

United States Patent

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[56]

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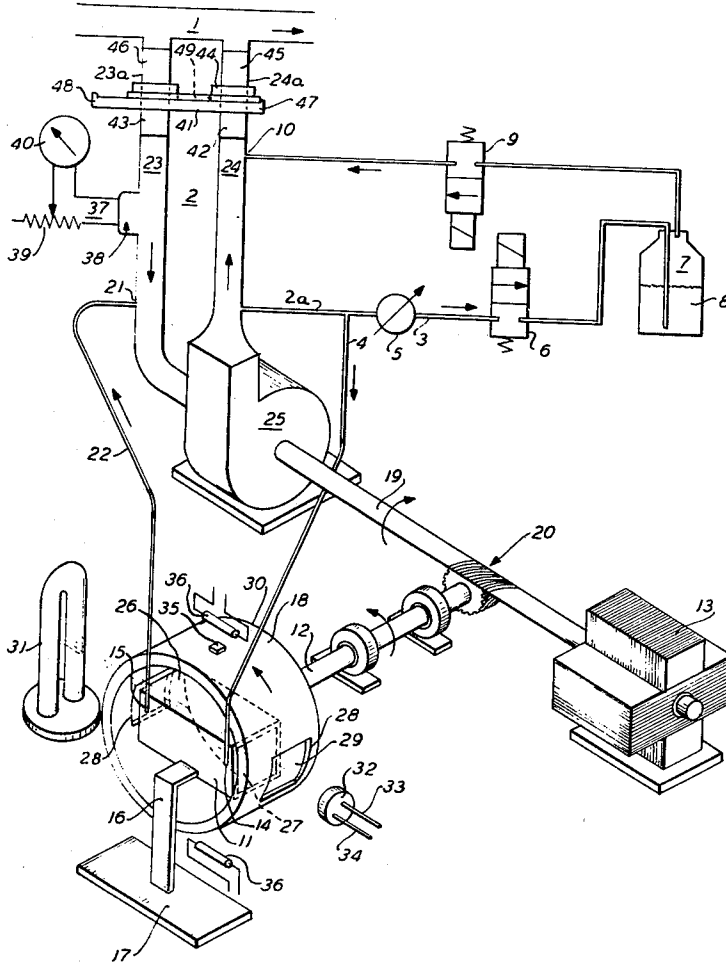
[54] ANESTHESIA SYSTEM
7 Claims, 3 Drawing Figs.

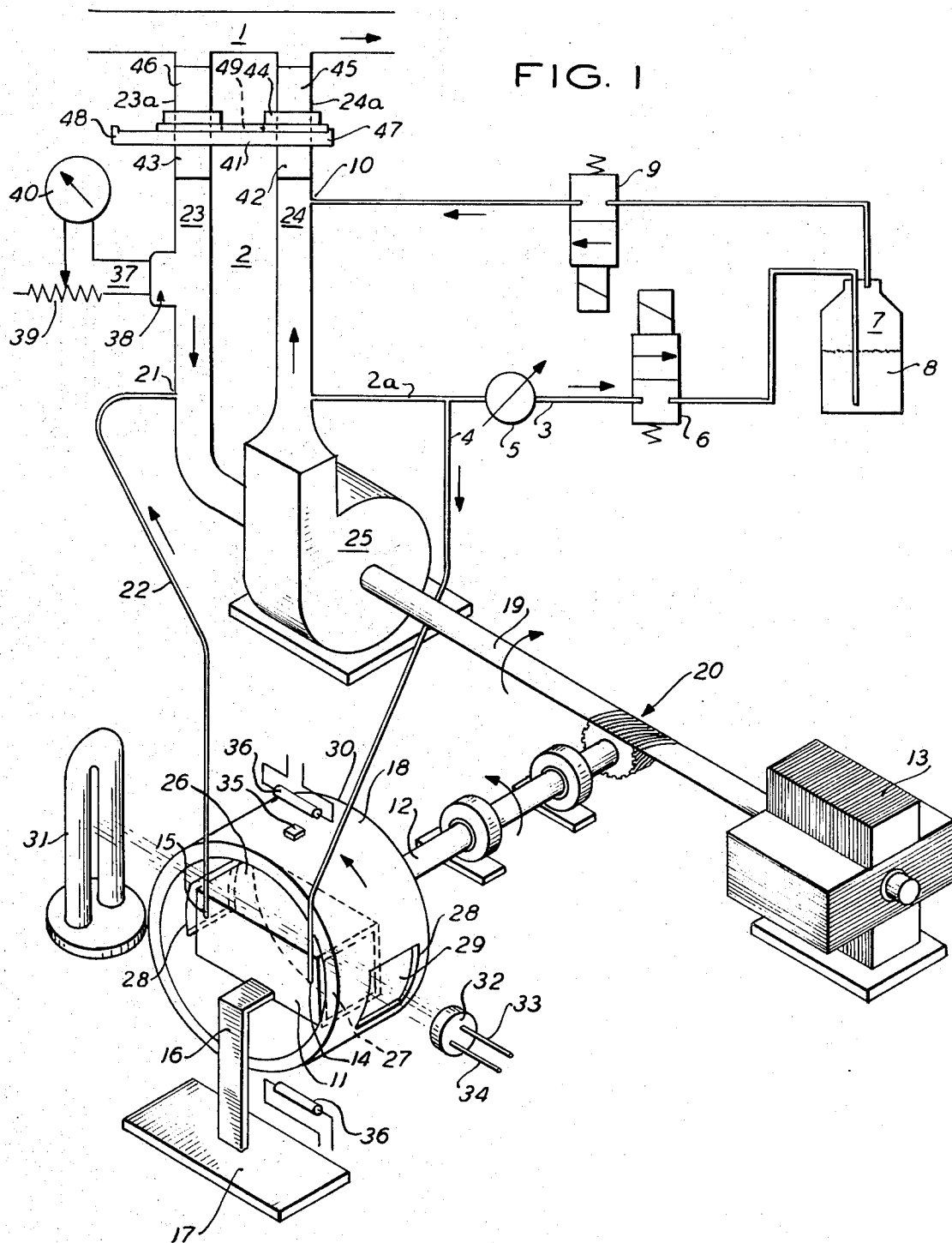
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137/611, 137/625.62, 73/1(A), 73/422

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[50] **Field of Search**..... 128/188,
191, 194; 250/43.5; 307/235; 137/610, 625.62,
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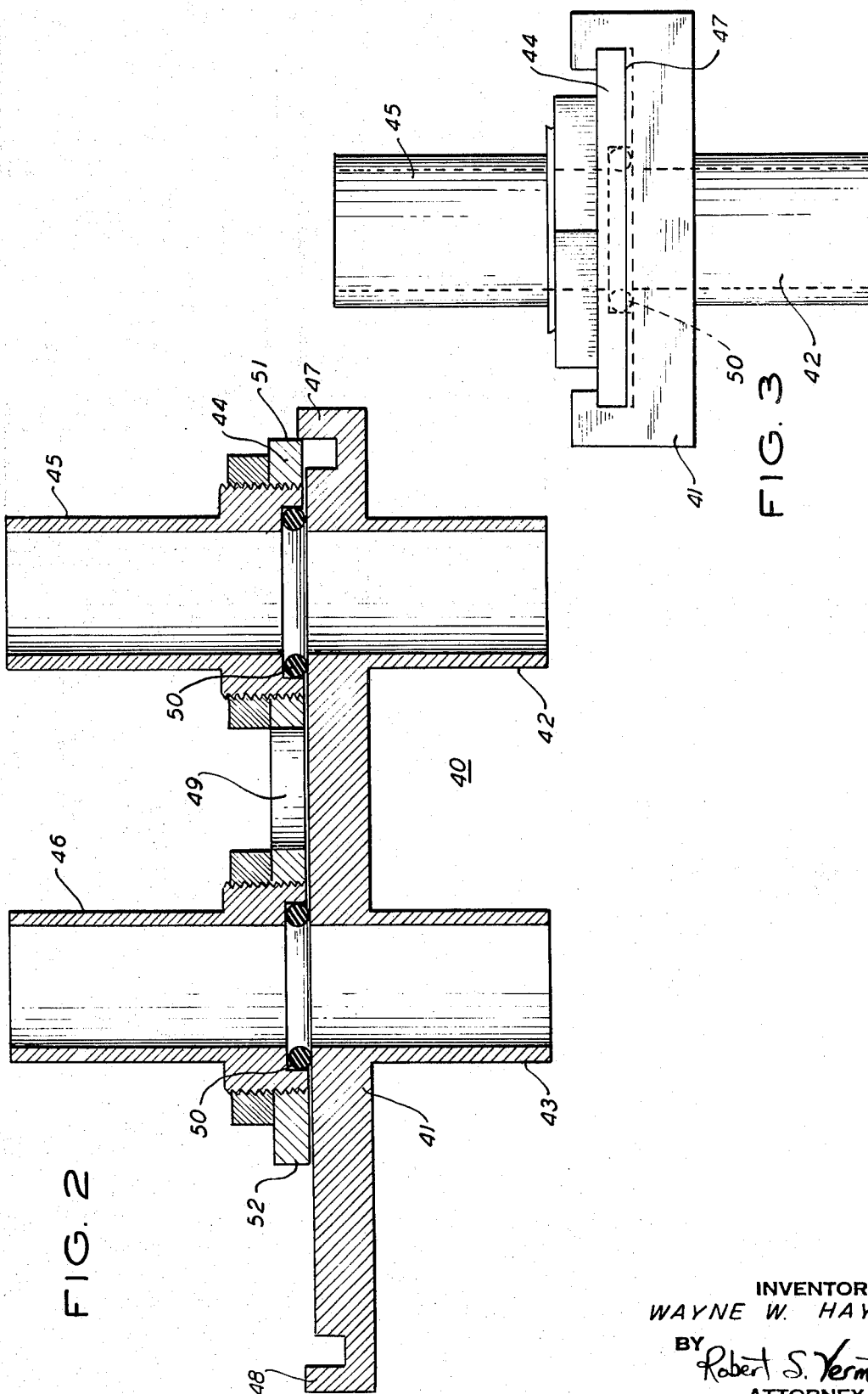
ABSTRACT: An anesthesia system having a main circuit and a sample bypass, said bypass being manually opened and closed to gas flow from the main circuit by a zeroing valve and having an oxygen analyzer, an anesthetic analyzer and automatic controllers associated therewith.





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ANESTHESIA SYSTEM

CROSS-REFERENCES TO RELATED APPLICATIONS

This application relates to the subject matter of application Ser. No. 688,480, filed on Dec. 6, 1967 for "Automatic Vaporizer Controller" and assigned to the same assignee.

BACKGROUND OF THE INVENTION

Anesthesia is administered through nonrebreathing, partial rebreathing, or rebreathing systems. The nonrebreathing system has permitted the most accurate knowledge of the concentration of anesthetic agent administered, since the concentration of new agent administered is the concentration of agent inhaled. However, use of the system is very costly because large amounts of anesthetic agent are exhaled to the atmosphere.

Where partial rebreathing and rebreathing systems are used, accurate knowledge of agent concentration is not readily available because of the recirculation of exhaled anesthetic agent in addition to that newly administered. The rebreathing systems substantially eliminate waste, but require intensive observation of the patient by the anesthetist and may employ extensive apparatus for analysis and even automatic control.

The prior art has not provided efficient apparatus for anesthetic concentration control in a rebreathing system, nor has the prior art provided for oxygen analysis in a rebreathing system to indicate the oxygen percentage reaching the patient. Presently, control is accomplished solely by the anesthetist through observation of the patient.

SUMMARY OF THE INVENTION

This invention relates to the analysis of the oxygen and anesthetic concentration in an anesthesia system, the automatic control of such concentrations, and the utilization of a unique valving arrangement for permitting a check on the stability of the analyzers employed.

The specific embodiment referred to hereafter relates to the analysis and automatic control of the concentration of 1,1,1-trifluoro-2-bromo-2-chloroethane (Halothane), although other embodiments are contemplated with different anesthetics and this in no way is to limit the scope of applicant's invention.

Since nitrous oxide is a common complement of an oxygen/Halothane mixture as well as other mixtures in chemical practice, users are in need of an oxygen content monitor built into the system to indicate oxygen content as well as provide a possible means for automatically controlling the flow of a diluent anesthetic, such as nitrous oxide or the oxygen itself. It is therefore an object of the present invention to incorporate oxygen and anesthetic analyzers with automatic concentration control into an anesthesia system.

Since an anesthetic analyzer must be zeroed to verify the accuracy of the zero point of its meter, air can be sampled for this purpose rather than the regular gas flow. The air sampling also permits checking of the oxygen analyzer meter at, for example, 21 percent concentration.

It is, therefore, a further object of this invention to provide a novel valving arrangement to permit checks on the accuracy of the analyzers.

The foregoing objects and other objects, features, and advantages will become apparent in the light of the following description and claims taken with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a combined schematic illustration of the anesthesia flow through the fluid analysis and anesthetic control sample bypass with the zeroing valve in position.

FIG. 2 is a cross-sectional view of the zeroing valve in position to permit flow from the anesthesia circuit through the analyzers.

FIG. 3 is an end view of the zeroing valve showing the sliding relationship.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now in more detail and with reference characters to the drawings, in FIG. 1, inhalation gas stream 1 leading to the patient has a sample bypass 2 which includes main lines 23, 23a and 24, 24a and branch line 2a which splits into a vaporizer flow line 3 and analysis flow line 4. Main line 24, 24a is shown in FIG. 1 returning to stream 1, but it could return elsewhere, as, e.g. the exhalation gas stream, not shown. Vaporizer flow line 3 includes a pump 5, a first solenoid-operated valve 6, a vaporizer 7 including liquid anesthetic 1,1,1-trifluoro-2-bromo-2-chloroethane (Halothane) reservoir 8 through which the vaporizer flow is bubbled for saturation with the Halothane vapor, and a second solenoid-operated valve 9 before rejoining main line 24 at 10.

It should be noted that the pump and two solenoid operated valves operate simultaneously to permit flow in line 3 under a pressure differential.

The analysis flow 4 enters sensor cell 11 at 14. Sensor cell 11 is held fixedly in place by support bar 16 attached to support 17. Drum 18 is adapted to rotate at a constant speed of approximately 120 r.p.m. on drive shaft 12 which is in drive relation to drive shaft 19 of synchronous motor 13 by a worm gear arrangement generally designated at 20. The flow exits cell 11 at 15 and rejoins main line 23 at 21 through line 22.

Circulation fan 25 moves the flow through the main bypass lines 23, 24, and is driven by motor 13 through shaft 19 at approximately 3,600 r.p.m. The fan provides for circulation of a representative sample of the rebreathing gas constituents.

Sensor cell 11 is of hollow rectangle box shape with opaque sidewalls 26 and opposed light transparent windows 27 preferably made of quartz. Drum 18 comprises a hollow cylindrical member having diametrically opposed openings 28. Within one opening is placed a phosphor-quartz material 29 having a light conversion peak at a predetermined wavelength band while the other is left vacant. Drum 18 further comprises a base plate 30 closing one end to which the drive shaft 12 is connected and an open end through which is received sensor cell 11.

In operation, an ultraviolet light source, lamp 31, emitting light at the conversion peak of material 29 is placed to one side of the drum and a photoresistor 32 having lead wires 33, 34 is placed adjacent the diametrically opposed side of the drum. As the drum rotates at a constant speed, each 180° of drum rotation presents a drum opening 28 adjacent the source 31 alternately vacant as in FIG. 1 and then with the material 29. With cell windows 27 in fixed position, the drum acts as a chopper to the light source to each 180° when the source 31, openings 28, windows 27, and photoresistor 32 are aligned. Since the single cell 11 is used, there is a pulse-type output through the photoresistor. The pulse-type output is a result of a reference pulse obtained when material 29 is adjacent source 31 and a data pulse obtained when vacant opening 28 is adjacent to the source.

The reference pulse is obtained when the source emits light in the given wavelength band which light is converted by material 29 to visible light which then passes through the sensor cell 11 undiminished in intensity and is "read" by photoresistor 32. The data pulse is obtained when the source emits light in the given wavelength band which light passes through vacant window 28 when the chopper drum has rotated 180° and, in passing through cell 11, has its intensity diminished by absorption in the given wavelength band by the gas sample present in the cell. The diminished light intensity is then converted by material 29 to visible light at the reduced intensity which is "read" by the photoresistor.

The comparison between reference and data pulses determines the concentration of anesthetic vapor agent in the gas sample since it is only the vapor agent which is capable of light absorption in the given wavelength band.

Conventional Reed switches 36 are positioned adjacent opposed drum sides. The drum further comprises a permanent magnet 35 which is positioned on said drum so that when said drum permits light to pass to the photoresistor said magnet actuates one of said Reed switches.

Although the electrical analysis and control circuitry for Halothane is not being shown or disclosed herein in particularity, it is shown and disclosed in application Ser. No. 688,480, referred to hereinabove. For purposes of this application, Reed switches 36 lead to a pair of linear gates which separate the pulses for data charge storage and reference charge storage. Photoresistor 32 has a lead into the separator and supplies it with the pulses for separation and later charge storage. The photoresistor also has a lead to a Schmidt trigger which initiates the action of the charge storage drain circuit which is responsive to drum rotation. The trigger actuates the drains which drain the charge from the capacitor storage systems for receipt of new pulse charges.

The storage systems each feed an amplifier through which a meter reading can be obtained. The meter leads into a meter relay by which the anesthetic vapor agent concentration is controlled. The meter relay has a concentration control setting operated by the anesthetist which setting actuates the vaporizer pump 5 and solenoid operated valves 6 and 9 simultaneously to permit vapor flow 3 and increase the vapor concentration if such should fall below the setting. An additional control is provided to give the anesthetist the choice of monitoring or controlling anesthetic concentration. Vapor flow 3 provides increased Halothane vapor concentration in the analysis flow 4 after circulation thus causing a new meter reading eventually bringing the reading up to the setting.

It should be noted that in order to have a stable system, the ultraviolet light source 31 should be maintained at a constant intensity by means of regulating the lamp current such that the reference pulse is of constant amplitude. Thus, a lamp starter for initial use and regulator is provided so that if the intensity is decreasing, the regulator can permit additional current flow to maintain the lamp intensity.

Since the preferred embodiment is intended for use in closed circuit anesthesia, it is not feasible to use anything but oxygen and Halothane in the mixture unless the oxygen content of the respired mixture is monitored. Nitrous oxide is a common complement of an oxygen/Halothane mixture in clinical practice, and many users would be reluctant to dispense with it and be unable to monitor the oxygen concentration with a conventional oxygen analyzer not built into the system.

An oxygen analyzer generally designated at 37 is positioned with a conventional self-powered fuel cell 38 in flow relation to main line 23 and further comprises a potentiometer 39 and a milliammeter 40. The current generated by the fuel cell 38 is proportional to the oxygen concentration of the contacting fluid in line 23, and the milliammeter is calibrated to read oxygen concentration.

As in the Halothane analyzer, the meter reading of oxygen concentration can be fed to a meter relay (not shown) by which the oxygen concentration can be controlled — either by oxygen flow control or nitrous oxide flow control of the needle valves associated with the respective gas sources.

To permit a check on the zeroing of the Halothane analyzer and the accuracy of the oxygen analyzer, a zeroing valve generally designated at 40 is positioned as shown in FIG. 1.

More particularly, as shown in FIG. 2, the valve 40 comprises an analyzer plate 41 having nipples 42 and 43 which are received within lines 24 and 23, respectively, and bypass plate 44 having nipples 45 and 46 which are received within lines 24a and 23a, respectively.

As shown in FIG. 3, bypass plate 44 is slidably received within the flanged recesses of plate 41. However, plate 41, as shown in FIG. 2, has stops 47, 48 to limit the sliding movement of plate 44 with respect thereto.

Bypass plate 44 has an opening 49 between nipples 45, 46 with nipples 45, 46 each having an internal recess adjacent plate 41 receiving an O-ring seal 50 therein to prevent the entry of air or gas as the case may be.

In operation, when end 51 of plate 44 abuts stop 47, O-ring seals 50 prevent air from entering the nipples. Nipples 42 and 45 and nipples 43 and 46 are aligned to permit gas flow from the gas stream 1 through nipples 46 and 43, respectively, into

bypass 2 through lines 23a and 23. After passing through the bypass circuitry, the gas returns to the gas stream through lines 24 and 24a and nipples 42 and 45. The gas has been analyzed for oxygen and Halothane concentration and, depending on the readings of each, could be automatically controlled as to concentration of Halothane and oxygen, the oxygen content being controlled through the needle valves at the flow lines from either the oxygen or nitrous oxide sources.

When the accuracy of the oxygen analyzer and the zeroing of the Halothane analyzer is to be checked, the bypass plate 44 is moved until the end 52 of plate 44 abuts stop 48. In this position, nipple 42 is unopposed by nipple 45 since nipple 45 has moved to the former position of opening 49 and is sealed against plate 41. Opening 49 now is aligned with nipple 43 and nipple 46 is sealed against plate 41. Thus, air will be introduced into bypass 2 through opening 49, nipple 43 and line 23 by the circulation fan and returned to atmosphere through line 24 and nipple 42 which is unopposed.

Since air contains no Halothane and a known concentration of oxygen at a given location, the Halothane meter can be rezeroed on a no-Halothane reading and the oxygen analyzer can be checked for a reading of the known oxygen concentration of the air. Under these checking circumstances, the anesthetist would terminate automatic concentration control and merely monitor to minimize loss of Halothane due to the zero air reading of the analyzer which would be below the normal setting.

This valving arrangement minimizes the number of motions required to check accuracy and also provides an important safety function in retaining all tubing connections (23, 23a, 24, 24a) intact rather than requiring removal with possible transposing of tubes on reconnection.

The above description should be viewed as illustrative of a preferred embodiment and not in a limiting sense.

I claim:

1. An anesthesia system comprising a flow stream to and away from a patient and source means of oxygen and anesthetic, said stream having a sample bypass, said bypass receiving a sample of the flow in said stream and having analysis means for determining the concentration of certain constituents in said sample flow, and valve means connected to said bypass and adapted to cut off sample flow to said bypass and open said bypass to a second flow of known concentrations to permit the bypass to sample said second flow and check the accuracy of the analysis means, said valve means comprising a pair of parallel plates, one of said plates has means slidably receiving the other of said plates and stop means to limit sliding movement, each plate has a pair of nipples connected to respective bypass tubes and extending perpendicularly to the plates with each extending oppositely and having the same spacing, and one of said plates has a hole therethrough between its pair of nipples so that when the pairs of nipples are aligned in a first position, the bypass will sample flow from said stream and when the pairs of nipples are nonaligned in a second position, the opening of said one plate is aligned with a nipple of the other plate to permit the bypass to sample said second flow.

2. An anesthetic system comprising a flow stream to and from a patient and source means of oxygen, nitrous oxide and vaporizable anesthetic agent, said stream having a sample bypass, said bypass receiving a sample of flow in said stream and having analysis means, said analysis means including oxygen analysis means for determining the oxygen content of the sample flow and anesthetic analysis means for determining the concentration of said vaporizable anesthetic agent in said sample flow, valve means connected to said bypass and adapted to cut off flow to said bypass and open said bypass to a second flow of known concentrations to permit the bypass to sample said second flow and check the accuracy of the analysis means, said valve means comprising a pair of parallel plates, one of said plates has means slidably receiving the other of said plates and stop means to limit sliding movement, each plate has a pair of nipples connected to respective bypass

tubes and extending perpendicularly thereto with each pair extending oppositely and having the same spacing, and one of said plates has a hole therein between said nipples so that when the pairs of nipples are aligned in a first position, the bypass will sample flow from said stream and when the pairs of nipples are nonaligned in a second position, the opening of said one plate is aligned with a nipple of the other plate to permit the bypass to sample said second flow.

3. In an anesthetic system having a flow stream for delivering anesthetic to a patient, a bypass system comprising a first tubing means for withdrawing fluid from the flow stream, a second tubing means for returning withdrawn fluid to the flow stream, analysis means intermediate said first and second tubing means for determining the anesthetic content of the withdrawn fluid, and a valve means connected to said first and second tubing means, said valve means comprising a pair of parallel plates, one of said plates having a pair of holes in alignment with said tubing means and the other of said plates slidably received in said one plate and having three holes therein, said other plate being movable between a first position wherein two of its holes are aligned with said tubing means to introduce withdrawn fluid to said analysis means, and a second position wherein the third hole is aligned with said first tubing means whereby a second fluid is allowed to enter said first tubing to said analysis means.

4. An anesthesia system as set forth in claim 3 wherein said second fluid is air.

5. An anesthesia system as set forth in claim 4 wherein said valve means includes stop means to limit the relative movement of said plates at said first and second positions.

6. In an anesthesia system having a flow stream for delivering anesthetic to a patient, a bypass system comprising tubing means for withdrawing fluid from the flow stream, analysis means for determining the anesthetic content of the withdrawn fluid, and valve means in said tubing for interrupting the flow of withdrawn fluid to said analysis means, said valve means comprising first and second parallel plates, said first plate having at least one opening, said second plate having at least two openings, said plates slidably received with respect to each other between a first position wherein one of said openings in said second plate is aligned with said at least one opening in said first plate whereby withdrawn fluid passes therethrough to said analysis means and a second position wherein the other of said openings in said second plate is aligned with said at least one opening in said first plate whereby a second fluid is introduced to said analysis means.

7. An anesthesia system as set forth in claim 6 wherein said second fluid is air.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,566,865 Dated March 2, 1971

Inventor(s) Wayne W. Hay

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 4, line 51, after "each" insert -- pair --;
line 68, "vale" should read -- valve --.

Signed and sealed this 31st day of August 1971.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents