

United States Patent

Hay

[15] 3,703,172

[45] Nov. 21, 1972

[54] HEATED VAPORIZER ANESTHESIA MACHINE

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[73] Assignee: Airco, Inc.

[22] Filed: June 26, 1970

[21] Appl. No.: 56,073

Related U.S. Application Data

[63] Continuation of Ser. No. 671,741, Sept. 29, 1967, abandoned.

[52] U.S. Cl. 128/188

[51] Int. Cl. A61m 17/00

[58] Field of Search 128/188, 186, 204, 145.8, 142.2, 128/192, 191

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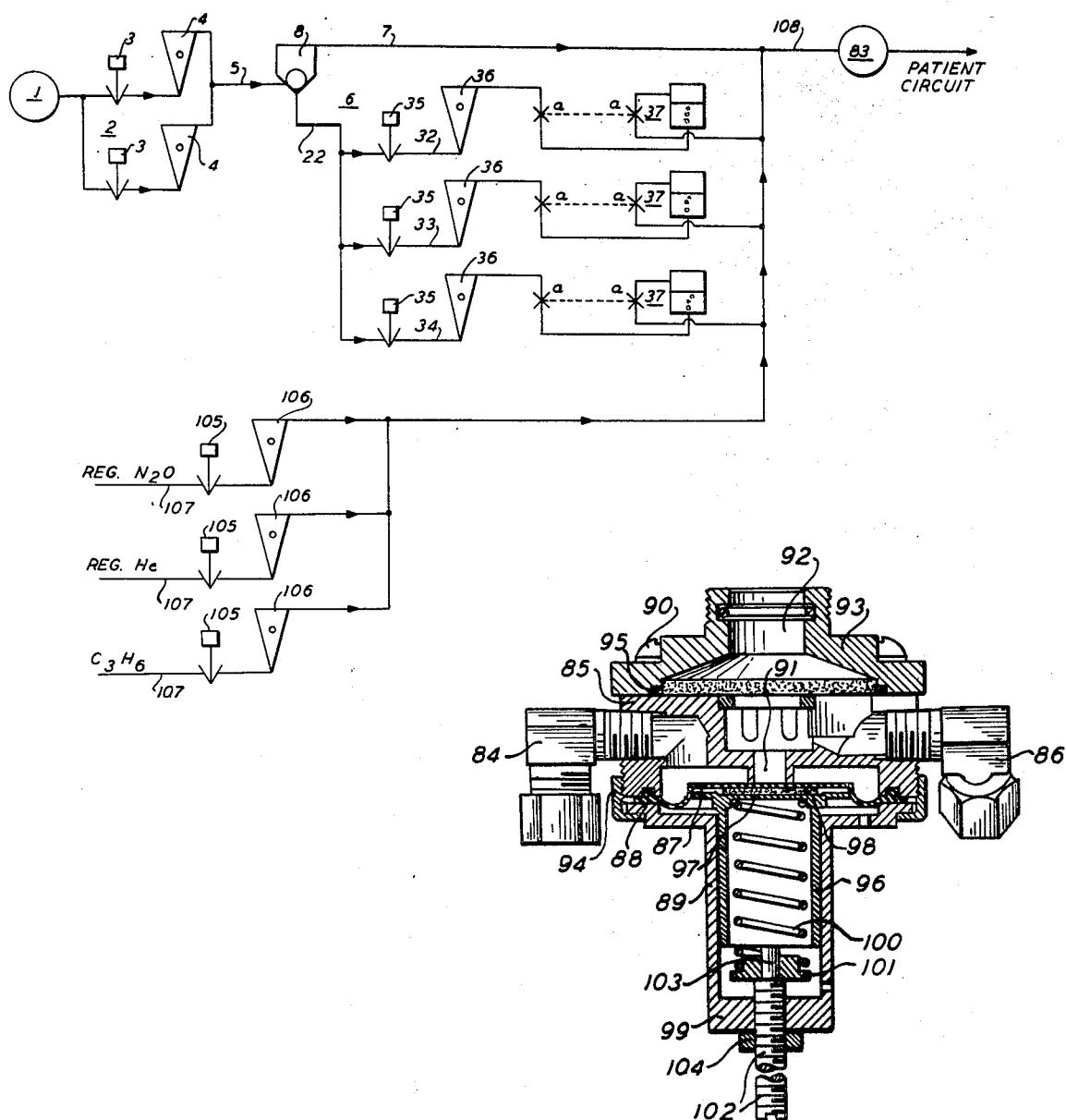
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[57]

ABSTRACT

An anesthesia machine which utilizes a plurality of vaporizers, each individually adapted to be heated to a constant temperature when in use and governed by a shut-off valve assembly. The oxygen carrier passes from a source through a pressure regulator, needle valve, flowmeter calibrated in flowrate of oxygen to a by-pass valve and, thereafter, to a gas fluid circuit in parallel, one branch of which permits unadulterated oxygen flow therethrough when the pressure exceeds a predetermined level and the other branch of which is divided into three subbranches in parallel via a manifold, each sub-branch including a needle valve, flowmeter calibrated in flowrate of vapor, and a vaporizer containing liquid anesthetic agent. All branches join for passage through an altitude compensator valve operating on a back pressure principle to maintain the pressure in the upstream side of the compensator at a predetermined amount above average sea level atmospheric pressure by damping the effect of pressure fluctuations occurring in the downstream portion of the system on the upstream portion.

10 Claims, 8 Drawing Figures



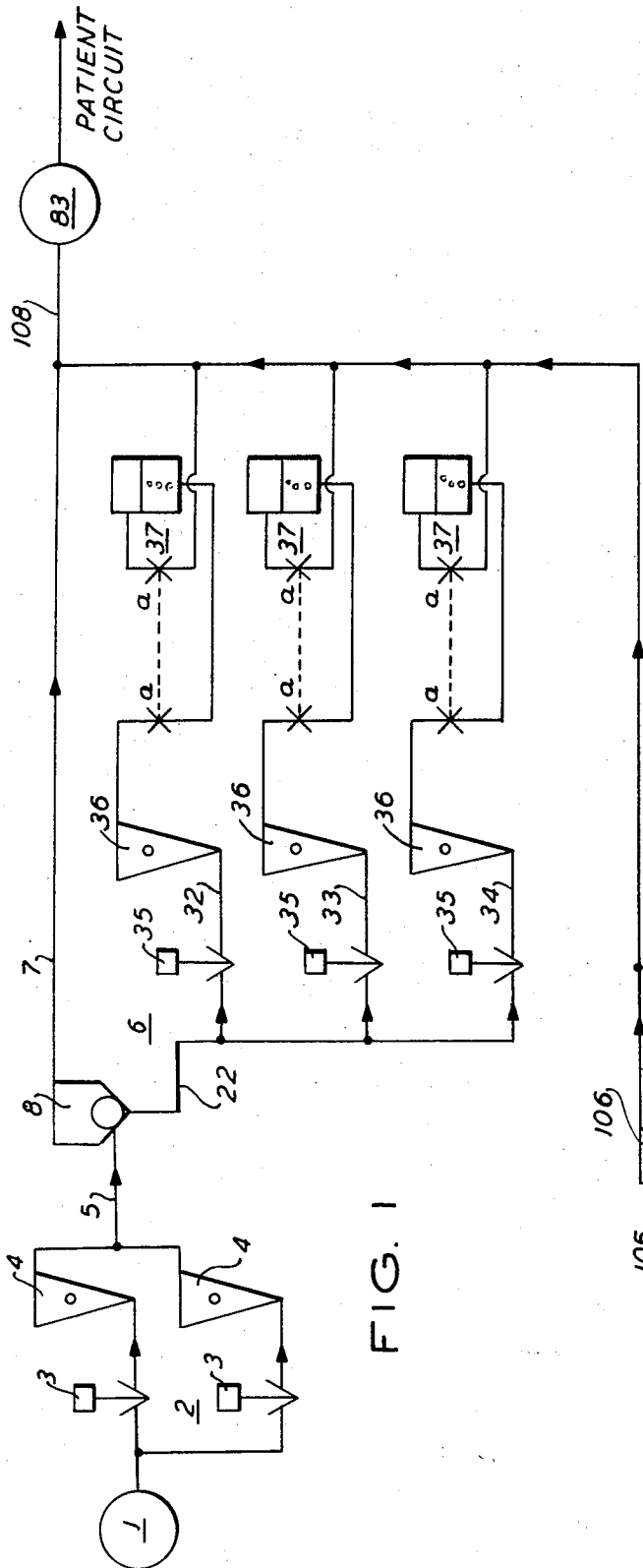


FIG. 1

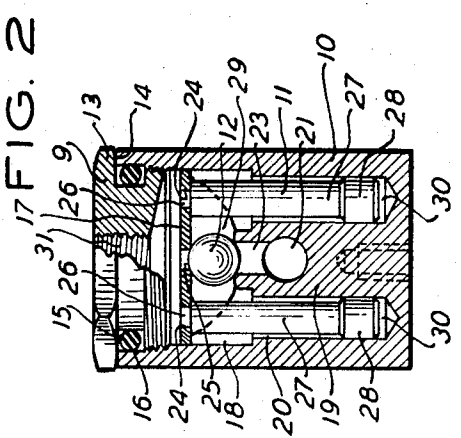
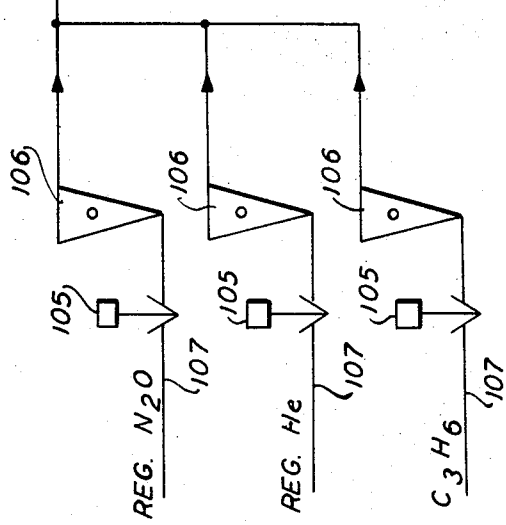


FIG. 2



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FIG. 3

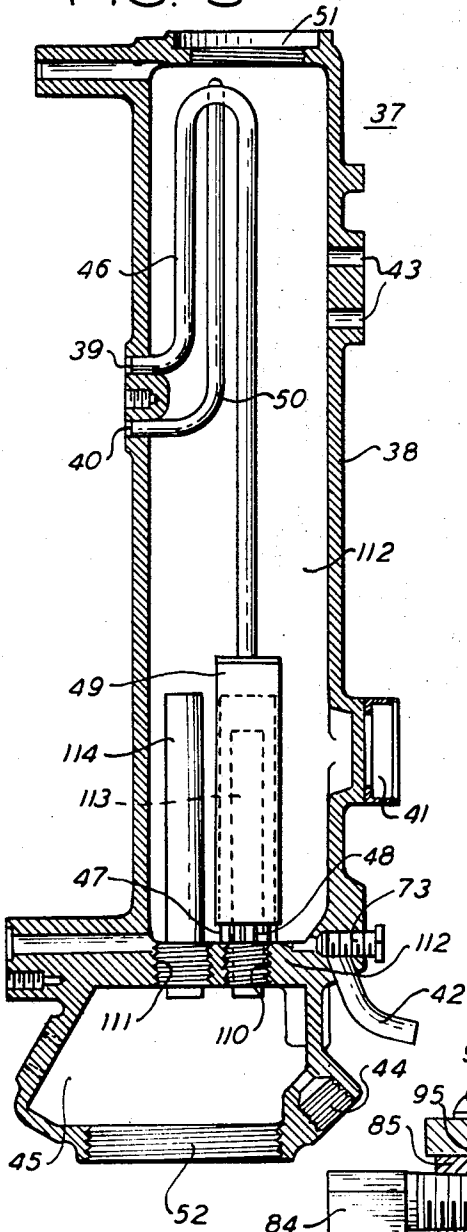


FIG. 4

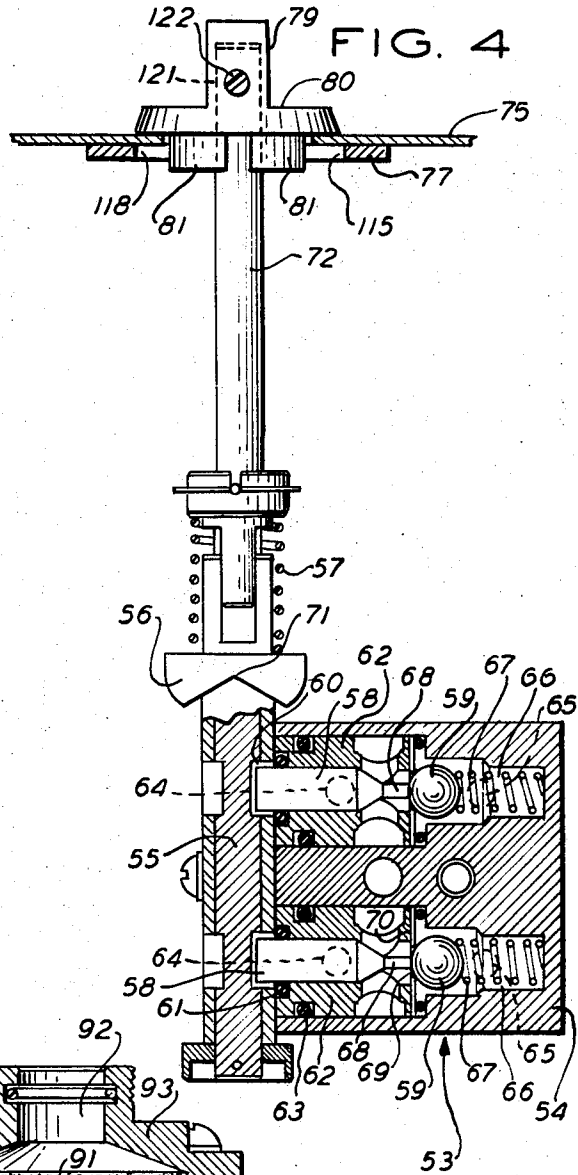
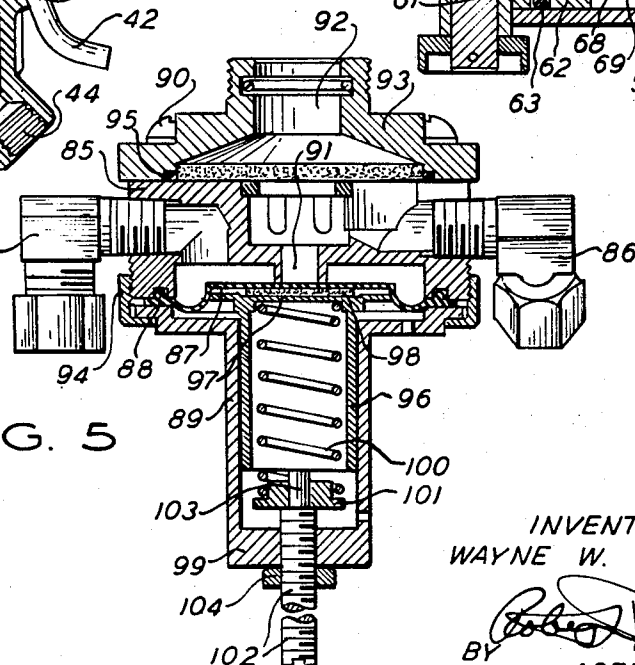
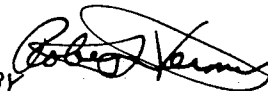
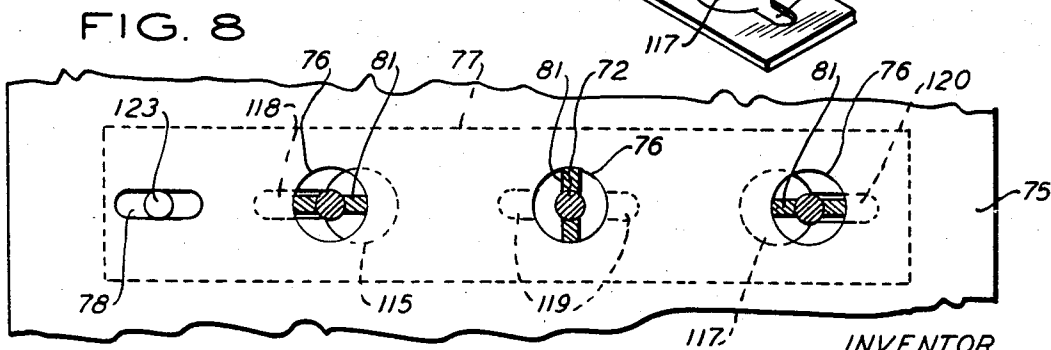
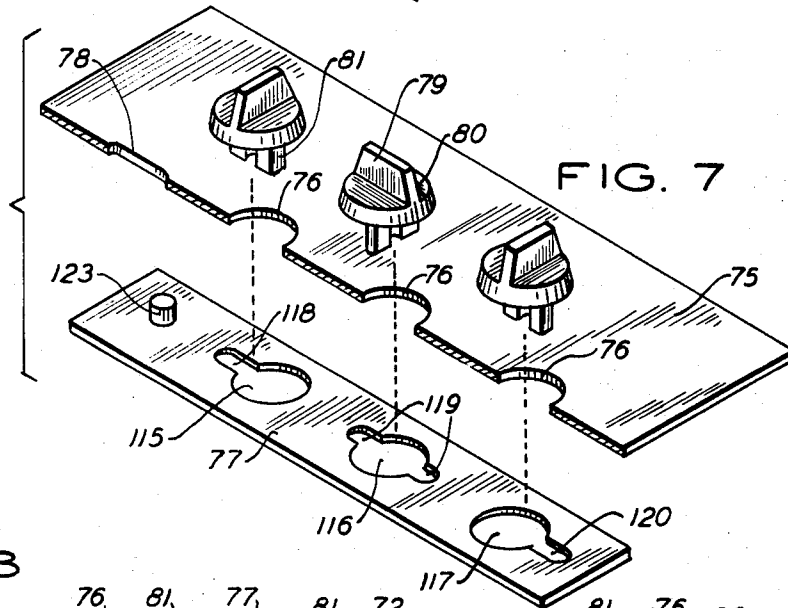
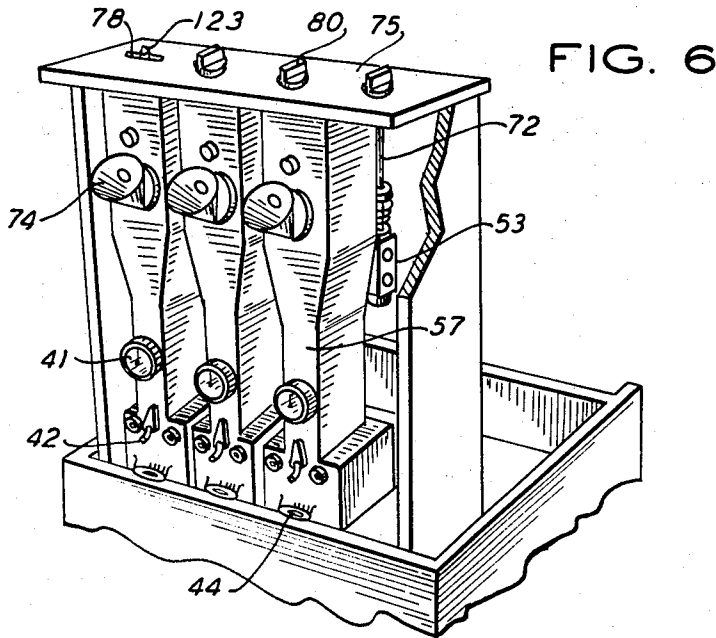


FIG. 5

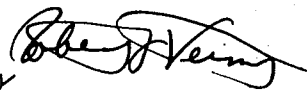


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HEATED VAPORIZER ANESTHESIA MACHINE

This is a continuation of application Ser. No. 671,741, filed Sep. 29, 1967, and now abandoned.

BACKGROUND OF THE INVENTION

Vaporized liquid agents play an important role in anesthesia either alone or in combination with some other agent. For proper use, knowledge of the precise concentration of vapor for introduction to the patient should be available to avoid over-dosage and danger to the patient.

The concentration of vapor for introduction to the patient is a function of the temperature of the liquid in the vaporizer, the surface area of contact between the gas carrier and the liquid to be vaporized and the time of such contact.

A practical way to achieve saturation of the gas carrier by the vapor is by bubbling the gas through the liquid to be vaporized. This provides a substantial area of contact which makes the exposure time required a negligible factor under normal gas flow rates.

Anesthesia machines of the prior art have commonly used the external environment as a source of heat for the liquid within the vaporizer and sometimes thermal compensation means to compensate for vaporizer temperature variations due to changes in the environment. The flowrate of vapor could only be determined by calculation, and this was subject to error due to differences in atmospheric pressure.

SUMMARY OF THE INVENTION

It is a primary object of the present invention to provide an anesthesia machine in which the flowrate of vapor can be read directly from a flowmeter and in which only a single oxygen flow reading is required so as to facilitate a determination of the vapor concentration.

It is a further object of this invention to provide a vaporizer including a heater and thermostat to maintain the liquid to be vaporized at a constant, known temperature.

It is also an object of this invention to provide a means built into the system for easy adjustment to compensate for reductions in ambient pressure.

It is still another object of this invention to provide a novel interlock for the shut-off valve assemblies which can preclude the use of more than one vaporized agent at a given time.

Other objects and advantages of the invention will become apparent from a consideration of the following description and claims, taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a flow diagram of the system;

FIG. 2 is a cross-sectional view of the by-pass valve;

FIG. 3 is a cross-sectional view of the vaporizer;

FIG. 4 is a partial cross-sectional view of the shut-off valve assembly;

FIG. 5 is a cross-sectional view of the altitude compensator valve;

FIG. 6 is a rear perspective view of the vaporizer housing;

FIG. 7 is an exploded view of the interlock mechanism; and

FIG. 8 is a planar view of the interlock mechanism in operation.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now in more detail and by reference characters to the drawings, in FIG. 1, pressure regulated oxygen 1 enters split circuit 2 having needle valves 3 and flowmeters 4 calibrated in flowrate of oxygen. The oxygen flow reunites into line 5 and passes to a second circuit 6. Circuit 6 comprises branches 7 and 22 in parallel with branch 7 receiving flow through by-pass valve 8 and branch 22 receiving direct flow from line 5. By-pass valve 8 shown in FIG. 2 comprises cap 9, body 10, yoke 11 and ball 12. Cap 9 includes a stop flange 13 abutting the free edge 14 of the body, peripheral groove 15 receiving an O-ring gasket 16 and central through-bore 31, and is threadably received in body 10 in sealed relation thereto. Body 10 is cylindrical in cross-section and has a hollow upper portion 18 and a solid lower portion 19 which has extending therein a pair of partial bores 20 with major axes parallel to the major body axis. Lower portion 19 also includes a transverse through-bore 21 which provides a passage for oxygen into branch 22 of circuit 6 from line 5. Bore 23 in lower portion 19 provides a communication between bore 21 and upper portion 18. Yoke 11 comprises a plate 17 having aligned openings 24 and 25 and a pair of opposed downwardly extending flanges 29 shown in dotted lines. Openings 24 receive the reduced ends 26 of cylindrical bars 27 which have enlarged base portions 28. The bars 27 of the yoke are received within bores 20 of body lower portion 19, said bores containing a viscous fluid 30 which dampens sliding movement of bars 27 in bores 20 in response to oxygen flow through bore 23. Ball 12 is positioned within flanges 29 and closes bore 23 and opening 25. In operation, oxygen passes under pressure through bore 21 and exerts a force in opposition to the ball and yoke weight less the bouyant effect of the viscous fluid. When the pressure differential across the ball exceeds approximately 1 p.s.i., ball 12 is displaced vertically to open bore 23 and permit oxygen flow through the spaces formed between the perimeter of plate 17 and the internal diameter of hollow upper portion 18 to branch 7 through bore 31.

Branch 22 of circuit 6 is basically a manifold having three outlet sub-branches 32, 33, and 34. Each sub-branch includes needle valve 35, flowmeter 36 calibrated in flowrate of vapor, and vaporizers 37. Each vaporizer has an associated shut-off valve assembly shown in FIG. 4 and interlock means provided, if desired, for precluding the operation of more than one vaporizer at a time. The latter means will be described more particularly hereinafter.

In FIG. 3, vaporizer 37 includes hollow casing 38 having inlet and outlet openings 39 and 40, respectively; an electrical equipment housing 45 separated from casing 38 by wall 112, thermometer 41, nipple spigot 42 with movable plug 73 for drainage of liquid anesthetic agent, openings 43 for filling funnel 74 as shown in FIG. 6, and opening 44 which accommodates the electrical power leads into the electrical equipment housing 45. within the casing, inlet tube 46 is positioned between inlet opening 39 and heater well 47.

Heater well 47 comprises a hollow cylindrical member having axial grooves 48 extending the length thereof and secured to the casing at opening 110 with a heater 113 shown in dotted lines inserted therein and communicating with housing 45. Tube 46 has at its lower end an enlarged hollow cylinder 49 which fits snugly over heater well 47. Opening 111 in wall 112 receives therethrough closing same a thermostat assembly 114. Outlet tube 50 extends from outlet opening 40 to the upper part of the casing interior which is free of liquid anesthetic agent. After the oxygen passes through inlet tube 46 down through grooves 48 to the bottom of the casing, it bubbles upwardly through the liquid anesthetic agent to the upper part of the casing interior, and, with the vaporized agent, passes down outlet tube 50 and exits from the vaporizer at 40. It should be noted that the casing openings at 51 and 52 are capped.

A shut-off valve assembly, designated generally at 53 in FIG. 4, extends between points a-a on each sub-branch as shown in FIG. 1 to control on-off flow through each vaporizer. As shown in FIG. 4, the assembly includes a body portion 54, a camshaft 55, a detent 56 with spring bias 57, a pair of thrust pins, 58, and balls 59. The camshaft 55 comprises a cylindrical bar with pairs of opposed, flat grooves 60 into which an end portion of a thrust pin is received. Each thrust pin 58 is received within a guide 62 which is in sealed relation at 63 to the body portion. The thrust pin is sealed within the guide by O-ring 61.

The body portion has oxygen inlet and outlet openings 64 and 65, respectively, shown in dotted lines, with inlet openings 64 communicating with their respective circuit sub-branch and outlet openings 65 communicating with their respective vaporizer inlet opening 39. Balls 59 are positioned in body portion bores 66 and are spring biased at 67 to maintain them against thrust pin noses 68. When pins 58 are in grooves 60, balls 59 close the openings 69 in gasket 70, said gasket dividing the body portion between the inlet and outlet openings into two sealed chambers. Spring-loaded detent 56 is notched as at 71 at each quarter turn and is secured to the camshaft so that every other quarter turn of the detent will cam the thrust pins to force balls 59 from sealing engagement with openings 69 and allow oxygen to flow between the inlet and outlet openings of the body portion, thus making the vaporizer communicating therewith available for use.

Camshaft 55 has an extension 72 which permits turning of the detent by way of a control knob 80 which receives the end of the extension in bore 121 and is fixedly held by set screw 122. As seen in FIGS. 4, 6, and 7, extensions 72 extend through cover 75 which has aligned holes 76 and slot 78. Under cover 75 can be slidably mounted a plate 77 having aligned openings 115, 116, and 117 with keying slots 118, 119, and 120, respectively. Each control knob 80 has a grip 79 and key 81 which is of a thickness and length to fit through holes 76 and openings 115, 116, and 117 and into desired keying slots. It should be noted, however, that the holes 76 are spaced apart a greater distance than openings 115, 116, and 117. Thus, for example, as shown in FIGS. 7 and 8, opening 116 is properly concentrically aligned with an associated hole 76 so that the control knob key therein can rotate 90° in the opening 116 and open the vaporizer. The other two knob

keys can not be rotated since they are in slots 118 and 120 as seen in FIGS. 4 and 8. This interlock mechanism prevents the possible erroneous or careless use of more than one vaporizer at a time. A pin 123 extends through slot 78 to slide the plate 77 below cover 75 so that the knob above the desired vaporizer can be rotated. If such is consciously desired, the plate 77 can be removed entirely and the knobs operated without restriction. Once the knob has been rotated 90° in the hole 76 and opening 116, the plate 77 as seen in FIG. 8 cannot be slid to permit another knob to be rotated until the first knob returns to off position. Other gases, e.g., nitrous oxide or helium, can be introduced to the system through supply lines 107 as shown in FIG. 1. Each supply line 107 includes needle valve 105 and flowmeter 106 calibrated in flowrate of the specific gas.

With any one vaporizer open, oxygen passes therethrough, becomes saturated with vaporized anesthetic agent and reunites in line 108 with the unadulterated oxygen flow and other gas. The united flow then passes through altitude compensator valve generally designated in FIG. 1 as 83 and into the circuit leading directly to the patient.

The altitude compensator valve, shown in FIG. 5, includes inlet elbow 84 received within body portion 85 and communicating with diaphragm 87, and pressure relief elbow 86 also received within the body portion. Diaphragm 87 is held in place at 88 by pressure contact between the lower part of body portion 85 and the upper part of cap 89 caused by clamp 94. Body portion 85 has central opening 91 which communicates with central opening 92 of outlet 93 which is mounted on the body portion and secured thereto by bolts 90. The outlet and body portions are secured in sealed relation by "O" ring gasket 95. Cap 89 includes an open end receiving a hollow piston 96 having a closed end 97 adjacent the diaphragm and secured thereto by adhesive 98, and a substantially closed end 99. Compression spring 100 is received within piston 96 and has one end abutting the piston closed end 97 and the other end attached to seat 101. Adjusting screw 102 extends through an opening in substantially closed end 99 and has a neck portion 103 received within an opening in seat 101. Hex nut 104 is threaded onto screw 102 and securely abuts end 99.

In operation, the system is designed to flow at a pressure of approximately 800 mm of mercury absolute. In order to reduce this pressure to ambient pressure where used, the screw 102 varies the spring force against diaphragm 87 to produce a back pressure equal to the difference between 800 mm of mercury and the ambient pressure of the environment. Thus, the back pressure affects both branches 7 and 22 of circuit 6 with branch 7 pressure being 1 p.s.i. below the back pressure at the by-pass valve inlet so that ball 21 can be displaced vertically and oxygen can flow into branch 7. As the back pressure in the breathing circuit will have a negligible effect on the difference between the pressure in the anesthesia machine and the atmospheric pressure with which the machine is surrounded, the compensator means acts to dampen the effect of pressure fluctuations occurring at its downstream side upon the upstream side of the compensator.

Temperature in the vaporizer should be held constant at 75° F. by means of thermostat regulated heater 47.

Thus, the system provides a single oxygen flow reading at 4, a constant pressure differential regulated by the altitude compensator valve, and constant temperature in the vaporizers.

With a known constant temperature in the vaporizer, a known vapor pressure results. Flowmeters 36 can, therefore, be calibrated directly in flowrate of vapor for oxygen flow in branch 22 through flowmeters 36. Knowing the volume of vapor by reading flowmeters 36 and the volume of oxygen by reading flowmeters 4 and other gases by reading flowmeters 106, the concentration of vapor entering the system directly feeding the patient breathing circuit can be determined.

It is intended that all matter contained in the above description or shown in the accompanying drawings shall be interposed as illustrative and not in a limiting sense.

Having thus described my invention, what I claim as new and desire to secure Letters Patent of the United States is:

1. An anesthesia machine comprising an oxygen source, a supply line leading from said source to a by-pass valve, said supply line including a pressure regulator, a needle valve, and flow meter adapted to measure flow rate of oxygen, said by-pass valve comprising a body having a through-bore and a partial bore transverse to said through-bore, said partial bore communicating with said through-bore and an exterior surface of said valve, pressure responsive means reversibly closing said partial bore, said supply line being secured to said valve at one end of said through-bore, a first outlet line being secured at one end to said valve at the other end of said through-bore, a second outlet line being secured at one end to said valve at the point of communication of said partial bore with said valve exterior surface, said first outlet line including a needle valve, a flow meter adapted to measure flow rate of oxygen, said first line being secured at its other end to a first opening in a vaporizer, said vaporizer including a liquid anesthetic agent, means for introducing said agent into said vaporizer, means maintaining said agent at a given constant temperature, means for bubbling oxygen received from said first outlet line through said agent, and a second opening in said vaporizer, a third outlet line being secured at one end in said second opening for removal of oxygen and vaporized agent, said third outlet line merging with said second outlet line, said merged line communicating with a breathing circuit directly feeding a patient and altitude compensator means in said merged line for maintaining the pressure in said merged line at a predetermined amount above average sea level atmospheric pressure by damping the effect of pressure fluctuations occurring in the downstream side of said compensator means upon the upstream side of said compensator means.

2. The combination set forth in claim 1 wherein said first outlet line further includes secondary outlet lines connected thereto and being secured to a plurality of vaporizers, each vaporizer having first means independent of the other vaporizers to open and close said first vaporizer opening, and second means joining said first means and preventing use of more than one vaporizer at a time.

3. The combination set forth in claim 1 wherein said predetermined amount above average sea level atmospheric pressure is about 40 mm. Hg.

4. An anesthesia machine comprising an oxygen source, a gas fluid system supply line running from said source into at least one vaporizer and from said at least one vaporizer to a breathing circuit, said supply line including at least one needle valve, by-pass means associated with said gas fluid system supply line adapted to direct a portion of the oxygen from said oxygen source to the breathing circuit, a flow meter adapted to measure total flow rate of oxygen from said oxygen source, a flow meter in said supply line adapted to measure flow rate of oxygen for vaporizing liquid anesthetic agent, means maintaining said liquid agent at a predetermined constant temperature, and altitude compensator means located between said at least one vaporizer and said breathing circuit for maintaining the pressure in said supply line at a predetermined amount above average sea level atmospheric pressure by damping the effect of pressure fluctuations occurring in the downstream side of said compensator means upon the upstream side of said compensator means.

5. An anesthesia machine comprising an oxygen source, a gas fluid system supply line running from said source into a plurality of vaporizers and from said plurality of vaporizers to a breathing circuit, first means associated with each of said plurality of vaporizers for permitting flow therethrough, second means joining said first means and preventing use of more than one of said plurality of vaporizers at a time, said supply line including at least one needle valve, by-pass means associated with said gas fluid system supply line adapted to direct a portion of the oxygen from said oxygen source to the breathing circuit, a flow meter adapted to measure total flow rate of oxygen, a flow meter adapted to measure flow rate of oxygen for vaporizing liquid anesthetic agent, means maintaining said liquid agent at a predetermined constant temperature; and altitude compensator means in said gas fluid supply system immediately upstream of said breathing circuit for maintaining the pressure in said supply line at a predetermined amount above sea level atmospheric pressure by damping the effect of pressure fluctuations occurring in the downstream side of said compensator means upon the upstream side of said compensator means.

6. An anesthetic machine comprising a gas fluid system supply line adapted to receive oxygen from an oxygen source and to supply an anesthetic fluid combined with the oxygen to a breathing circuit, said supply line including at least one valve means adapted to control the total flow of oxygen from the oxygen source, by-pass means associated with said gas fluid system supply line adapted to direct a portion of the oxygen from the oxygen source to the breathing circuit, a flow meter in said supply line adapted to measure total flow rate of oxygen from the oxygen source, an anesthetic vaporizer in said supply line containing a liquid anesthetic agent, a flow meter in said supply line adapted to measure flow rate of oxygen for vaporizing the liquid anesthetic agent, an electrical resistance heater adapted to heat the liquid agent within said vaporizer, control means adapted to sense the temperature of the liquid agent for controlling the resistance heater whereby the liquid agent is maintained at a predetermined constant temperature and, altitude compensator means in said gas fluid supply system immediately upstream of the breathing circuit for main-

taining the pressure in said supply line at a predetermined amount above sea level atmospheric pressure by damping the effect of pressure fluctuations occurring in the downstream side of said compensator means upon the upstream side of said compensator means.

7. An anesthetic machine as defined in claim 6 wherein said predetermined amount above average sea level atmospheric pressure is about 40 mm. Hg.

8. An anesthetic machine comprising a vaporizer adapted to contain an anesthetic liquid therein, said vaporizer having an inlet and an outlet, an electrical resistance heater within said vaporizer, means responsive to the temperature of the anesthetic liquid within said vaporizer to control said heater to maintain the anesthetic liquid at a predetermined constant temperature, a first supply line having one end thereof adapted to connect to a source of oxygen and having the other end thereof connected to said vaporizer inlet, valve means in said first supply line for controlling the total flow of oxygen from the oxygen source, a flow meter in said first supply line adapted to measure the total flow rate of oxygen from the oxygen source, a flow meter in said first supply line adapted to measure flow rate of oxygen for vaporizing the liquid anesthetic agent, an outlet line having one end connected to said vaporizer outlet to receive anesthetic vapor therefrom for delivery to a patient circuit, by-pass means in said first supply line adapted to direct a portion of the oxygen from the oxygen source to said outlet line, a second

supply line having one end adapted to be connected to a source of second fluid and the other end communicating with said outlet line, said second supply line having a valve means to control the flow of the second fluid and a flow meter to measure the flow of said second fluid, and altitude compensator means in said outlet line immediately upstream of the patient circuit for maintaining the pressure in said outlet line at a predetermined amount above average sea level atmospheric pressure by damping the effect of pressure fluctuations occurring in the downstream side of said compensator means upon the upstream side of said compensator means.

9. An anesthetic vaporizer as defined in claim 8 wherein said predetermined amount above average sea level atmospheric pressure is about 40 mm. Hg.

10. An anesthesia machine as defined in claim 8 wherein said altitude compensator comprises a body having an inlet means and an outlet means, and having a central opening intermediate said inlet means and said outlet means, a resilient diaphragm disposed opposite said central opening movable toward and away from said central opening to change the restriction of fluid flow passing therethrough, spring biased operating means adapted to move said resilient diaphragm to a selected position with respect to said central opening whereby a predetermined backpressure is established in the fluid flow.

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