undulating region **60** of the tube **42** which, when the distillation apparatus is held in an upright position, is below the portion of the undulating region **60** of the tube **42** circumscribed by the thinner region **52**. The flared edge **54** can be adapted to cover and substantially or fully create a seal or airtight seal or connection with an upper end of a flask or boiling flask. As such, vapors extending out of a flask situated below the distillation device shown (e.g. in FIG. **5**) move substantially or fully upwards into the distillation apparatus by way of passage into the outer cover (between walls **52**) and/or into the lower portal **44** of the tube **42**.

The cover **20**, as a whole, surrounds the fraction collector **22** and cooling spiral **80** such as in an unencumbered manner, at every horizontal cross section in embodiments of the disclosed technology but for where the side portal **30**, intake tube **86**, and outtake tube **88** extend there-through. "Unencumbered" is defined as "at a horizontal cross section, having no other portion of the distillation apparatus surrounding or to the outside of." An interior space of the cooling spiral **80** is also unencumbered, in embodiments of the disclosed technology.

In some embodiments of the disclosed technology, a tube **42** extends into the fraction collector **22** by way of an upper portal **40**. The tube **42** has a lower undulating portion **60** connecting to a lower portal **44**. The tube **42** extends through and below and interior circumscribed (substantially surrounded by) the outer cover **20**. By way of this passage of the tube **42** into the fraction collector **22**, a rejection area **70** is created between the tube **42** the outer wall **20**. Vapors then experience turbulent flow or condensation causing movement downwards until passing upwards through the lower portal **44** of the tube **42**.

A distillation key **90** is connected to and/or disposed within the neck **12** and extends downward through fraction collector **22**, cooling spiral **80**, and tube **42** in an unencumbered manner. A lowest point **91** of the key **90** extends to a point within and slightly above the lower portal **44** of the tube **42**. In other embodiments, the lowest point **91** of the key **90** may extend into a point which is substantially inline with or below the lower portal **44** of the tube **42**. A lower portion **99** of the key **90** has undulating sidewalls.

The distillation key **90** has a bulbous upper head on which are disposed two portals **92**, **94**. A first portal **92** is connected to an internal hollow section **96** of the key **90**. A second portal **94** is connected to an internal space of the key **90**. The internal hollow section **96** extends through a majority of the internal space of the key **90** in an unencumbered manner. A majority of the internal hollow section **96** is substantially straight. The internal hollow section **96** terminates at a lower portal **98**.

The undulating side walls of both the undulating region **60** of the tube **42** and of the lower region **99** of the distillation key **90** move inwards and outwards in a repeating pattern. In the embodiment shown, a portion of the lower region **99** is above the undulating region **60**. In other

embodiments, the lower region **99** is entirely surrounded by and/or below the undulating region **60**. At every point where the lower region **99** is surrounded by the undulating region **60**, the undulations of each relative side wall correspond (i.e. the undulations of one move inward and outward at a same respective cross section at the other).

In another embodiment, vapors rise directly into the bottom portal **44** of vertical tube **42**. Vertical tube **42** may have, in various embodiments, a more and/or a less bulbous portion thereof.

In some embodiments, a bottom end of a vertically-extending distillation tube **42** has a portal open to a bottom side of the device, such as a portal **44** and bottom end **60** thereof which are, or can be, inserted into a boiling flask. In such an instance, vapors extending upwards from the boiling flask further continue to extend upwards into the distillation tube, such as in a manner lacking obstruction between a top end of the boiling flask and the bottom portal into the distillation tube.

Vapors which do enter the tube **42** continue upwards into the fraction collector **22** before condensing and falling to the bottom **29** of the fraction collector **22**. Continued upward moving vapors from the vertical tube, which are often warmer than the condensing vapors, prevent a majority or substantially all of condensed liquid, in embodiments of the disclosed technology, from falling down through the vertical tube **42**. Rather, the vapors condense into liquid at the bottom **29** of the fraction collector **22**, outside of the tube **42** and then flow out the side portal **30** which shares a lowest side or floor with the fraction collector, passing then into the condenser **34**.

While the vapors move upward through the tube **42**, the undulating sides of the lower region **99** of the distillation key **90** as well as the undulation sides of the undulating region **60** cause the vapors to experience a turbulent flow. This causes heavier particles to fall downwards while the lighter parties rise further upwards.

The distillation key **90** can further be filled with water as a method of cooling and/or heating the area surrounding the distillation key **90**. The water may be added through either the first portal **92** or through the second portal **94**. In this way, the distillation key may assist in heating a product (through the addition of hot water, defined as water which has a temperature substantially equal to or below ambient room temperature) or in cooling a product (through the addition of cold water).

The outer cover further surrounds the tube **40**, a part of the tube **40** being unencumbered by other elements (e.g. fraction collector or lower collection region) in some embodiments of the disclosed technology. The outer cover further surrounds part or a majority of (more than 50%) the lower collector region **60** and the cooling jacket **80** covers a majority of the fraction collector **22** and/or minority of a vertical tube **40**. Side walls **50** form a right angle or substantially a right angle or rounded corner with a horizontal seal **70** in a unitary connection in embodiments of the disclosed technology.

As shown by FIGS. **5-6**, the bottom side **29** of fraction collector **22**, which is partially formed by the lower curvilinear section **28** of the walls of fraction collector **22**, can be flat/horizontal around an opening which a top edge **40** of tube **44** extends there-through.

As shown in this embodiment, particularly that of FIG. **3**, the intake tube **83** and outtake tube **87** connect to portals **82**, **81** and **86**, **85**, respectively, and terminate in an area exterior to the outer cover **20**. In some embodiments, these tubes connect only to portals **81** and **85** (respectively) and instead terminate in an area interior to the outer cover **20** and exterior to the fraction collector **22**. Furthermore, in this embodiment, an interior space **84** of the cooling spiral **80** has a substantially identical height, width, and depth at every parallel horizontal or vertical cross section excepting those of spirals closest to the intake tube **83** and the outtake tube **87**. In various other embodiments, some horizontal or vertical cross sections differ from other horizontal or vertical cross sections in at least one dimension.

FIG. **7** shows a top plan view of the distillation apparatus of FIG. **1**. FIG. **8** shows a bottom plan view of the distillation apparatus of FIG. **1**. In various embodiments, the intake tube **83** and portals **82**, **81**, and the outtake tube **87** and portals **86**, **85**, are located inline (in a same horizontally or vertically-oriented plane) with each other, or are disposed such that intake tube and portals **83**, **82**, **81** are vertically above or below (in a same vertically-oriented plane) outtake tube and portals **87**, **86**, **85**. Intake tube and portals **83**, **82**, **81** may be offset from outtake tube and portals **87**, **86**, **85** by any number of degrees, such as 180 or 90. Intake tube **83** and outtake tube **87** may be substantially identical. Intake portals **82**, **81** and outtake portals **86**, **85** may be substantially identical. Alternatively, intake and outtake portals **82** and **86** in the outer cover **20** may be substantially, while intake and outtake portals **81** and **85** in the fraction collector **22** may be substantially identical. Intake tube and portals **83**, **82**, **81** and/or outtake tube and portals **87**, **86**, **85** may be horizontally inline with and/or vertically inline with side exit portal **30** and/or condenser entry area **32**.

In this embodiment, the intake tube **83** and the outtake tube **87** are substantially parallel and horizontal. In various embodiments of the disclosed technology, one or both of the intake tube **83** and the outtake tube **87** are angled above and/or below a horizontal plane which passes through portals **8**, **81** and/or **86**, **85** and are angled to a right side and/or a left side of a vertical plane which passes through portals **82**, **81** and/or **86**, **85**. Furthermore, in other embodiments, each of intake tube **83**, outtake tube **87**, intake portals **82**, **81**, and/or outtake portals **86**, **85** may be a plurality of, respectively, intake tubes, outtake tubes, intake portals, and/or outtake portals. Each individual component of the plurality of intake tubes, outtake tubes, intake portals, and/or outtake portals may be substantially identical or non-identical in size and/or shape.

As shown by FIGS. **7-8**, in an embodiment, the flared edge **54** of the side walls **50** of the outer cover **20** have a horizontal circumference which is substantially the largest horizontal circumference of any component of the device shown.

FIG. **9** shows a vertical cross section of the distillation apparatus of FIG. **1**. As shown clearly in this figure, the horizontal seal **70** of the outer cover **20** is connected to the thinner region **52** at the bottom of side walls **50** of the outer cover **20**. In various embodiments, at least a part of the horizontal seal **70** may be situated at an angle. The thinner region **52** may be of any width which is smaller than a greatest width of the flared region **54**. The horizontal seal **70** may be connected to a different part of the side walls **50** of the outer cover **20**.

While the disclosed technology has been taught with specific reference to the above embodiments, a person having ordinary skill in the art will recognize that changes can be made in form and detail without departing from the spirit and the scope of the disclosed technology. The described embodiments are to be considered in all respects only as illustrative and not restrictive. All changes that come within the meaning and range of equivalence of the claims

are to be embraced within their scope. Combinations of any of the methods, systems, and devices described herein-above are also contemplated and within the scope of the disclosed technology.

The invention claimed is:

1. A distillation apparatus comprising:

a first continuous internal region with a vertical extent from a bottom section of said apparatus to a side exit portal;

a cooling spiral with a second continuous internal region, a minority of said cooling spiral surrounding an inner tubular portion of said vertical extent of said first continuous internal region, wherein said second continuous internal region is separate from, and lacking portals to, said first continuous internal region;

wherein a vertically uppermost horizontal plane of said inner tubular portion of said vertical extent is below a horizontal plane at a midpoint of said cooling spiral.

2. The distillation apparatus of claim **1**, wherein a portion of said first continuous internal region comprising a majority of an area between an uppermost horizontal tubular plane and a lowermost horizontal tubular plane of an entirety of a vertical tube extends below said cooling spiral.

3. The distillation apparatus of claim **1**, further comprising an outer cover surrounding each of substantially a majority portion of said first continuous internal region and an entirety of said cooling spiral;

wherein a minority of said first continuous internal region is unencumbered by said outer cover.

4. A distillation apparatus comprising:

an internal glass section with a lower intake and a side outtake; and

a hollow glass spiral, a lower minority portion of said hollow glass spiral substantially surrounding a vertically-extending portion of said internal glass section;

wherein a vertically uppermost horizontal plane of said vertically-extending portion is below a horizontal plane at a vertical midpoint of said hollow glass spiral.

5. The distillation apparatus of claim **4**, wherein a majority of said vertically-extending portion surrounded by said spiral is vertically above said side outtake;

wherein said vertically-extending portion surrounded by said spiral is a minority of said vertically-extending portion;

wherein a majority of an entirety of said vertically-extending portion is unencumbered by said spiral.

6. A distillation apparatus comprising:

a first continuous internal region with a vertical extent from a bottom section of said apparatus to a side exit portal;

a cooling spiral with a second continuous internal region, a minority of said cooling spiral surrounding an inner tubular portion of said vertical extent of said first continuous internal region, wherein said second continuous internal region is separate from, and lacking portals to, said first continuous internal region;

wherein a portion of said first continuous internal region comprising a majority of a vertical tube thereof extends below said cooling spiral.

7. The distillation apparatus of claim **6**, further comprising an outer cover surrounding each of substantially a majority portion of said first continuous internal region and an entirety of said cooling spiral.

8. The distillation apparatus of claim **6**, wherein a majority of said vertically-extending portion surrounded by said spiral is vertically above said side outtake;

wherein said vertically-extending portion surrounded by said spiral is a minority of said vertically-extending portion.

* * * * *