US 20250262403A1

(19) United States
(12) Patent Application Publication
McCarthy et al.
(10) Pub. No.: US 2025/0262403 A1
(43) Pub. Date: Aug. 21, 2025

(54) **PORTABLE AUTOMATIC RESCUE BREATHING UNIT**

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(21) Appl. No.: **19/058,342**

(22) Filed: **Feb. 20, 2025**

Related U.S. Application Data

(60) Provisional application No. 63/555,400, filed on Feb. 20, 2024.

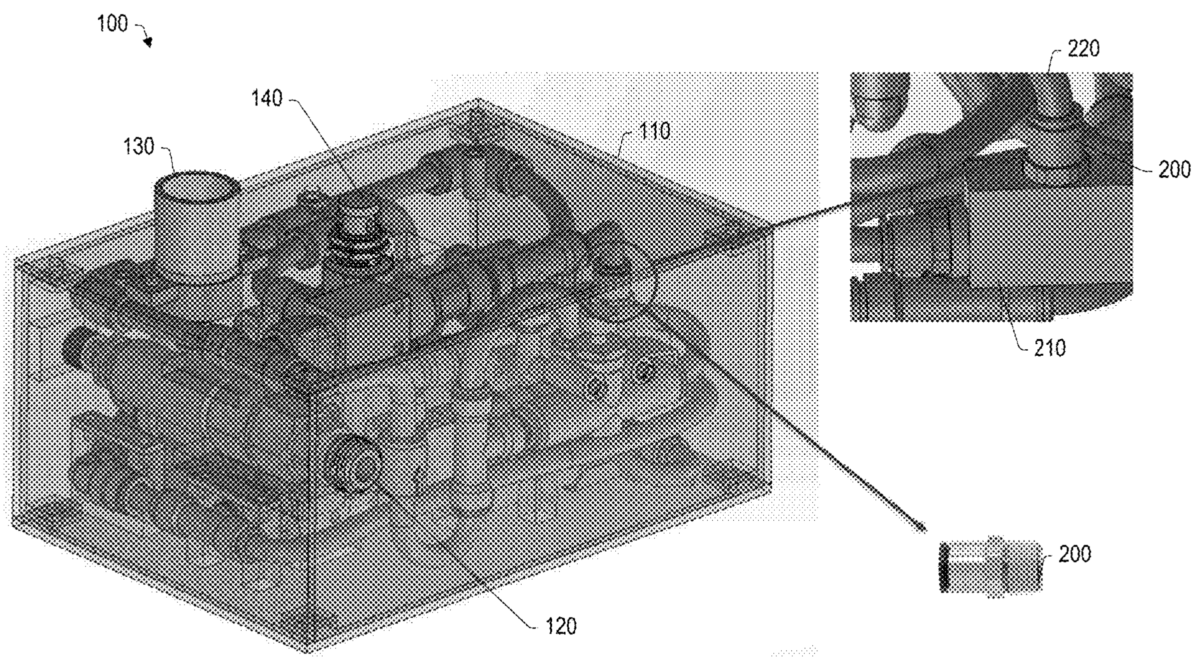
Publication Classification

(51) **Int. Cl.**
A61M 16/20 (2006.01)
A61M 16/00 (2006.01)

(52) **U.S. Cl.**
CPC *A61M 16/204* (2014.02); *A61M 16/208* (2013.01); *A61M 2016/0039* (2013.01)

(57) **ABSTRACT**

A rescue breathing apparatus and methods of operation for the rescue breathing apparatus are disclosed. The apparatus is an automatic rescue breathing unit (ARBU) device that includes a reservoir that is filled and/or drained according to alternative operations that may operate automatically or manually. One operation for filling and/or draining the reservoir is automatically controlled by a pneumatic logic circuit operating in combination with valves before and after the reservoir. A manual operation for filling the reservoir is controlled by a switch controlling flow into the reservoir.



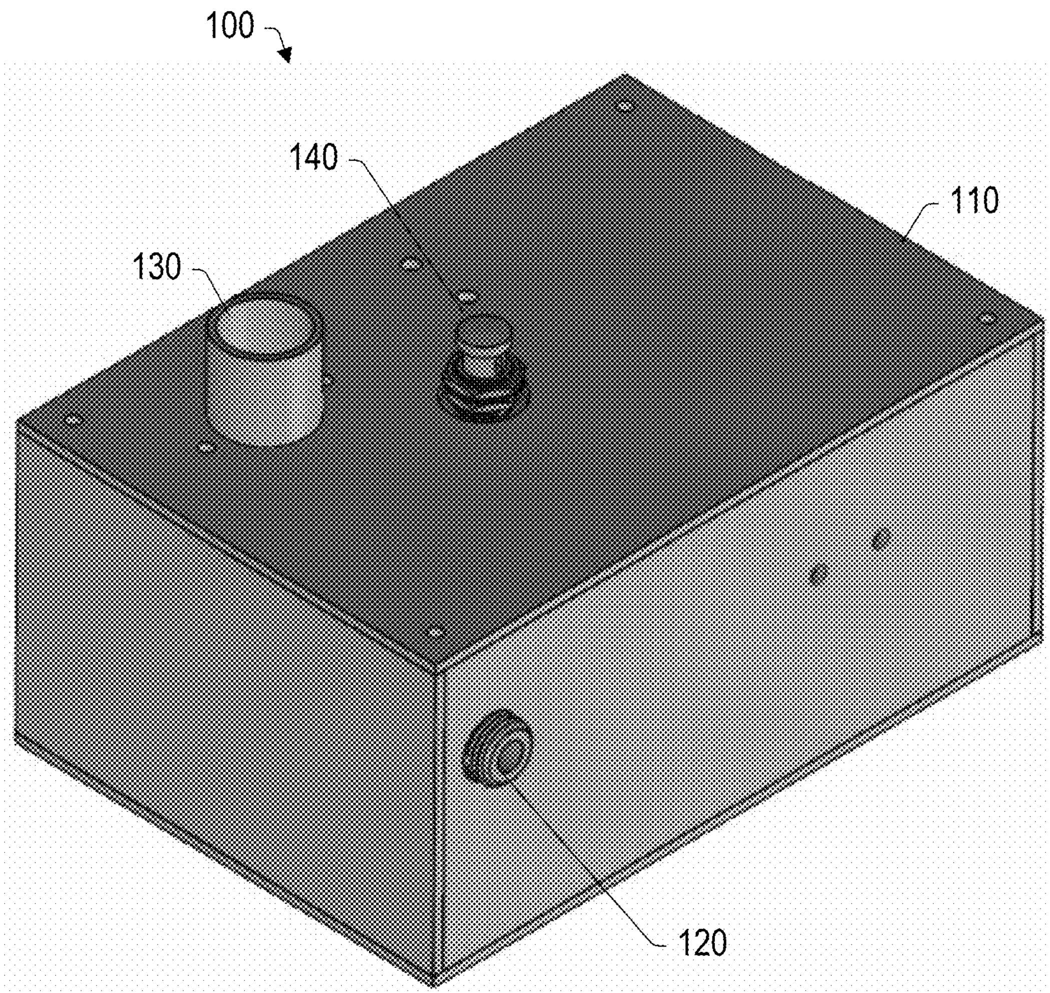


FIG. 1

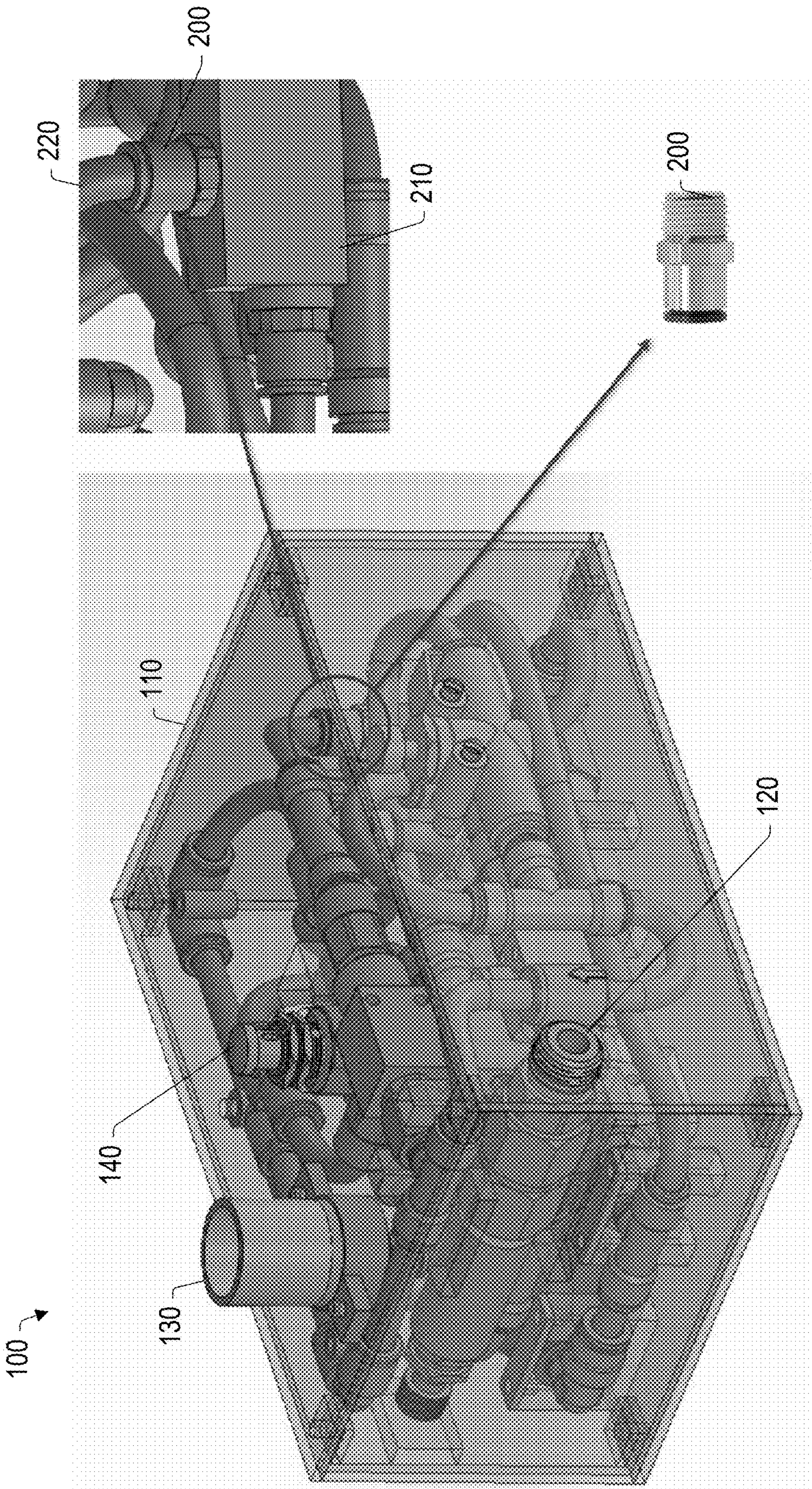


FIG. 2

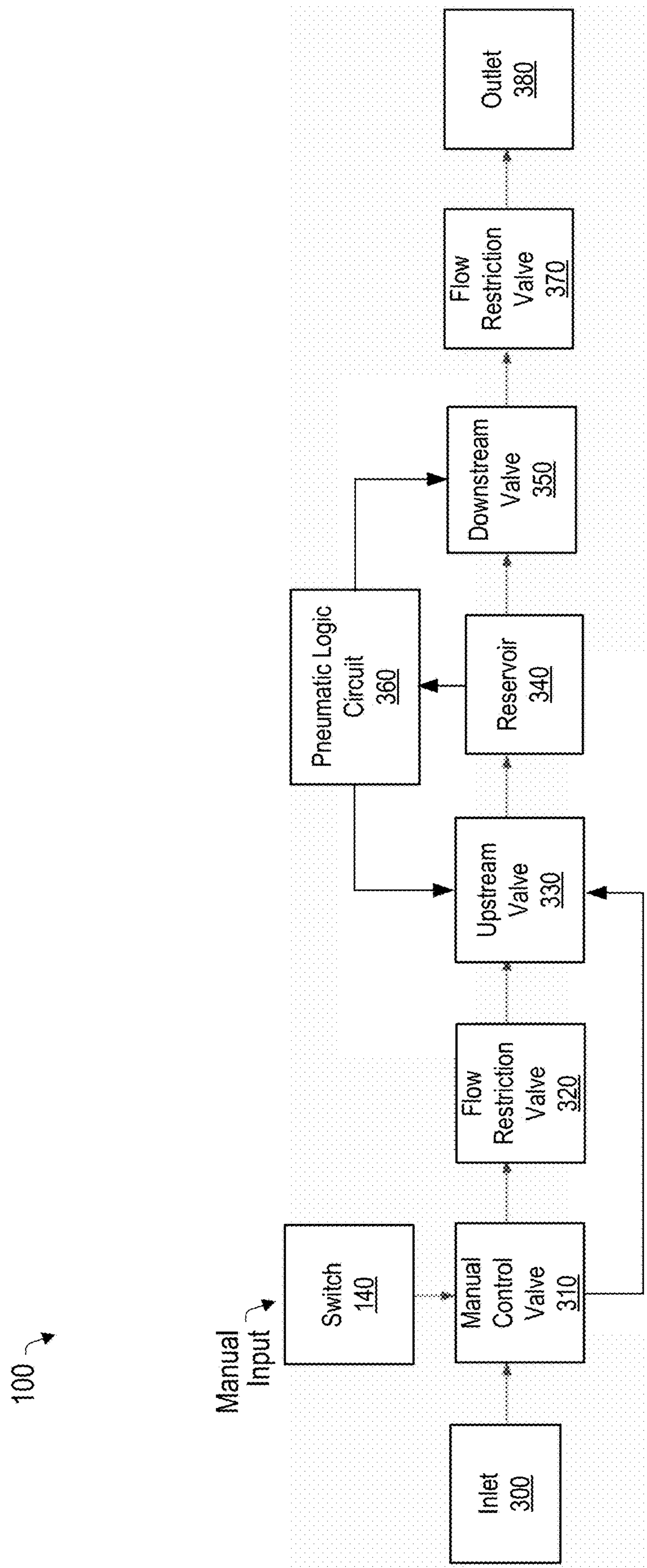

100
Manual Input
Inlet 300
Switch 140
Manual Control Valve 310
Flow Restriction Valve 320
Upstream Valve 330
Reservoir 340
Pneumatic Logic Circuit 360
Downstream Valve 350
Flow Restriction Valve 370
Outlet 380

FIG. 3

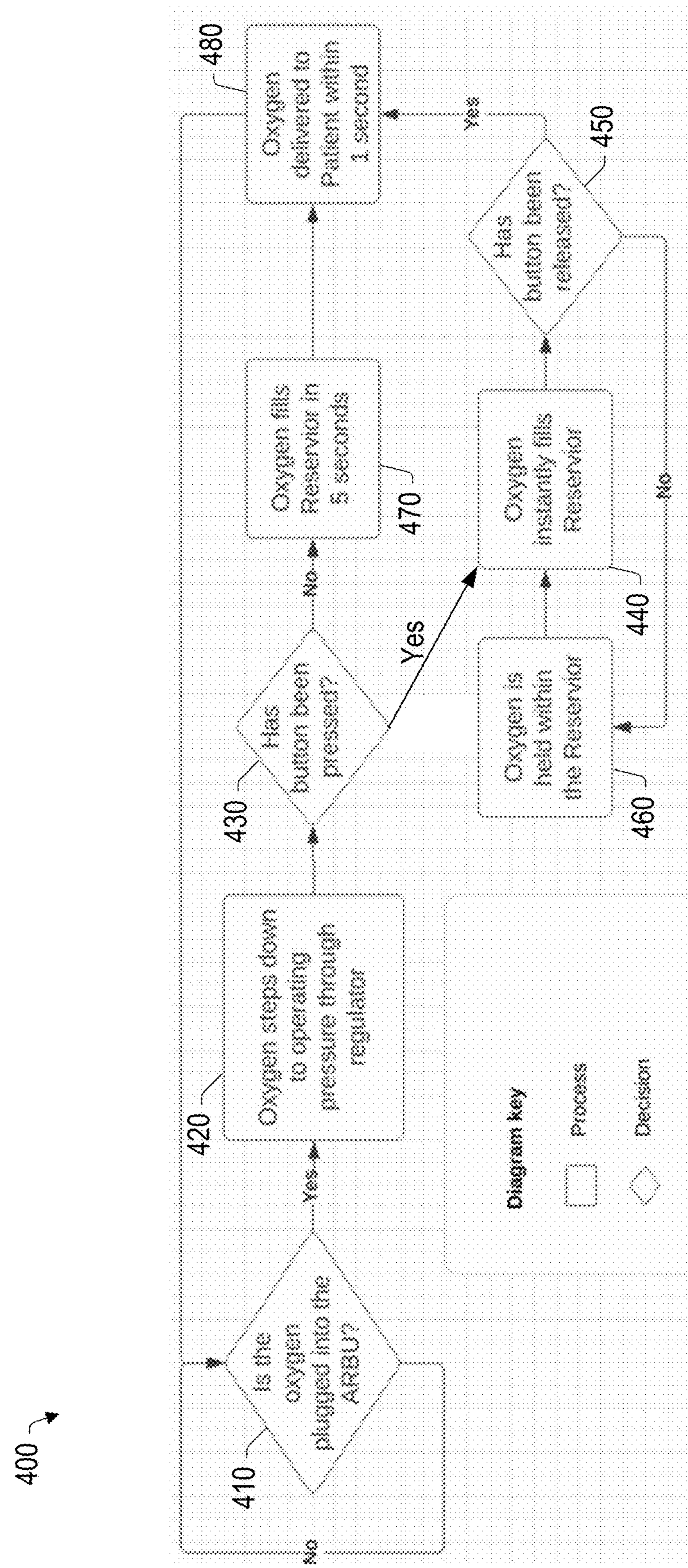

400
410
Is the oxygen plugged into the ARBU?
No
Yes
420
Oxygen steps down to operating pressure through regulator
430
Has button been pressed?
No
Yes
470
Oxygen fills Reservior in 5 seconds
480
Oxygen delivered to Patient within 1 second
440
Oxygen instantly fills Reservior
450
Has button been released?
Yes
No
460
Oxygen is held within the Reservior
Diagram key
Process
Decision

FIG. 4

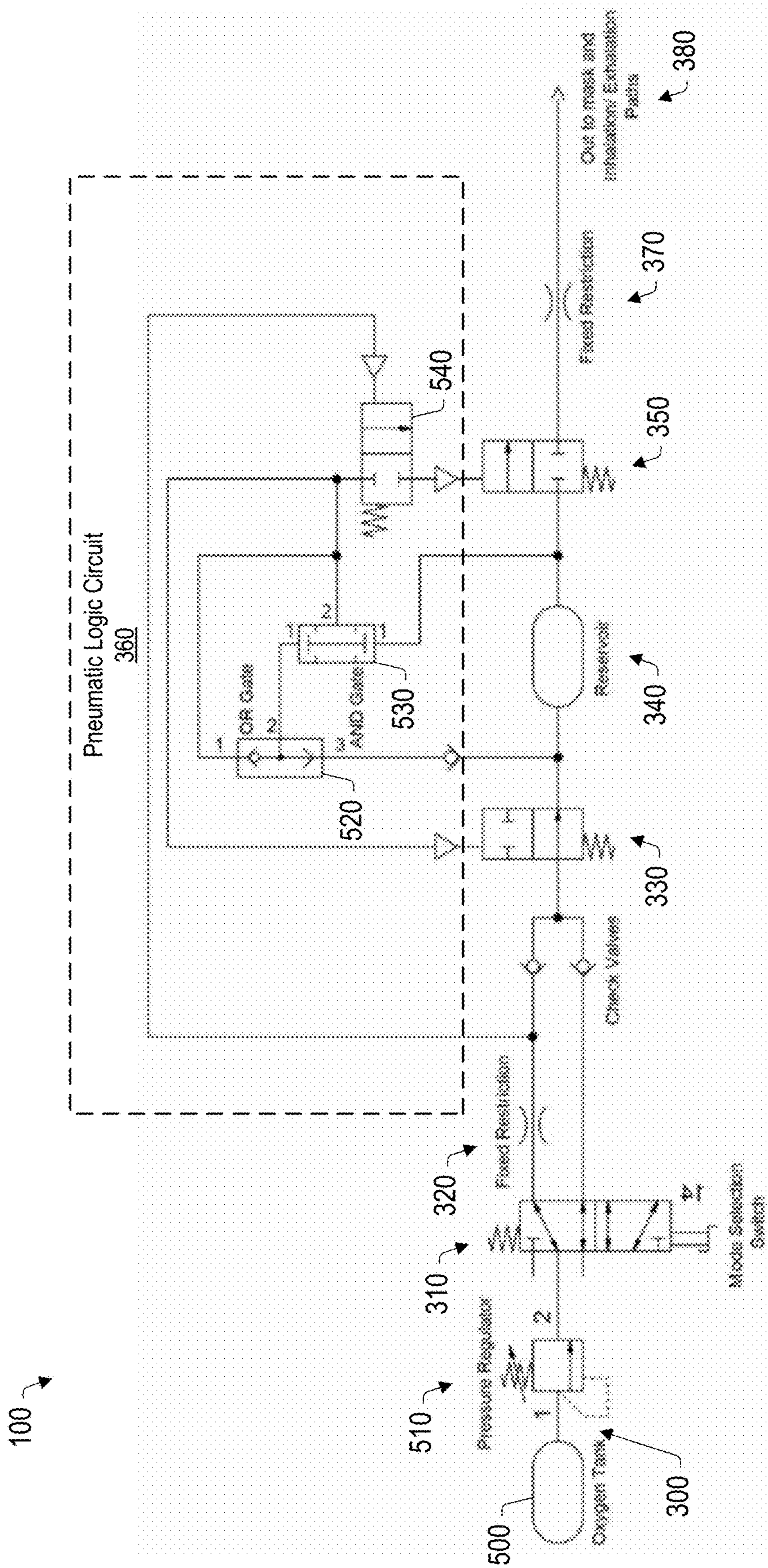

100
Pneumatic Logic Circuit
360
OR Gate
AND Gate
Reservoir
Check Valves
Fixed Restriction
Pressure Regulator
Oxygen Tank
500
300
510
310
140
320
330
520
530
340
350
540
370
380

FIG. 5

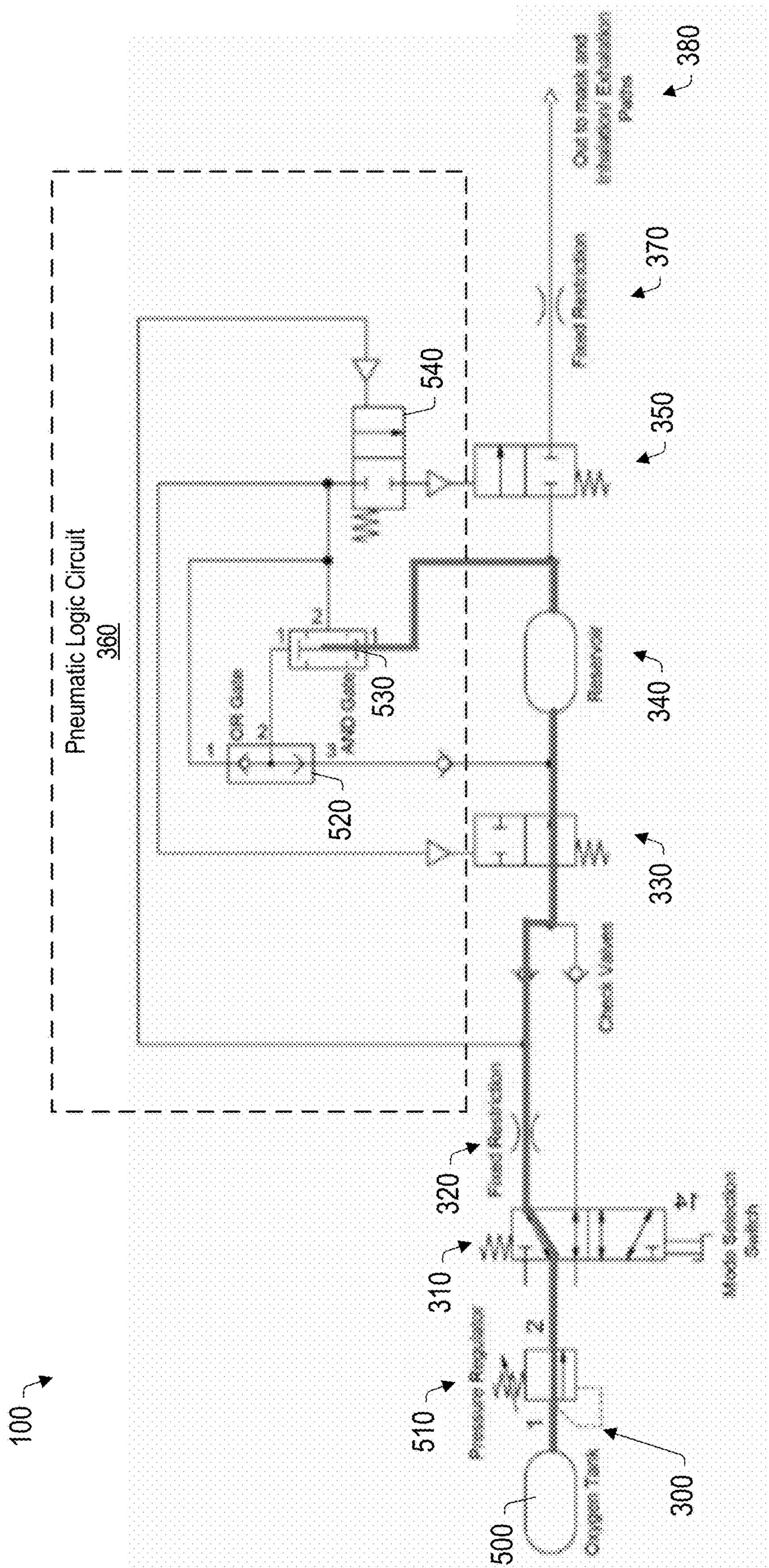

100
Pneumatic Logic Circuit
360
500
300
510
310
140
320
330
520
530
340
540
350
370
380
1
2
1
2
3
1
2

FIG. 6

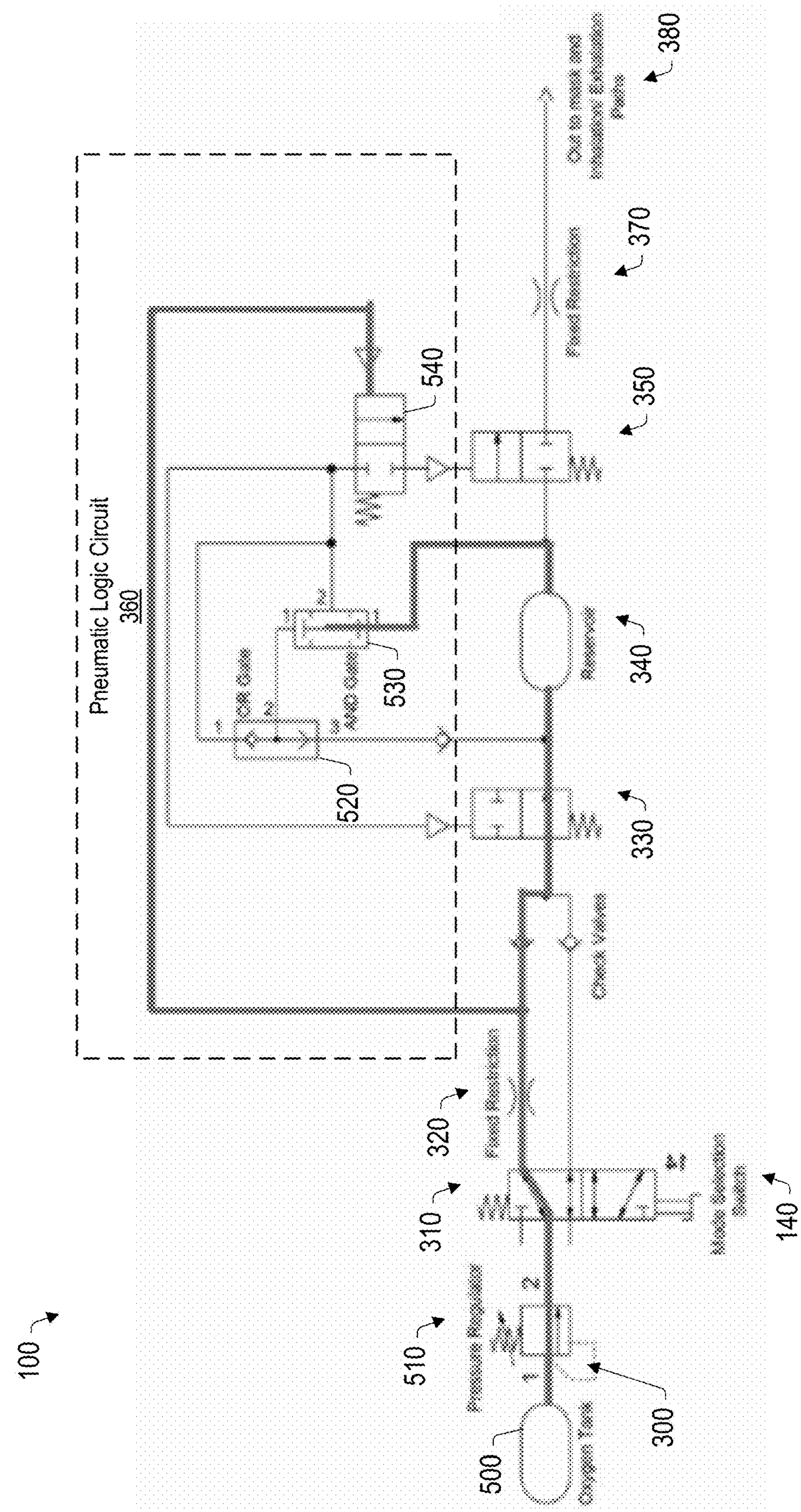

100
Pneumatic Logic Circuit
360
500
510
300
310
140
320
330
520
530
340
350
540
370
380

FIG. 7

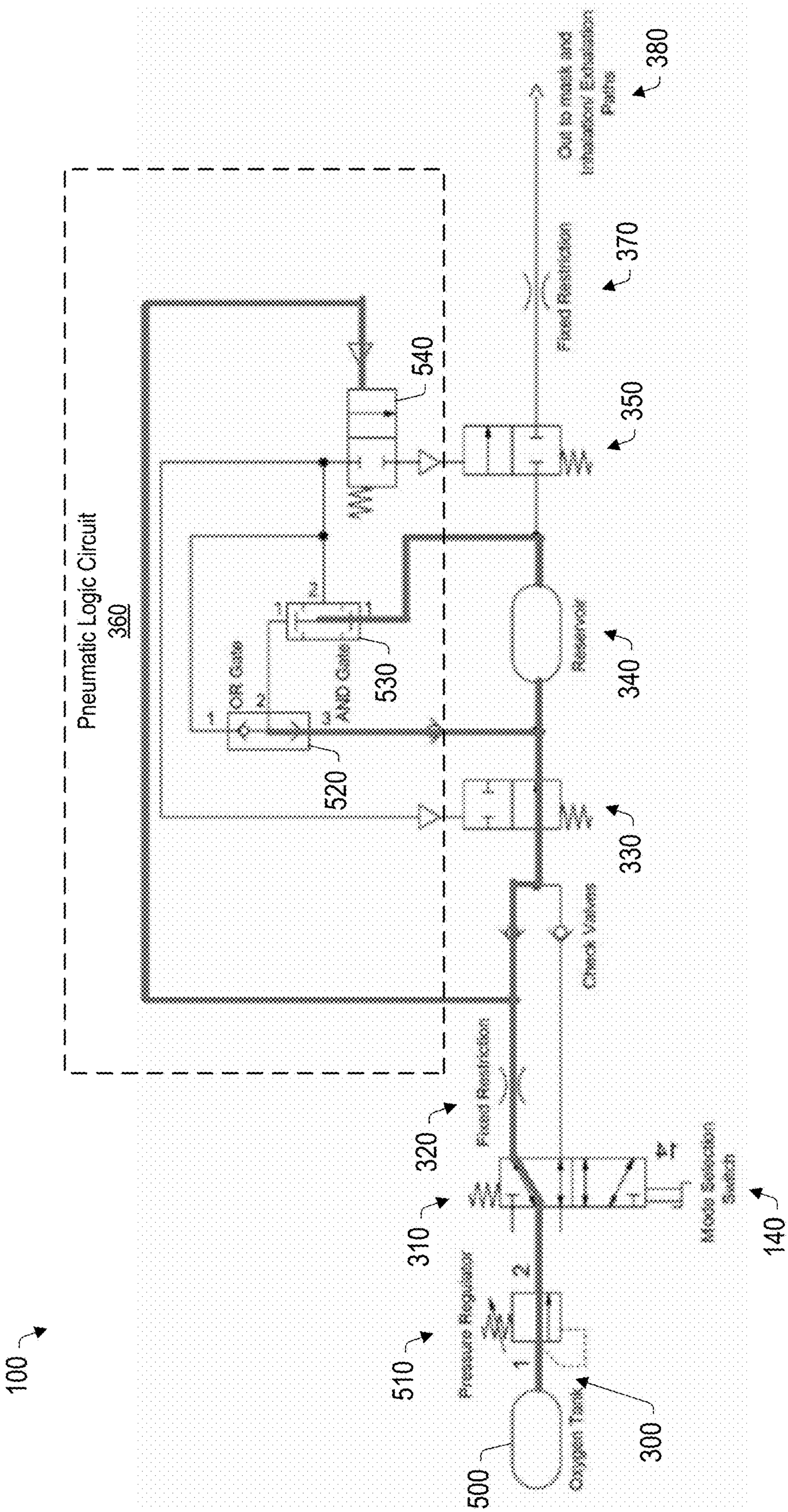

100
Pneumatic Logic Circuit
360
500
Oxygen Tank
300
510
Pressure Regulator
1
2
310
140
Mode Selection Switch
320
Fixed Restriction
Check Valves
330
520
OR Gate
1
2
3
530
AND Gate
340
Reservoir
540
350
370
Fixed Restriction
380

FIG. 8

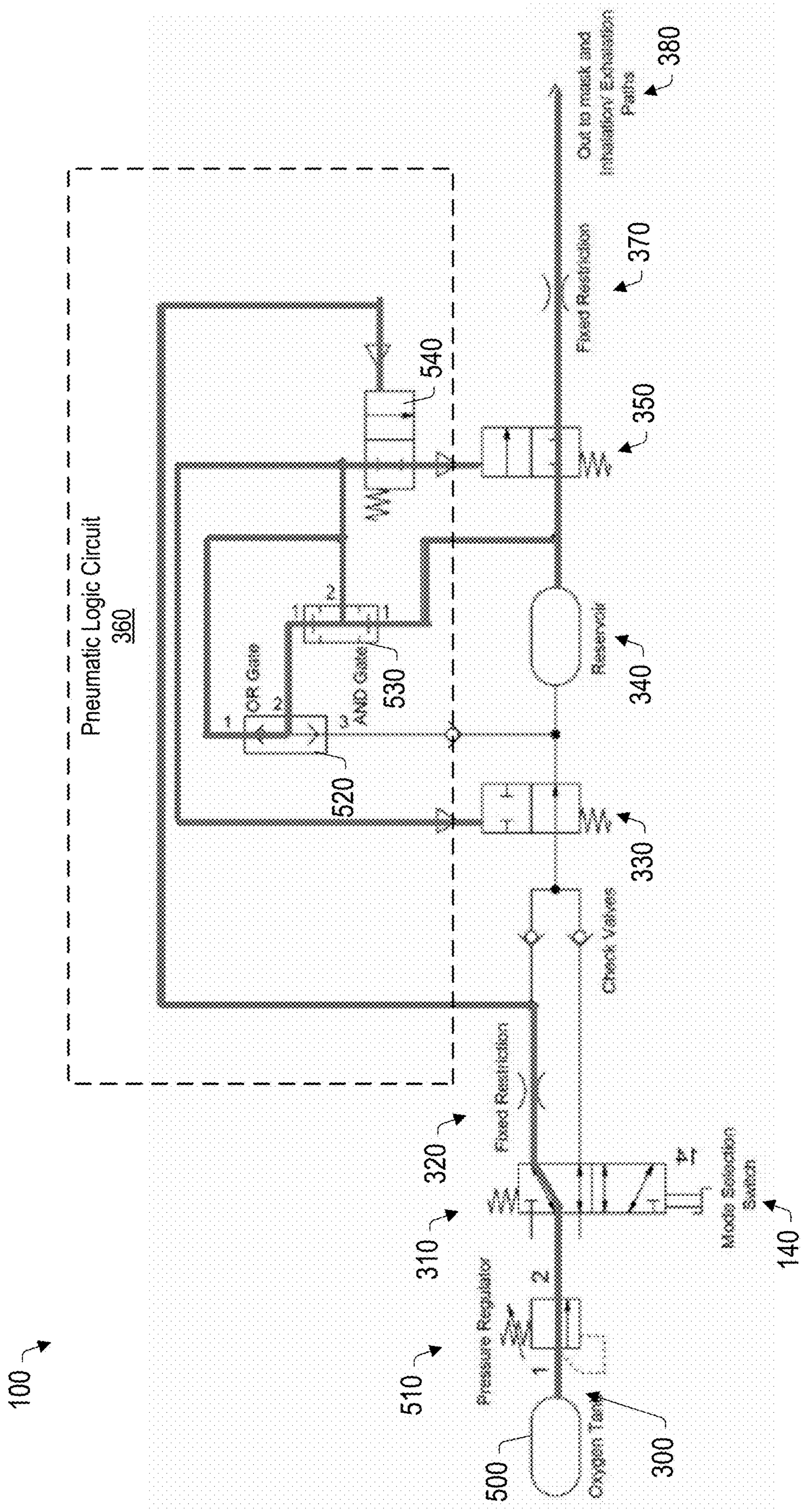

100
Pneumatic Logic Circuit
360
Out to mask and Inhalation/ Exhalation Paths
380
Fixed Restriction
370
540
350
Reservoir
340
AND Gate
530
OR Gate
520
330
Check Valves
Fixed Restriction
320
310
Mode Selection Switch
140
Pressure Regulator
510
Oxygen Tank
500
300

FIG. 9

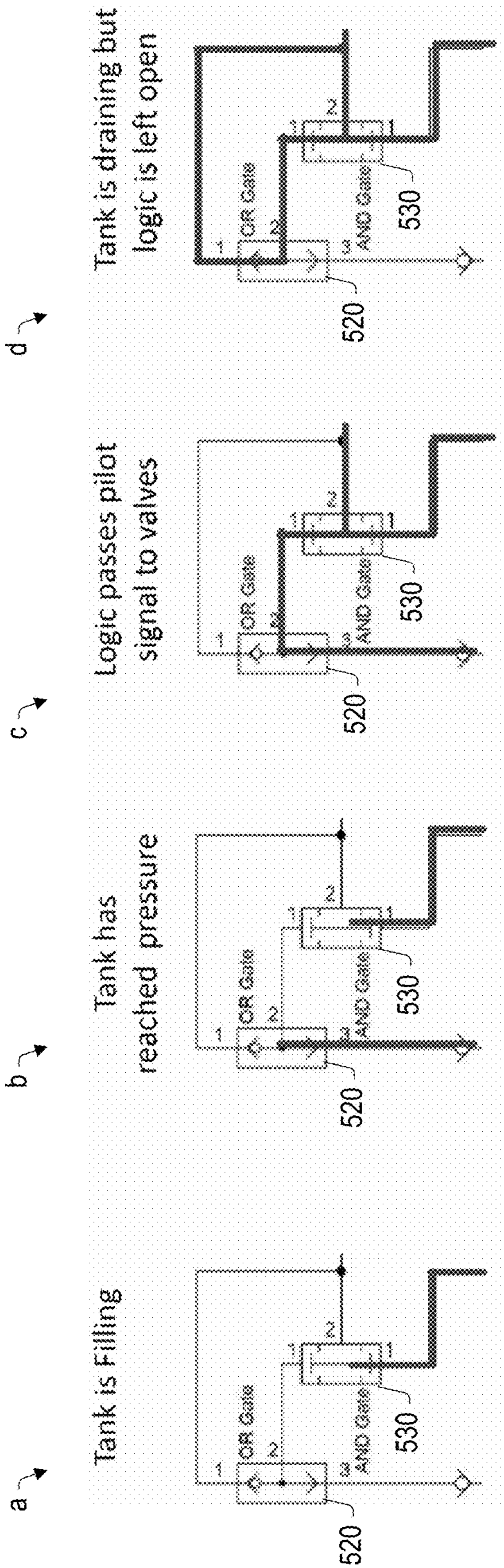

a
Tank is Filling
OR Gate
AND Gate
520
530
b
Tank has reached pressure
OR Gate
AND Gate
520
530
c
Logic passes pilot signal to valves
OR Gate
AND Gate
520
530
d
Tank is draining but logic is left open
OR Gate
AND Gate
520
530

FIG. 10

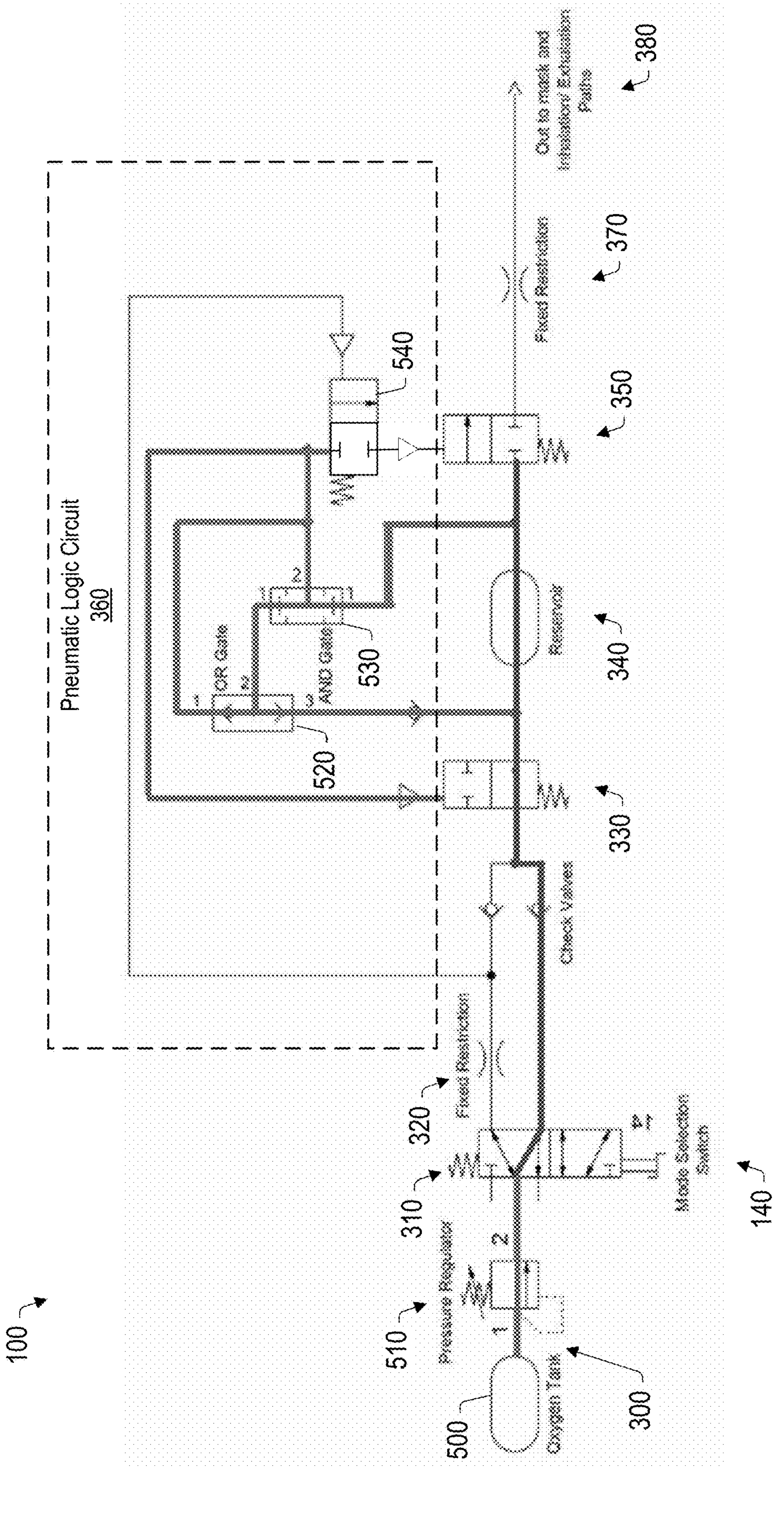

100
Pneumatic Logic Circuit
360
Out to mask and Inflation/ Extension Paths
380
370
Fixed Restriction
540
350
2
1
1
530
AND Gate
OR Gate
1
3
520
Reservoir
340
330
Check Valves
Fixed Restriction
320
310
Mode Selection Switch
140
2
1
Pressure Regulator
510
300
Oxygen Tank
500

FIG. 11

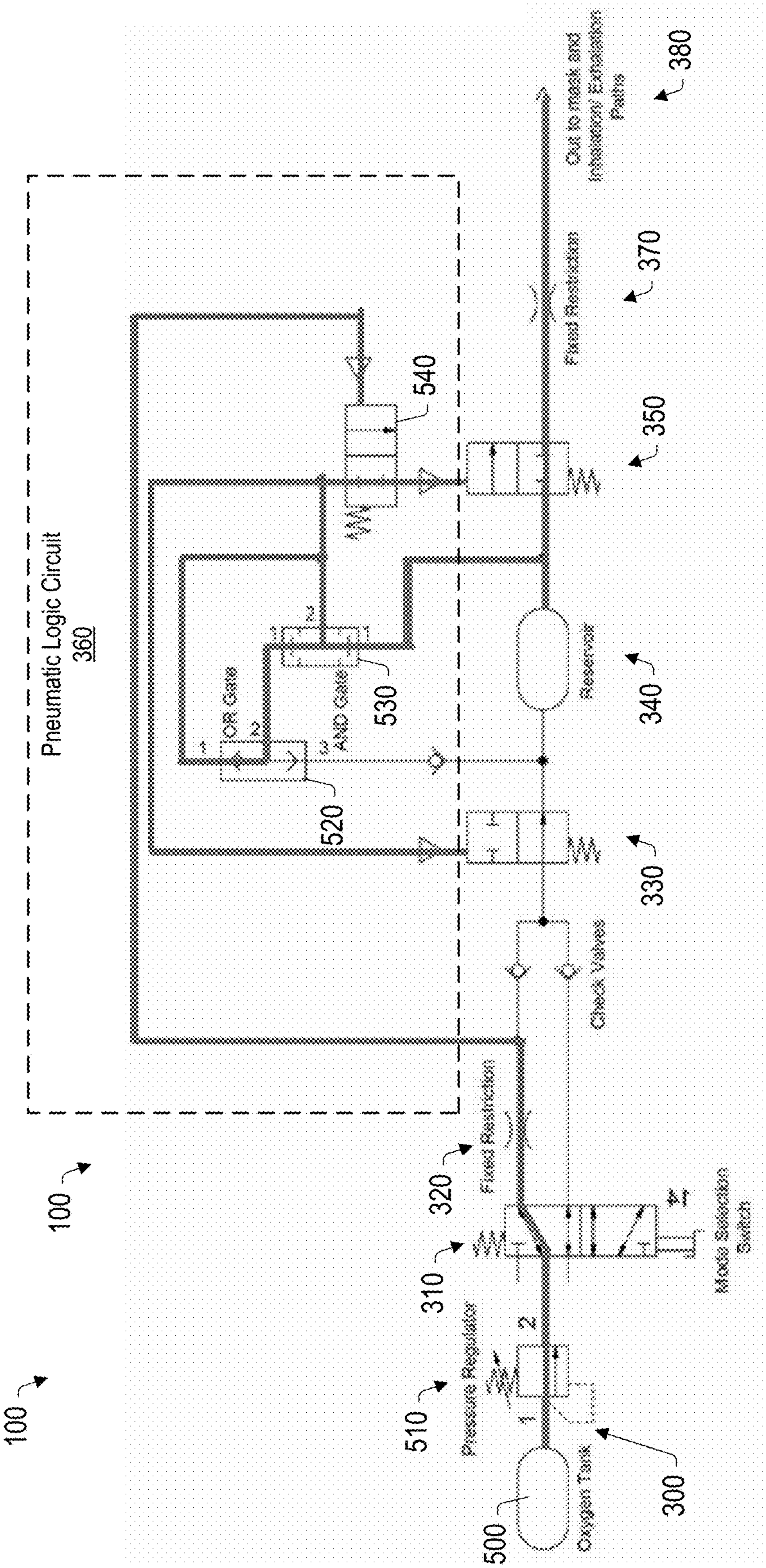

100
100
Pneumatic Logic Circuit
360
500
Oxygen Tank
300
510
Pressure Regulator
1
2
310
320
Fixed Restriction
Mode Selection Switch
140
Check Valves
330
520
OR Gate
1
2
3
530
AND Gate
340
Reservoir
350
540
370
Fixed Restriction
380
Out to mask and Inhalation/ Exhalation Paths

FIG. 12

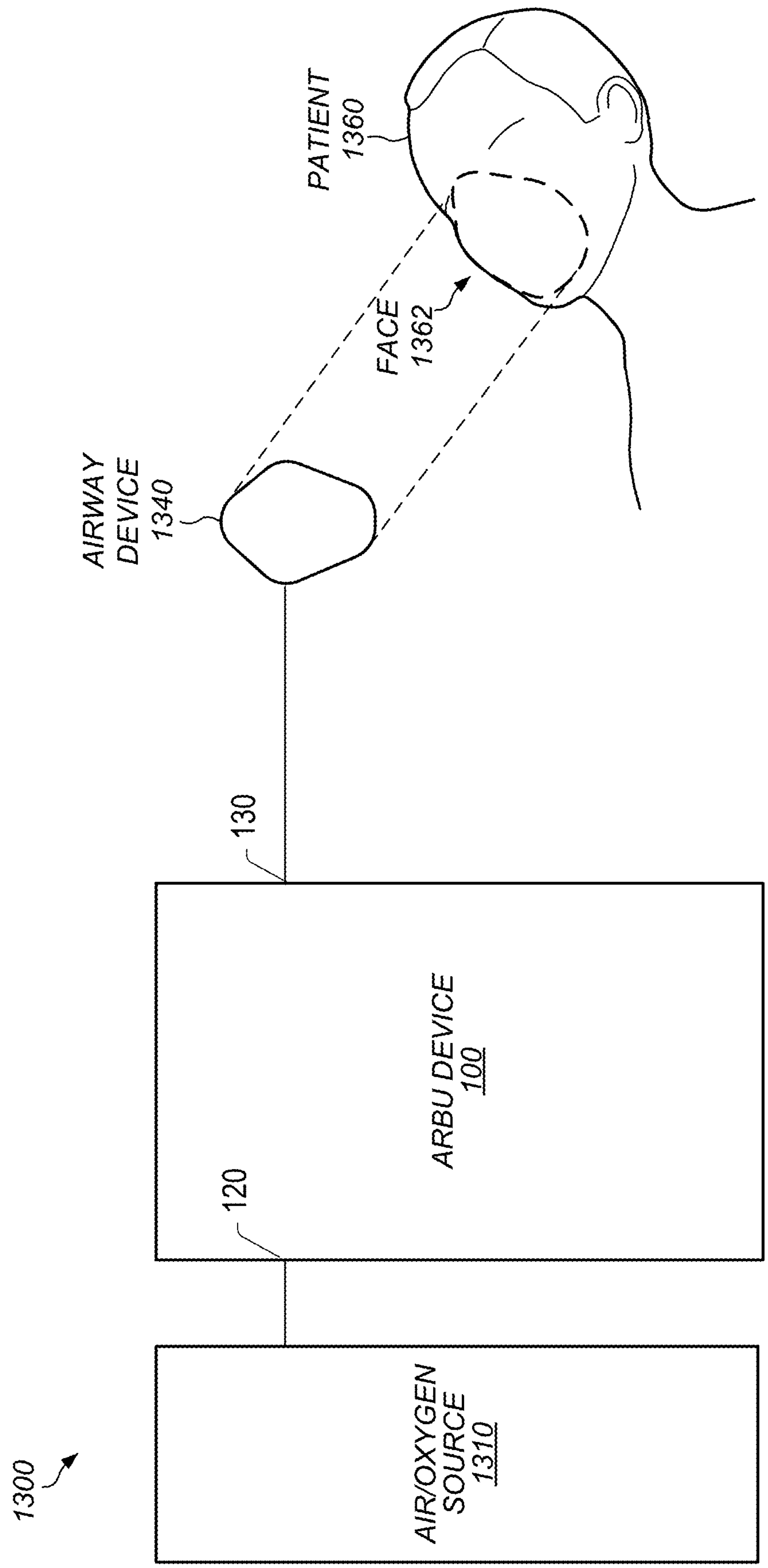

1300
AIR/OXYGEN SOURCE 1310
120
ARBU DEVICE 100
130
AIRWAY DEVICE 1340
FACE 1362
PATIENT 1360

FIG. 13

PORTABLE AUTOMATIC RESCUE BREATHING UNIT

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Provisional Patent Application Ser. No. 63/555,400 entitled "PORTABLE AUTOMATIC RESCUE BREATHING UNIT" filed Feb. 20, 2024, the entirety of which is incorporated herein by reference.

BACKGROUND

1. Field of the Invention

[0002] The disclosed embodiments generally relate to a system and method for providing air/oxygen (e.g., breathing fluid) to a subject, and more particularly to a mask keying mechanism for determining breath profile and parameters to be delivered by the air/oxygen system.

2. Description of Related Art

[0003] Medical emergencies often call on one or more people to provide life-saving support. For example, CPR may be performed when a person is not breathing, or breathing inadequately (e.g., during cardiac arrest). CPR generally involves providing air into a person's lungs via the mouth, or mouth and nose, and/or performing a series of chest compressions. This may be performed repeatedly to help oxygenate and circulate the blood. Blowing air into the victim's mouth forces air into the lungs to replace spontaneous respiration and compressing the chest compresses the heart to maintain blood circulation. In a situation in which the heart has stopped beating, performing CPR is intended to maintain a flow of oxygenated blood to the brain and heart, thereby delaying tissue death and extending the opportunity for a successful resuscitation without permanent brain damage. Defibrillation and other advanced life support techniques may also be used to improve the outcome for a victim of cardiac arrest.

[0004] CPR techniques can vary depending on the person needing assistance. For example, administering CPR to an adult generally includes providing a set number of full breaths via the mouth, whereas administering CPR to an infant or child may require a larger number of smaller breaths or puffs via the mouth and/or nose. The lower pressure and larger numbers of breaths administered to an infant or child may reduce the likelihood of injury to the respiratory system of the infant or child. Similarly, the force used in administering the chest compressions is reduced when administering CPR to an infant or child. Accordingly, a person who administers CPR must consider several variables and remember a variety of protocols.

[0005] CPR is more effective the sooner it is initiated and thus, the time between the onset of the medical emergency and the time of initiating CPR may be critical. Brain cells may begin to die in as little as 4-6 minutes without an adequate supply of oxygen. Unfortunately, medical emergencies can, and often do, happen at locations that are remote to medical facilities and where no trained medical professionals are readily available and, thus, a by-stander may be in the best position to perform CPR.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Advantages of the present invention will become apparent to those skilled in the art with the benefit of the following detailed description of embodiments and upon reference to the accompanying drawings in which:

[0007] FIG. **1** depicts a perspective view of an ARBU device, according to some embodiments.

[0008] FIG. **2** depicts a transparent perspective view of internal components of an ARBU device, according to some embodiments.

[0009] FIG. **3** is a block diagram overview of an ARBU device, according to some embodiments.

[0010] FIG. **4** is a flowchart illustrating a user controlled operation of an ARBU device, according to some embodiments.

[0011] FIG. **5** is a schematic depiction of the pneumatic components of an ARBU device, according to some embodiments.

[0012] FIGS. **6**-**9** depict operation of an ARBU device according to the schematic of FIG. **5** when a switch is deactivated, according to some embodiments.

[0013] FIG. **10** depicts schematics of the various stages of operation of an OR gate and an AND gate, according to some embodiments.

[0014] FIGS. **11** and **12** depict operation of an ARBU device according to the schematic of FIG. **5** when a switch is activated, according to some embodiments.

[0015] FIG. **13** depicts an example representation of implementation of an ARBU device in treatment of a patient, according to some embodiments.

[0016] While the invention may be susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. The drawings may not be to scale. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but to the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

DETAILED DESCRIPTION OF EMBODIMENTS

[0017] When cardiac arrest occurs, the heart stops beating. The loss of heart function causes oxygen content, the amount of usable oxygen in the blood, to be depleted. Cardiopulmonary resuscitation (CPR) on the cardiac arrest victim is required immediately. CPR consists of delivering chest compressions and air/oxygen (rescue breaths) to the patient. The goal of CPR is for the return of spontaneous circulation of blood to the body. Developments have been made in automatic rescue breathing units (ARBUs) in the treatment of patients suffering cardiac arrest to increase the chances of survival. Even with the implementation of ARBUs, however, errors can be made, even by trained professionals, that may decrease the chances of survival. Errors may, for instance, be made in the rates and volumes of rescue breaths provided to the patient due to the complexities involved in remembering and delivering appropriate rates and volumes for different types (e.g., ages or sizes) of patients. Various embodiments of ARBU devices have been described in previous patent applications. For example, example ARBU devices are found in U.S. patent application

Ser. No. 18/525,346 to McCarthy et al., filed Nov. 30, 2023, which is incorporated by reference as if fully set forth herein.

[0018] The present disclosure contemplates various embodiments of an automatic rescue breathing unit (ARBU) device that includes a reservoir for building a pressure of air/oxygen for a rescue breath where filling and draining of the reservoir is automatically controlled by a pneumatic logic circuit. Draining of the reservoir provides a flow of air/oxygen (e.g., a rescue breath) to an airway device coupled to the outlet of the ARBU device. The airway device may, for instance, be placed on a face (e.g., mouth and/or nose) of a patient to provide rescue breaths to the patient. In some embodiments, the ARBU device includes a manually controlled valve that, when activated, expedites the filling process by switching flow into the reservoir to bypass the pneumatic logic circuit when filling the reservoir. The reservoir may not be drained by the pneumatic logic circuit while the manually controlled valve is activated. When the manually controlled valve is deactivated, the pneumatic logic circuit may then operate to drain the reservoir and provide rescue breath to the patient through the outlet of the ARBU device.

[0019] FIG. **1** depicts a perspective view of an ARBU device, according to some embodiments. In the illustrated embodiment, ARBU device **100** includes housing **110**, input port **120**, output port **130**, and manual override switch **140**. In various embodiments, as described herein, input port **120** is coupled to a source of air/oxygen (e.g., a source of breathing fluid). For instance, input port **120** may be coupled to a cylinder of pressurized oxygen or air. Output port **130** may be coupled to an airway device. As used herein, an "airway device" may include any of, but not be limited to, masks, endotracheal tubes, laryngeal mask airways, Igels, King airways, or any other airway device suitable for providing a flow or pulse of air (e.g., a rescue breath) to a patient. Manual override switch **140** may be, for example, a button or other manually operated control that can be operated to override/bypass the pneumatic logic circuit for filling a reservoir located inside ARBU device **100**.

[0020] FIG. **2** depicts a transparent perspective view of internal components of an ARBU device, according to some embodiments. In the illustrated embodiment, various internal components of ARBU device as shown by example within transparent housing **110**. The internal components may include, but not be limited to, connectors, manifolds, tubing, valves, gates, regulators, and tanks/reservoirs. One example component is NPT to push connector **200**, shown in the insets of FIG. **2**. Connector **200** may be coupled to manifold **210** to provide a connection between the manifold and tubing **220**.

[0021] FIG. **3** is a block diagram overview of an ARBU device, according to some embodiments. In the illustrated embodiment ARBU device **100** includes inlet **300**, manual control valve **310**, flow restriction valve **320**, upstream valve **330**, reservoir **340**, downstream valve **350**, pneumatic logic circuit **360**, flow restriction valve **370**, and outlet **380**. In various embodiments, a flow of air/oxygen enters ARBU device at inlet **300**. The flow then passes to manual control valve **310**. Manual control valve **310** may be operated according to manual input provided through switch **140**. For instance, in certain embodiments, when switch **140** is not activated, manual control valve **310** is in its normal state and flow passes to flow restriction valve **320**. When switch **140** is activated, manual control valve switches the flow to bypass flow restriction valve **320** and proceed directly to upstream valve **330**, which, as described below, is a normally open valve thus allowing flow directly into reservoir **340**.

[0022] In various embodiments, flow restriction valve **320** is a valve controls a flow of air/oxygen through the valve. For instance, flow restriction valve **320** sets a predetermined flow rate through the valve. Accordingly, the predetermined flow rate of flow restriction valve **320** may set a predetermined time period for filling reservoir **340** based on a volume (e.g., a defined volume) of the reservoir when upstream valve **330** is open and downstream valve **350** is closed. In some embodiments, the predetermined time period for filling reservoir **340** is about 5 seconds, which is determined based on the predetermined flow rate of flow restriction valve **320** and the defined volume of the reservoir.

[0023] In certain embodiments, upstream valve **330** is a normally open valve coupled to an inlet of reservoir **340**. Upstream valve **330** may also be coupled to and receive control signal inputs (e.g., pneumatic control signal inputs) from pneumatic logic circuit **360**. In some embodiments, a check valve may be placed between flow restriction valve **320** and upstream valve **330**. As shown in FIG. **3**, upstream valve **330** is coupled to the inlet of reservoir **340**. Accordingly, upstream valve **330** turns on/off the flow into reservoir **340**.

[0024] In various embodiments, downstream valve **350** is coupled to the outlet of reservoir **340**. In certain embodiments, downstream valve **350** is a normally closed valve. Thus, downstream valve **350** normally closes off flow out of reservoir **340** and is opened to allow flow to pass through flow restriction valve **370** to outlet **380**. Accordingly, operation of downstream valve **350** controls the flow of rescue breaths out of ARBU device **100** to outlet **380**, which is coupled to an airway device placed on the patient.

[0025] In various embodiments, flow restriction valve **370** is a valve controls a flow of air/oxygen through the valve. For instance, flow restriction valve **370** sets a predetermined flow rate through the valve. Accordingly, the predetermined flow rate of flow restriction valve **370** may set a predetermined time period for draining reservoir **340** based on a defined volume of the reservoir when downstream valve **350** is open. In some embodiments, the predetermined time period for draining the reservoir **340** is about 1 second, which is determined based on the predetermined flow rate of flow restriction valve **370** and the defined volume of the reservoir. The time period of 1 second is an approximate time period for typical rescue breaths.

[0026] In various embodiments, as shown in FIG. **5**, pneumatic logic circuit **360** is implemented to pneumatically control operation of upstream valve **330** and downstream valve **350**. In certain embodiments, pneumatic logic circuit **360** includes various components that control operation of upstream valve **330** and downstream valve **350** based on pneumatic information from reservoir **340** (e.g., flow at the inlet and the outlet of the reservoir). In some embodiments, pneumatic logic circuit includes a coupling to the flow between flow restriction valve **320** and upstream valve **330** and before the check valve to pneumatically receive information about flow from restriction valve **320** to upstream valve **330**.

[0027] FIG. **4** is a flowchart illustrating a user controlled operation of ARBU device **100**, according to some embodiments. In the illustrated embodiment, operation process **400** for ARBU device **100** begins at **410** with determining whether oxygen (or air) is plugged into (e.g., an oxygen cylinder is coupled to and opened to) the ARBU device. If "No", then the user may wait to operate the rest of the process until oxygen is plugged in. If "Yes", then process **400** continues at **420** with oxygen being stepped down to the proper operating pressure for ARBU device **100** by a pressure regulator (e.g., pressure regulator **510**, shown in FIG. **5**).

[0028] After pressure is stepped down at **420**, process **400** may include whether switch **140** has been activated at **430** and manual control valve **310** is activated. As shown in FIG. **4**, "Yes" at **430** sends process **400** to **440** where oxygen rapidly (e.g., "instantly") fills reservoir **340**. At **440**, as described herein, activation of switch **140** and manual control valve **310** ("Yes") sends the air/oxygen flow directly to upstream valve **330**, bypassing flow restriction valve **320**, to rapidly fill reservoir **340** at a fast rate (e.g., on the order of a second or less and faster than filling with flow through the flow restriction valve **320**). Then at **450**, it may be determined whether the button (e.g., switch **140**) has been released and manual control valve is deactivated to return the flow to be through flow restriction valve **320**. If "No" at **450**, then oxygen is held within the reservoir at **460**. Oxygen may be held within the reservoir until the button (switch **140**) is released and it becomes "Yes" at **450**, thus having process **400** procced to delivering oxygen to the patient by draining reservoir **340** (e.g., releasing air/oxygen from the reservoir) at **480**.

[0029] Returning back to the decision at **430**, when the button (e.g., switch **140**) is not activated at **430** ("No"), then oxygen fills reservoir **340** according to the flow through flow restriction valve **320** (e.g., in a time period of about 5 seconds) at **470**. After reservoir **340** is filled, process **400** then goes to **480** where oxygen is delivered to the patient by draining the reservoir.

[0030] FIG. **5** is a schematic depiction of the pneumatic components of ARBU device **100**, according to some embodiments. In the illustrated embodiment, oxygen tank **500** is coupled to ARBU device **100**. ARBU device **100** includes inlet **300**, pressure regulator **510**, manual control valve **310**, flow restriction valve **320**, upstream valve **330**, reservoir **340**, downstream valve **350**, pneumatic logic circuit **360**, flow restriction valve **370**, and outlet **380**.

[0031] In certain embodiments, pneumatic logic circuit **360** includes pneumatic OR gate **520**, pneumatic AND gate **530**, and normally closed valve **540**. As shown in FIG. **5**, one of the inputs of OR gate **520** ("3") is coupled to the inlet of reservoir **340**. The other input of OR gate **520** ("1") is coupled to the output of AND gate **530** ("2"). The output of OR gate **520** ("2") is coupled to one of the inputs of AND gate **530** ("1"). The output of AND gate **530** ("2") is also coupled to a control input of upstream valve **330** and the inlet of normally closed valve **540**. The other input of AND gate **530** ("1") is coupled to the outlet of reservoir **340**. The control input of normally closed valve **540** is coupled to the flow between flow restriction valve **320** and upstream valve **330**. The outlet of normally closed valve **540** is coupled to the control input of downstream valve **350**.

[0032] FIGS. **6-9** depict operation of ARBU device **100** according to the schematic of FIG. **5** when switch **140** is deactivated (e.g., manual control valve **310** is not activated), according to some embodiments. Flow of oxygen (or air) is shown by the thickened lines in the illustrated embodiments. As shown in FIG. **6-9**, with switch and manual control valve **310** not activated, flow of oxygen goes through flow restriction valve **320**. For instance, as shown in FIG. **6**, flow initially proceeds from oxygen tank **500**, through pressure regulator **510**, through manual control valve **310**, through flow restriction valve **320**, and through upstream valve **330** (normally open) to reservoir **340**. With downstream valve **350** being normally closed, a pneumatic signal from the outlet of reservoir **340** is received at the input to AND gate **530**.

[0033] Flow continues into reservoir **340** until the reservoir is filled. When reservoir **340** is filled, the excess flow provides a pneumatic signal to the control input of normally closed valve **540** in pneumatic logic circuit **360** from the connection between flow restriction valve **320** and upstream valve **330**, as shown in FIG. **7**. The control input at normally closed valve **540** causes the valve to open. Soon after, or around the same time, the excess flow also provides a pneumatic signal from the inlet of reservoir **340** to the input of OR gate **520**, as shown in FIG. **8**. This provides an indication that reservoir **340** is at full pressure (e.g., the reservoir is fully filled to a maximum pressure and/or the reservoir is filled to where the breathing fluid (air/oxygen) stops flowing into the reservoir).

[0034] With the pneumatic signal input received at OR gate **520**, OR gate **520** then provides an output pneumatic signal to AND gate **530**, as shown in FIG. **9**. As AND gate **530** is already receiving pneumatic signal input from the outlet of reservoir **340** at its other input, AND gate **530** then outputs a pneumatic signal. The pneumatic signal output of AND gate **530** is received at the other input of OR gate **520**, which continues the pneumatic signal output of the OR gate. The pneumatic signal of AND gate **530** is also sent to the control input of upstream valve **330**, which causes the upstream valve to close. The pneumatic signal output of AND gate **530** is further sent to the inlet of normally closed valve **540**, which is open based on receiving the pneumatic signal from the flow between flow restriction valve and upstream valve **330**. Accordingly, the pneumatic signal of AND gate **530** passes through normally closed valve **540** and is received at the control input of downstream valve **350**, which causes the downstream valve to open and send flow of oxygen (or air) from reservoir **340** through flow restriction valve **370** and to outlet **380** until the reservoir is drained. After reservoir **340** is drained of air/oxygen (e.g., the breathing fluid (air/oxygen) stops flowing out of the reservoir), AND gate **530** will reset, which causes resetting of all the gates and valves back to the original state to wait for the initial flow of air/oxygen, as shown in FIG. **6**. In some embodiments, reservoir **340** is considered to be "drained of air/oxygen" when the a pressure in the reservoir is below a minimum pressure for flow (e.g., a pressure below which flow of air/oxygen out of the reservoir is stopped).

[0035] FIG. **10** depicts schematics of the various stages of operation of OR gate **520** and AND gate **530**, according to some embodiments. In (a), reservoir **340** is filling and a pneumatic signal is only received at one of the inputs to AND gate **530**. In (b), reservoir **340** has reached full pressure and pneumatic signals are received at the inputs to both OR gate **520** and AND gate **530**. At (c), the pneumatic signal output of OR gate **520** is received at AND gate **530** such that the AND gate provides an output pneumatic signal to coupled valves and the other input of the OR gate. At (d), with the pneumatic signal output of AND gate **530** being received at one of the inputs of OR gate **520**, the pneumatic logic is left open while reservoir **340** drains. As described above, the pneumatic logic remains open until reservoir **340** fully drains, at which point the pneumatic signal at the lower input of AND gate **530** is turned off and the pneumatic logic closes and resets the system.

[0036] FIGS. **11** and **12** depict operation of ARBU device **100** according to the schematic of FIG. **5** when switch **140** is activated (e.g., manual control valve **310** is activated), according to some embodiments. Flow of oxygen (or air) is shown by the thickened lines in the illustrated embodiments. As shown in FIG. **11**, with switch **140** and manual control valve **310** activated, flow of oxygen a second flow line connected to upstream valve **330** that bypasses flow restriction valve **320**. With the bypassing of flow restriction valve **320**, reservoir **340** fills rapidly (e.g., on the order of a second or less) and pneumatic signal inputs are quickly received at the inputs of OR gate **520** and AND gate **530** from the inlet and outlet of reservoir **340**, respectively. Accordingly, a pneumatic signal is received at upstream valve **330** to close the valve. However, normally closed valve **540** remains closed because there is no pneumatic signal input at the control input to normally closed valve **540** and thus the pneumatic signal from the output of AND gate **530** is not passed through the valve to downstream valve **350**.

[0037] Normally closed valve **540** remains closed as long as switch **140** and manual control valve **310** are activated since there is no connection to the flow line bypassing flow restriction valve **320**. Thus, in order for a breath to be released (e.g., downstream valve **350** to be opened), switch **140** and manual control valve **310** need to be deactivated (e.g., the button of switch **140** is released). When switch **140** and manual control valve **310** are deactivated, flow is returned to the flow line of flow restriction valve **320** and the pneumatic signal is received at normally closed valve **540**, opening the valve and providing the pneumatic signal from the output of AND gate **530** to the control input of downstream valve **350**, as shown in FIG. **12**. Note that the schematic of FIG. **12** and the providing of the rescue breath is substantially similar to the schematic and breath providing depicted in FIG. **9**.

[0038] As described herein, ARBU device **100** is a device capable of providing controlled volumes of breath to a patient in a small form factor. ARBU device **100** includes a reservoir with a defined volume that is filled to provide a specified volume of air/oxygen to the patient at a predetermined flow rate. Additionally, ARBU device **100** allows for a user to manually control the device to provide rapid filling of the reservoir and then release the breath to the patient based on the manual control.

[0039] FIG. **13** depicts an example representation of implementation of ARBU device in treatment of patient **1360**, according to some embodiments. In the illustrated embodiment of ARBU system **1300**, device **100** is coupled to air/oxygen source **1310**. Device **100** is being implemented in the treatment of patient **1360**, shown with face **1362**. In various embodiments, device **100** is a portable system that is transported to a location of patient **1360**.

[0040] In various embodiments, source **1310** is coupled to input port **120** (e.g., inlet) of device **100**. Source **1310** is a source capable of providing pressurized air/oxygen for use by device **100**. As used herein "pressurized air/oxygen" refers to air/oxygen having a pressure that promotes the flow of the air/oxygen from device **100** into the lungs of patient **1360**. In some embodiments, pressurized air/oxygen may have a pressure that is above a minimum-pressure threshold, such as 20 centimeters of water (cmH_2O) above ambient air pressure.

[0041] In certain embodiments, source **1310** is a cylinder containing pressurized air/oxygen. The pressure of the air/oxygen may be set significantly above the minimum-pressure threshold such that the air/oxygen in the cylinder is maintained above the minimum-pressure threshold as the air/oxygen is expelled from the cylinder and the pressure of the air/oxygen in the source **1310** drops as a function of the air/oxygen expelled from the cylinder. Source **1310** may include a mechanical device, such as a compressor, configured to move and/or pressurize the air/oxygen. Such a mechanical device may be used to pressurize and/or fill a cylinder of the source **1310**. In one embodiment, source **1310** may include the mechanical device to move the air from the cylinder to the subject.

[0042] During treatment (e.g., resuscitation) of patient **1360**, airway device **1340** (e.g., a mask) is coupled to face **1362**, or applied to the airway, of the patient. Airway device **1340** is coupled to output port **130** (e.g., outlet) of ARBU device **100**. In various embodiments, ARBU device **100** provides one or more rescue breaths to patient **1360** through airway device **1340** according to the embodiments described herein.

[0043] The order of the methods may be changed, and various elements may be added, reordered, combined, omitted, modified, etc. Various modifications and changes may be made as would be obvious to a person skilled in the art having the benefit of this disclosure. The various embodiments described herein are meant to be illustrative and not limiting. Many variations, modifications, additions, and improvements are possible. Accordingly, plural instances may be provided for components described herein as a single instance. Boundaries between various components, operations and data stores are somewhat arbitrary, and particular operations are illustrated in the context of specific illustrative configurations. Other allocations of functionality are envisioned and may fall within the scope of claims that follow. Finally, structures and functionality presented as discrete components in the example configurations may be implemented as a combined structure or component. These and other variations, modifications, additions, and improvements may fall within the scope of embodiments as defined in the claims that follow.

[0044] Further modifications and alternative embodiments of various aspects of the invention will be apparent to those skilled in the art in view of this description. Accordingly, this description is to be construed as illustrative only and is for the purpose of teaching those skilled in the art the general manner of carrying out the invention. It is to be understood that the forms of the invention shown and described herein are to be taken as examples of embodiments. Elements and materials may be substituted for those illustrated and described herein, parts and processes may be reversed or omitted, and certain features of the invention may be utilized independently, all as would be apparent to one skilled in the art after having the benefit of this description of the invention. Changes may be made in the elements described herein without departing from the spirit and scope of the invention as described in the following claims. The words "include", "including", and "includes" mean including, but not limited to. As used throughout this application, the singular forms "a", "an" and "the" include plural referents unless the content clearly indicates otherwise. Thus, for example, reference to "a mask" includes a combination of two or more masks. The term "coupled" means directly or indirectly connected.

What is claimed is:

1. A rescue breath apparatus, comprising:
- a ventilator device configured to be coupled to a breathing fluid source, wherein the ventilator device includes:
  - a fluid inlet configured to be coupled to the breathing fluid source;
  - a pressure regulator configured to control a pressure of the breathing fluid entering the apparatus through the fluid inlet;
  - a reservoir having a defined volume, the reservoir having an inlet and an outlet;
  - an upstream valve coupled to the inlet of the reservoir;
  - a downstream valve coupled to the outlet of the reservoir;
  - a pneumatic flow logic circuit coupled to the reservoir, the upstream valve, and the downstream valve, wherein the pneumatic flow logic circuit is configured to control operation of the upstream valve and the downstream valve to fill the reservoir with the breathing fluid and drain the reservoir of the breathing fluid based on a flow of the breathing fluid into and out of the reservoir;
  - a manually controlled valve coupled between the pressure regulator and the upstream valve, wherein the manually controlled valve, when activated, bypasses the pneumatic flow logic circuit to fill the reservoir; and
  - a fluid outlet coupled to the downstream valve, wherein the outlet is configured to be coupled to an airway device for a patient.

2. The apparatus of claim **1**, further comprising:
- a first flow control valve coupled between the pressure regulator and the upstream valve; and
- a second flow control valve coupled between the downstream valve and the outlet.

3. The apparatus of claim **2**, wherein the manually controlled valve bypasses the first flow control valve to fill the reservoir when activated.

4. The apparatus of claim **2**, wherein the first flow control valve restricts flow from the pressure regulator to the upstream valve to set a predetermined time period for filling the reservoir through the upstream valve.

5. The apparatus of claim **4**, wherein the predetermined time period for filling the reservoir is about 5 seconds.

6. The apparatus of claim **2**, wherein the second flow control valve restricts flow from the downstream valve to the outlet to set a predetermined time period for draining the reservoir through the downstream valve.

7. The apparatus of claim **6**, wherein the predetermined time period for draining the reservoir is about 1 second.

8. The apparatus of claim **1**, wherein the upstream valve is a normally open valve and the downstream valve is a normally closed valve.

9. The apparatus of claim **8**, wherein the pneumatic flow logic circuit includes:
- a pneumatic OR gate having:
  - a first input coupled between the upstream valve and the inlet of the reservoir;
  - a second input; and
  - an output;
- a pneumatic AND gate having:
  - a first input coupled between the outlet of the reservoir and the downstream valve;
  - a second input coupled to the output of the pneumatic OR gate; and
  - an output coupled to the second input of the pneumatic OR gate and a control input of the upstream valve;
- a second normally closed valve having:
  - an inlet coupled to the manually controlled valve and configured to receive flow then the manually controlled valve is not activated;
  - a control input coupled to the output of pneumatic AND gate; and
  - an outlet coupled to a control input of the downstream valve.

10. The apparatus of claim **9**, wherein the control input of the upstream valve closes the upstream valve in response to receiving a pneumatic signal from the output of the pneumatic AND gate.

11. The apparatus of claim **9**, wherein the control input of the downstream valve opens the downstream valve in response to receiving a pneumatic signal from the outlet of the second normally closed valve.

12. The apparatus of claim **1**, wherein the manually controlled valve switches flow between a first flow line, when not activated, and a second flow line, when activated, according to a manual actuation of the valve.

13. The apparatus of claim **12**, wherein the first flow line includes a first flow control valve coupled between the pressure regulator and the upstream valve, and wherein the first flow line is coupled to a second normally closed valve in the pneumatic flow logic circuit and to the upstream valve.

14. The apparatus of claim **12**, wherein the second flow line is directly coupled to the upstream valve.

15. The apparatus of claim **12**, further comprising check valves in the first flow line and the second flow line.

16. The apparatus of claim **1**, wherein the manually controlled valve inhibits opening of the downstream valve and draining of the reservoir when activated.

17. The apparatus of claim **1**, wherein the pneumatic flow logic circuit is configured to control operation of the upstream valve and the downstream valve to fill the reservoir with the breathing fluid and drain the reservoir of the breathing fluid based on a flow of the breathing fluid into and out of the reservoir in combination with the flow of the breathing fluid through the upstream valve and the downstream valve.

18. The apparatus of claim **1**, wherein the pneumatic flow logic circuit is configured to fill the reservoir with the breathing fluid until the reservoir is filled until the breathing fluid stops flowing into the reservoir and drain the reservoir of the breathing fluid until the breathing fluid stops flowing out of the reservoir.

19. A rescue breath apparatus, comprising:
- a ventilator device configured to be coupled to a breathing fluid source, wherein the ventilator device includes:
  - a fluid inlet configured to be coupled to the breathing fluid source;
  - a pressure regulator configured to control a pressure of the breathing fluid entering the apparatus through the fluid inlet;

a reservoir having a defined volume, the reservoir having an inlet and an outlet;

an upstream valve coupled to the inlet of the reservoir;

a downstream valve coupled to the outlet of the reservoir;

a pneumatic flow logic circuit coupled to the reservoir, the upstream valve, and the downstream valve, wherein the pneumatic flow logic circuit is configured to control opening and closing of both the upstream valve and the downstream valve to fill the reservoir with the breathing fluid and drain the reservoir of the breathing fluid based on a flow of the breathing fluid through a combination of the pneumatic flow logic circuit, the upstream valve, and the downstream valve;

a manually controlled valve coupled between the pressure regulator and the upstream valve, wherein the manually controlled valve, when activated, bypasses the pneumatic flow logic circuit to fill the reservoir; and

a fluid outlet coupled to the downstream valve, wherein the outlet is configured to be coupled to an airway device for a patient.

20. The apparatus of claim **19**, wherein the pneumatic flow logic circuit is configured to fill the reservoir with the breathing fluid until the reservoir is at full pressure and drain the reservoir of the breathing fluid until a pressure of the reservoir is below a minimum pressure for flow.

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