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[54] **RECOVERY OF ANESTHETIC AGENTS**
 29 Claims, 7 Drawing Figs.

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 55/269

[51] Int. CL. A61m 17/00,
 B01d 51/10

[50] Field of Search 55/267-9;
 128/188, 191, 186, 140—142.3, 185, 189, 197,
 146.6, 191.1, 202, 142, 142.5, 145.8, 196

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ABSTRACT: In a system for administering a volatile inhalation anesthetic agent to a patient at a flow rate that is in excess of the patient's uptake rate and wherein a portion of the excess anesthetic agent is exhausted from the system, a method and apparatus for recovering the exhausted anesthetic agent. Recovery is effected by collecting the exhausted gas and removing the water vapor either by condensation or with a hygroscopic material. The anesthetic agent is then extracted from the dried gas by a cryogenic process in which the vapors in the anesthetic agent are condensed to a liquid phase or by an absorbent material which is processed later to remove the agent. When employing the condensing process, the anesthetic condensate is collected and may be readmitted directly into the anesthetic system.

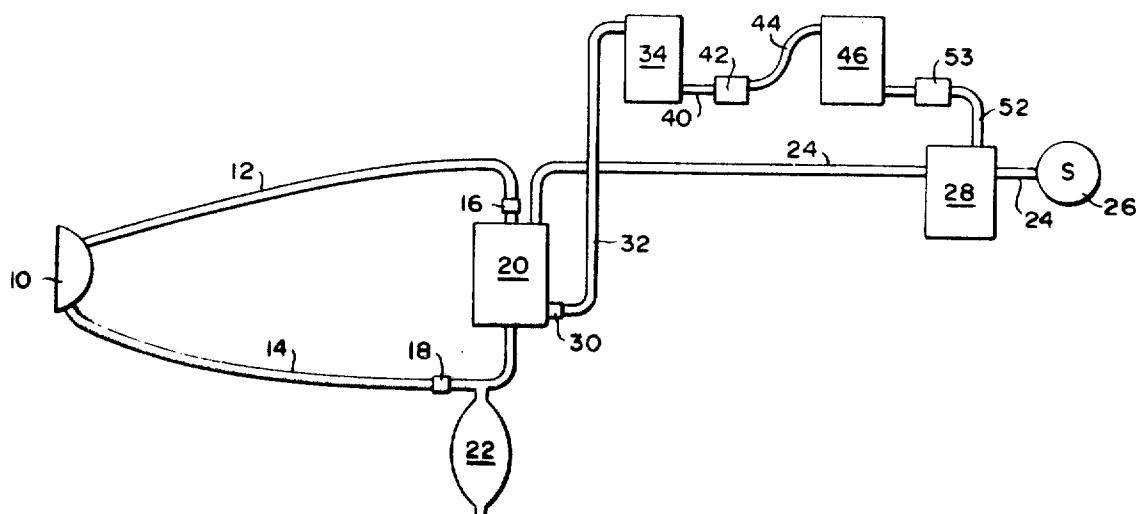


FIG. 1

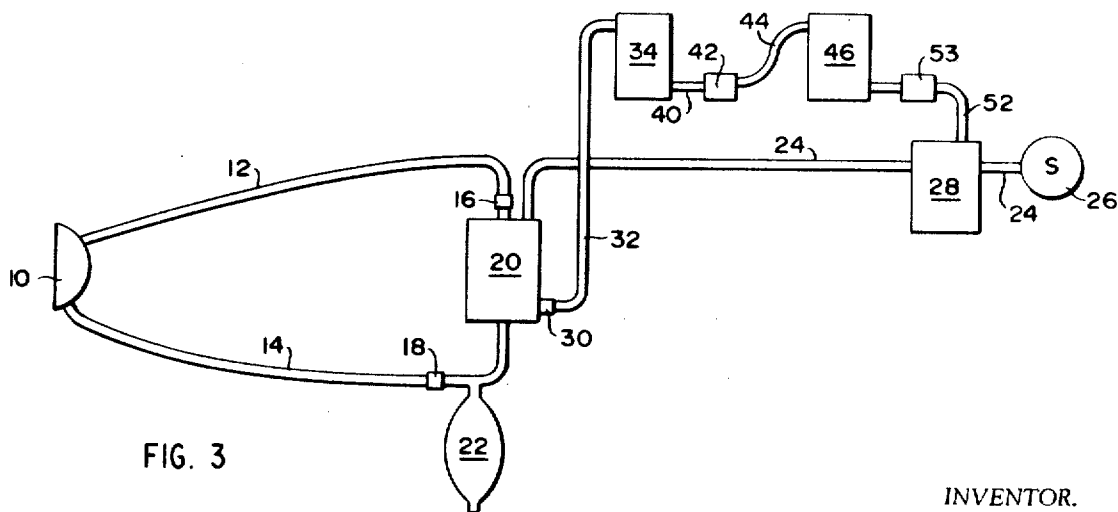
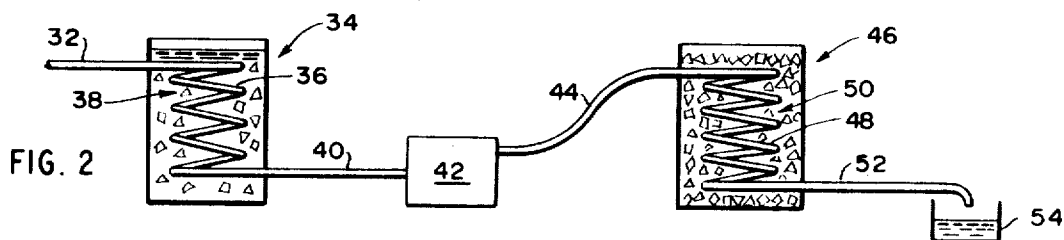
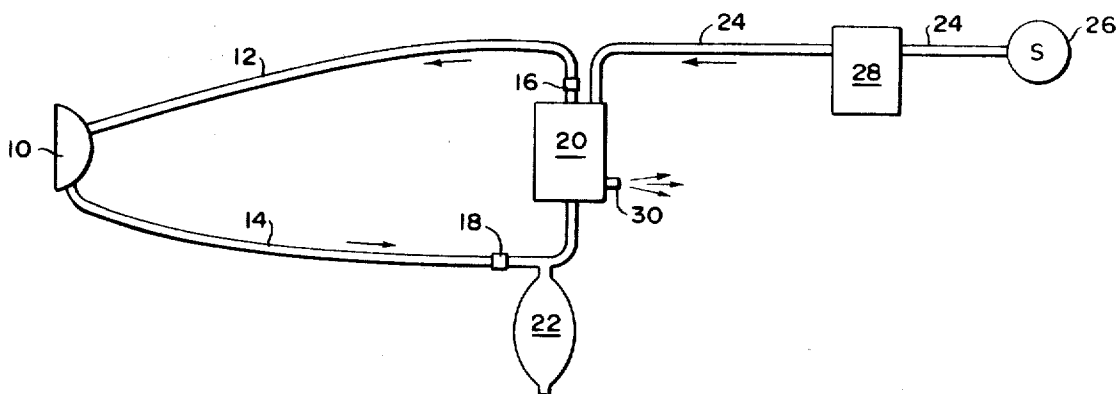


FIG. 3

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FIG. 4

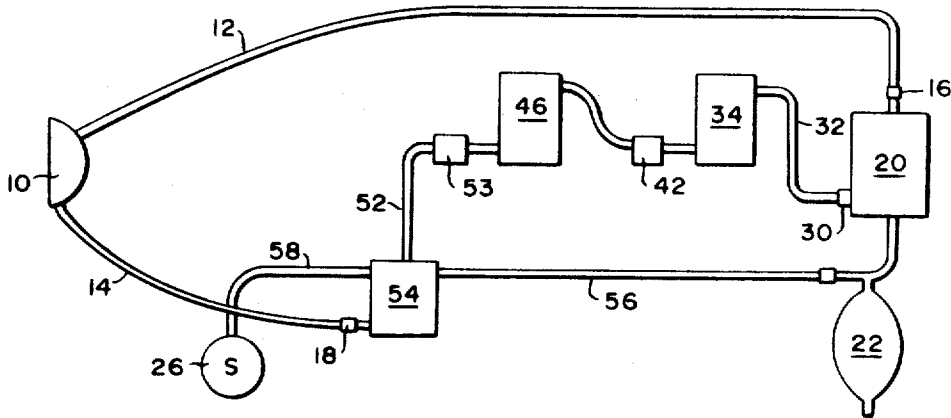


FIG. 5

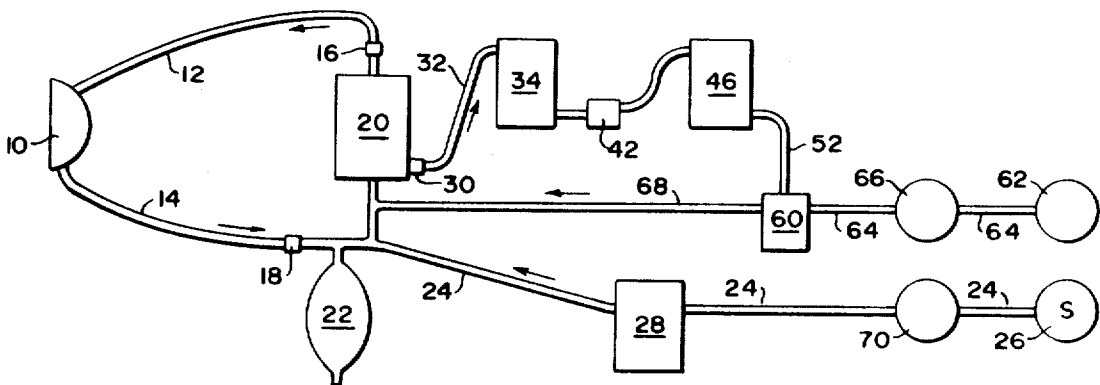


FIG. 6

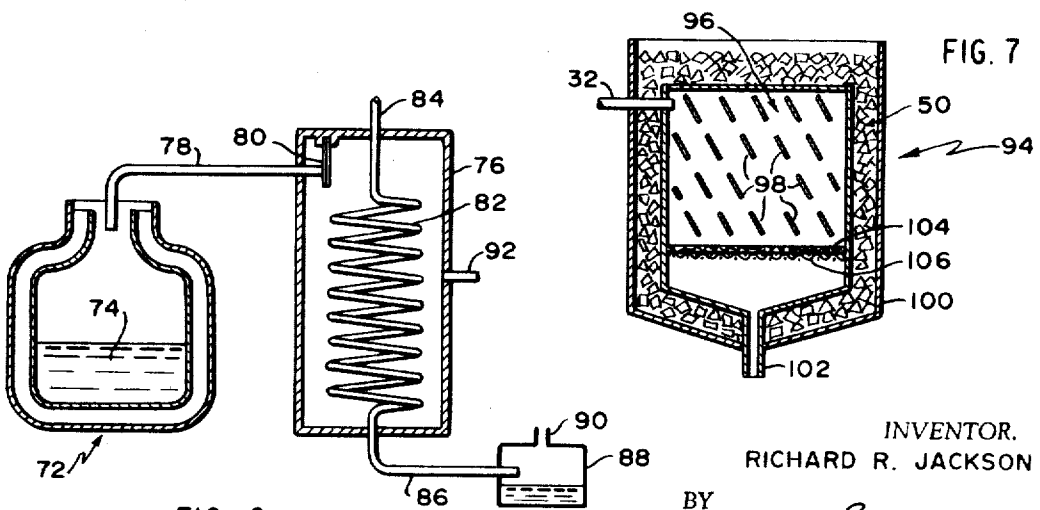
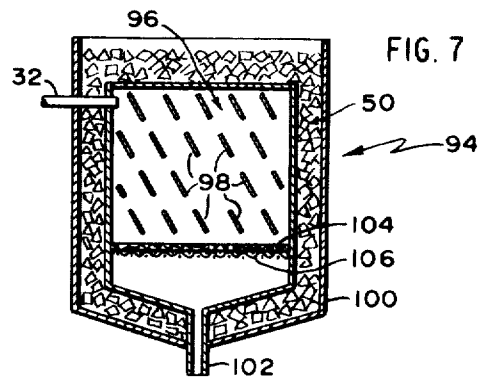


FIG. 7



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RECOVERY OF ANESTHETIC AGENTS

SUMMARY OF THE INVENTION

My invention is directed to a method and apparatus for increasing the efficiency of existing systems for administering an inhalation anesthetic agent to a patient. More particularly, it relates to those anesthetic delivery systems in which a portion of the anesthetic agent which is delivered to but not taken up by the patient normally is exhausted to the atmosphere. It is among the primary objects of my invention to provide a method and apparatus for recovering that portion of the anesthetic agent which normally is exhausted from such a system. My invention is particularly useful when the employed anesthetic agent is relatively expensive, such as halothane which is a commonly used name for 2-bromo-2-chloro-1, 1, 1-trifluoroethane.

A number of systems have been employed in the prior art to deliver a gaseous mixture bearing an inhalation anesthetic to a patient. Among the more common of these systems are the "open system" in which that portion of the delivered gaseous mixture which is not taken up by the patient is exhausted completely to the atmosphere and there is no recirculation of any portion of the gaseous mixture to the patient. In an alternative technique, known as the "closed system," the anesthetic gases are delivered to the patient and the gases not taken up by the patient then are returned to the circuit so that there is a negligible loss of gas to the atmosphere. In the closed system the rate with which the patient's tissues take up the anesthetic agent is dependent on the amount of agent added to the circuit. When administering the anesthesia with a closed circuit system, the amount of agent added to the circuit must be carefully controlled so that as the patient's rate of uptake decreases the amount of agent added as the circuit is reduced. Failure to reduce accurately the quantity of agent added to the system, as the depth of anesthesia increases, may tend to cause the patient to become saturated with anesthetic to a degree in excess of that which is necessary for maintenance of anesthesia. If the rate of introduction of anesthetic into the closed circuit is not controlled properly the patient may become saturated dangerously to the degree where cardiac arrest or dangerously low blood pressure may occur.

Another system, preferred in a great number of instances, is the "semiclosed system," in which a portion of the gases flowing through the circuit is exhausted from the circuit. This arrangement permits fresh gases to be introduced into the circuit at a relatively high flow rate. It has been found that when the fresh gas is introduced into the circuit at a flow rate that is considerably greater than the respiratory rate or minute volume of the patient, the tendency for the patient to become saturated excessively with the agent is reduced materially. This eliminates the need to monitor and adjust continually the amount of anesthetic agent introduced into the system as the patient's depth of anesthesia increases. One of the disadvantages of employing the semiclosed technique is that a considerable portion of the anesthetic agent, which is not taken up by the patient is exhausted to the atmosphere. When employing costly anesthetic agents, such as halothane, this procedure may become quite expensive. It is among the primary objects of my invention to provide an arrangement for recovering that portion of the anesthetic agent that normally is exhausted to the atmosphere. Recovery of the exhausted anesthetic agent enables the semiclosed technique to be employed with an economy approaching that of the closed system.

In accordance with my invention the exhausted gas is collected and then is processed, externally of the anesthesia circle, to remove the particular anesthetic component. The anesthetic then may be readmitted to the circle for immediate reuse or may be stored for use at a later time. A number of methods may be employed for extracting the anesthetic component from the exhausted gas, the illustrative embodiments of my invention employing either a cryogenic or absorption technique.

In the semiclosed system the gases are exhausted from the circle at a location that is downstream from the patient uptake station or inhalation mask so that the exhausted gas may be saturated with water vapor exhaled by the patient. In accordance with the invention, it is desirable to remove as much of this water vapor as possible from the exhausted gas before the anesthetic agent is extracted. This may be effected by passing the gas through a scrubber of hygroscopic material such as silica-gel or, preferably, by cooling the gas to a temperature at which the water vapor will condense to a liquid phase. The remaining gas, which includes the anesthetic agent is then extracted by further cooling to a yet lower temperature at which the anesthetic agent will condense to its liquid phase. The liquid anesthetic agent then may be readmitted directly into the vaporizer of the anesthesia circle and thus be reused immediately.

In addition to the exhaled water vapor, the exhausted gas will contain additional contaminants exhaled by the patient, such as carbon dioxide and, possibly, hydrocarbon gases. In addition, the patient may have been anesthetized earlier with another anesthetic agent and the exhaled gases may include this as well. Another aspect of my invention is directed to a technique and an arrangement for readmitting the anesthetic to a secondary vaporizer, located externally of the anesthesia circle, to isolate the contaminants so that they may be in communication only with the patient from which they originated as well as to preclude contamination of the main source of anesthetic agent.

My technique may be employed to extract the anesthetic agent by a condensation process which enables immediate reuse of the condensate or, alternatively, to the anesthetic agent from the exhausted gas by passing the gas through a material which is capable of absorbing the particular anesthetic agent. For example, when halothane is employed as the anesthetic agent, activated charcoal may be used as the absorbent material. The absorbent material bearing the agent then may be retained for processing at a later time to extract and purify the agent.

Other objects and advantages of my invention will be apparent from the following detailed description with reference to the accompanying drawings in which like reference characters indicate like elements, and wherein:

FIG. 1 is an illustration of a conventional semiclosed system for administering an inhalation anesthetic;

FIG. 2 is an illustration of an embodiment of my invention by which the inhalation anesthetic is recovered by a cryogenic process;

FIG. 3 is an illustration of a conventional semiclosed system, modified in accordance with my invention to recover the anesthetic agent which normally would be exhausted to the atmosphere;

FIG. 4 is an illustration of a closed system employing my technique of recovering the anesthetic agent;

FIG. 5 shows an anesthetic delivery system including means for recovering the uninspired anesthetic agent and means for isolating the recovered agent to preclude contamination of the primary source of anesthetic;

FIG. 6 shows an alternative arrangement for extracting cryogenically the anesthetic agent from the uninspired gas; and

FIG. 7 is an illustration of another technique for extracting the anesthetic agent.

As shown in FIG. 1, the conventional semiclosed system for delivering an inhalation anesthetic agent to a patient includes a breathing mask 10 which is positioned over the patient's mouth and into which the patient breathes. An inlet hose 12 and an outlet hose 14 are connected to the mask 10 respectively, to deliver a flow of fresh gas to the mask 10 and to conduct the mixed exhaled gas and uninspired gases away from the mask 10. The hoses 12, 14 are provided with one-way valves 16, 18 which insure unidirectional flow through the mask 10. Because the gaseous mixture flowing through the outlet hose 14 includes a component of exhaled gases, such as carbon dioxide, it is common practice to process the gas flow-

ing through the outlet hose 14 to remove the carbon dioxide before that gas is recircled through the inlet hose 12 to the mask 10. To this end a canister 20 is connected to the downstream end of the outlet hose 14. The canister 20 is filled with a material which absorbs readily carbon dioxide, such as soda-lime. The inlet hose 12 is connected to the other end of the canister 20 to receive and conduct the processed gas, which includes a previously uninspired portion of inhalation anesthetic, to the mask 10. A conventional reservoir bag 22 may be connected to the outlet hose 14 downstream of the one-way valve 18. The circuitous path defined by the inlet hose 12, mask 10, outlet hose 14 and canister 20 is referred to commonly as the "anesthetic circle."

In the semiclosed system shown in FIG. 1, a fresh mixture of gases, including the anesthetic agent, is introduced continually to the anesthetic circle through the hose 24 which leads into the outlet end of the canister 20 so that the gases flowing through the hose 24 may mix with the processed gas that has passed through the soda-lime in the canister 20. This mixture is then delivered through the one-way valve 16 and inlet hose 12 to the breathing mask 10. The fresh, gaseous mixture passing through the hose 24 may include a mixture of oxygen and nitrous oxide which may be supplied in the desired proportions from a source 26. The anesthetic agent is combined with the nitrous oxide-oxygen mixture by means of a vaporizer 28 which is interposed along the hose 24. The vaporizer 28 contains a supply of liquid anesthetic agent, and is effective to vaporize the anesthetic agent so that it will mix, in predetermined and controllable ratios, with the oxygen-nitrous oxide mixture flowing into the vaporizer 28. The flow rates employed and the proportions in which the various gases are mixed depends on the type of delivery system employed, the type of anesthetic agent utilized as well as the needs of the particular patient to be anesthetized. For example, in a semiclosed system in which halothane is employed as the anesthetic agent, the flow rate may be between 2—7 liters per minute of nitrous oxide-oxygen mixture of which approximately 0.5—2.5 percent of which is vaporized halothane. A number of such vaporizers are available commercially, and, although they operate under somewhat different principles, they all are effective to produce the same results of vaporizing and mixing the anesthetic agent with the fresh flow of gas introduced to the anesthetic circle.

One of the characteristics inherent in the semiclosed system is that the gaseous mixture flows through the anesthetic circle at a flow rate that is greater than the uptake rate of the patient. Furthermore, because fresh gases are being introduced continually to the anesthetic circle by the supply hose 24, it is necessary to bleed or otherwise permit some of the gas to be exhausted or otherwise escape from the anesthetic circle. This is accomplished commonly by means of a pressure responsive "pop-off" valve 30, formed integrally with canister 20 and which is effective to enable the excess gas in the circle to be exhausted to the atmosphere. The pop-off valve 30 is located in the anesthetic circle so that the gas which escapes through the valve 30 comes from the outlet hose 14. Because one of the gaseous components flowing through the outlet hose 14 includes that portion of the anesthetic agent which was not taken up by the patient at the mask 10, some of this excess anesthetic necessarily will be exhausted to the atmosphere through the pop-off valve 30. This practice can become quite expensive when employing a costly anesthetic agent and it is among the primary objects of my invention to collect the gaseous mixture which normally would be exhausted and then to extract the anesthetic agent therefrom so that it may be reused.

A number of methods may be employed for extracting the anesthetic agent from the exhausted gas. It should be noted that the gas flowing from the mask 10 to the hose 14 will include a number of gaseous constituents generated and exhaled by the patient in addition to the uninspired anesthetic and carbon dioxide. Among the more common of the exhaled constituents which is present in a significant concentration is

water vapor, and, in the preferred embodiment of my invention, a considerable portion of the water vapor is removed initially from the gas.

As shown in FIG. 2, which illustrates an arrangement for extracting the anesthetic agent, the exhausted gas is collected in a bleed hose 32 which conducts the gas to a first condenser 34. The condenser 34 includes a condenser coil 36 which is in communication with the bleed hose 32, the coil 36 being immersed in an ice-water bath 38. By reducing the temperature of the gas to this level, most of the water vapor present in the gas will condense on the inner walls of the coil 36. The coil 36 terminates in an outlet to 40 which is connected to a water trap 42. The water trap is effective to permit the remaining gases to pass therethrough into the tube 44, but to preclude the condensed water vapor from passing therethrough. It should be noted that little, if any, of the anesthetic agent will be condensed when reduced to the temperature (0° C.) of the first condenser 34. This is due to the fact that anesthetic agents, such as halothane are of markedly greater volatility than water and are characterized by their considerably greater vapor pressures for a given temperature. After passing through the water trap 32, the remaining gases are passed through a second condenser 46 which includes a condenser coil 48 which is immersed in solid carbon dioxide ("dry ice") at a temperature of approximately minus 70° C. Reduction of the temperature to this level is effective to reduce the vapor pressure of the anesthetic agent to a level wherein it will condense to the liquid phase on the inner surface of the coil 48. For example, when subjecting a halothane-bearing mixture to the second condenser 46, the partial pressure of the halothane is reduced to less than 1 millimeter Hg. which is adequate to enable condensation and recovery of practically all of the halothane. A drip tube 52 is connected to the outlet of the coil 48 and directs the condensed agent to a container 54 in which it may be collected. Other arrangements, such as a silica-gel scrubber, may be employed, in place of the condenser arrangement for removing the water vapor from the collected gas before extraction of the anesthetic agent.

The foregoing cryogenic arrangement for extracting the anesthetic agent from the gas is shown, in FIG. 3, as employed in a conventional semiclosed anesthetic delivery system. In this arrangement the bleed hose 32 is connected directly to the pop-off valve 30 to collect and conduct the gases, which normally would be exhausted to the atmosphere, to the condensers 34 and 46. The drip tube 52, leading from the second condenser 46 is connected to a liquid trap 53 which retains the condensed agent that permits the remaining, unwanted gases to be eliminated from the system. The trap is connected to the vaporizer 28 to enable the recovered liquid anesthetic to be readmitted into the delivery system.

The foregoing arrangement may be employed in a semiclosed system in which the vaporizer 28 is located outside the anesthetic circle, as described thus far, or in an arrangement in which the vaporizer is located within the anesthetic circle. Such an arrangement is shown in FIG. 4 and includes a vaporizer 54 which receives the flow from the outlet hose 14 and which is connected to the inlet of the canister 20 by the hose 56. The source 26 of the fresh gases is connected to the vaporizer 54 by the conduit 58. The anesthetic agent which is extracted from the exhausted gas is readmitted to the anesthetic circle by the drip-tube 52 and liquid trap 53 which is connected to the vaporizer 54.

Because the patient may emit a variety of contaminant gaseous constituents from his lungs, such as volatile hydrocarbons or traces of another anesthetic agent that was previously administered to the patient, it may be desirable to isolate the exhausted gas and the anesthetic agent extracted therefrom from the main source of agent stored in the vaporizer. This is particularly true if it is not possible practicably to eliminate these contaminants from the recovered anesthetic agent. In order to avoid contamination of the main supply of anesthetic agent which is retained in the vaporizer, an arrangement may be employed, in accordance with my invention, to isolate the ex-

tracted anesthetic agent from that contained in the vaporizer. As shown in FIG. 5, this arrangement includes an anesthetic circle system in which a small, secondary vaporizer 60 is employed to collect the extracted anesthetic agent from the drip tube 52. No portion of the collected anesthetic is redirected to the main vaporizer 28 so that if any contaminants are present in the extracted anesthetic agent, they will not affect the purity of the main supply of anesthetic agent in the main vaporizer 28. The recovered anesthetic is vaporized in the secondary vaporizer 60 and is combined with an oxygen-nitrous oxide mixture which flows from a source 62 through the conduit 64 into the secondary vaporizer 60. A fine flow meter 66 is interposed along the conduit 64 to regulate the flow of fresh gas through the secondary vaporizer 60 so that the relatively low flow of gaseous mixture from the secondary vaporizer 60 back to the anesthetic circle along the conduit 68 will contain a large proportion of agent, for example, of the order of 30 percent concentration. This mixture, introduced to the anesthetic circle through the conduit 68, is supplemented by and mixed with a flow of fresh gas from the source 26 which is regulated by the coarse flow meter 70. The flow meter 70 is adjusted so that the fresh gases which are mixed with the vaporized anesthetic agent in the main vaporizer 28 will be delivered to the anesthetic circle along the conduit 24 at a flow rate and concentration which will dilute the relatively low flow and high concentration of the gas introduced along the conduit 68 to a concentration which may be safely administered to the patient. It will be appreciated that this arrangement isolates completely the extracted anesthetic agent and any contaminants contained therein from the main supply of anesthetic in the main vaporizer 28.

It should be appreciated that other arrangements may be provided for cooling the exhausted gas to extract the anesthetic agent in its liquid phase. Such an alternative arrangement is shown in FIG. 6 and includes a source 72 of liquid oxygen 74 at a temperature of approximately minus 220° C. As shown in FIG. 6, the source 72 may comprise a Dewar flask. The oxygen is admitted to an insulated condenser 76 by a tube 78, the outlet of which is controlled by a thermostatic valve 80 which is adapted to regulate the flow of oxygen into the condenser 76, thereby to maintain the condenser at a temperature which is sufficient to condense substantially all of the anesthetic agent but which will not render the agent too viscous to handle. For example, when the anesthetic agent is halothane the thermostatic valve 80 should control the admission of oxygen so that the temperature within the condenser 76 is of the order of minus 70° C. A condenser coil 82 is contained within the condenser 76 and receives the predried gas through the inlet 84 and directs the condensed anesthetic agent to the outlet 86 into a trap 88 which retains the recovered fluid anesthetic agent. The trap 88, of course, is provided with a vent 90 through which the unrecovered, unwanted gases may escape to the atmosphere. The recovered anesthetic agent may be stored for subsequent use or may be readmitted directly into the anesthetic circle in the manners described above. Additionally, the condenser 76 may be provided with an outlet for the evaporated oxygen which may be redirected to the source of the fresh gas flow.

My invention, as described thus far, relates to an arrangement in which the water vapor is extracted from the exhausted gaseous mixture before and in separate step from the extraction of the anesthetic agent. In some instances, however, it may be desirable to separate simultaneously the water vapor and anesthetic agent by employing an arrangement as shown in FIG. 7. This arrangement differs from those described previously in that the bleed hose 32 from the pop-off valve 30 leads directly into the upper end of a cryogenic condenser 94. The condenser 94 includes an internal chamber 96 in which is mounted a plurality of condenser plates 98. The chamber 96 is maintained at a temperature that is low enough to condense substantially all of the anesthetic agent introduced into the chamber 96 through the bleed hose 32. Thus, when it is desired to extract halothane, the chamber 96 may be main-

tained at approximately -70° C by immersing the chamber 96 in a bath of solid carbon dioxide 50' and chamber 96. Other techniques may be employed to maintain the chamber 96 at the desired temperature. When the exhausted gas flows through the bleed hose 32 into the chamber 96 it will be subjected to an immediate and rapid temperature drop which will cause the water vapor in the exhausted gas to condense rapidly into minute ice particles ranging in size from approximately 0.5 to 20 microns in diameter. The temperature of the chamber 96 will cause the anesthetic agent to condense to its liquid phase on and about the condenser plates 98 from which the condensed anesthetic agent may drip downwardly toward an outlet 102 formed in the bottom of the chamber 96. The ice particles will also gravitate and drift downwardly toward the outlet 102 and may form a slurry with the condensed anesthetic agent. The ice particles are separated from the condensed anesthetic agent and other gases passing through the chamber 96 by means of a suitable filter 104, such as is available commercially from the Millipore Corporation. For example, a Millipore filter effective to block the passage of particles 1 micron in diameter and smaller would be suitable to separate most of the frozen ice particles, yet would permit the condensed liquid anesthetic agent and other gases to pass therethrough and drip or flow through the outlet 102. The filter 104 may be supported in any number of ways, as by a mesh or screen 106 having enlarged pores or passages, for example, of the order of one-sixty-fourths square inch. The condensed anesthetic agent flowing through the outlet 102 may be collected or may be returned to the anesthetic circle in the same manner as described above with regard to the other illustrative embodiments of my invention. Thus, by subjecting the exhausted gaseous mixture to a rapid, extreme temperature drop, the water vapor may be extracted at substantially the same time as the anesthetic agent thereby eliminating the need for preliminary extraction of the water vapor from the exhausted gas.

Although the foregoing cryogenic techniques are particularly useful for extraction of an anesthetic agent and permitting the extracted agent to be readmitted directly and immediately to the anesthetic circle, other techniques may be employed to recover the anesthetic. For example, an absorption technique may be employed in which the gas which normally would be exhausted is passed through an absorbent material in which the anesthetic agent is retained. After the absorbent material has become saturated with the anesthetic, it may be processed at a later time to remove the anesthetic agent. For example, activated charcoal displays an extremely high affinity for halothane. Thus when recovering halothane with activated charcoal, the water vapor in the exhausted gas is removed initially and then the remaining gas is passed through the activated charcoal which will absorb and retain the halothane, gram for gram. The charcoal is subjected subsequently to a reduced pressure distillation process at a later time. This technique is advantageous in that it is extremely simple and provides complete absorption.

It should be appreciated that, although the invention has been described herein primarily as being employed in a semiclosed system, it is equally suitable for recovery of the anesthetic agent exhausted to the atmosphere in an open system or any other system in which all or a portion of the anesthetic agent which is not taken up is exhausted to the atmosphere.

It should be understood that the foregoing description is intended merely to be illustrative of my invention and other modifications and embodiments will be apparent to those skilled in the art without departing from its spirit.

Having thus described my invention, I claim:

1. In a method for administering, to a patient, a gaseous mixture which includes a component of inhalation anesthetic, said gaseous mixture being supplied continuously to the patient along a circular path and at a flow rate that is in excess of the patient's rate of uptake and wherein a portion of said gaseous mixture which is not taken up by the patient normally is

exhausted from said circular path to the atmosphere, a method of recovering the anesthetic agent from said exhausted gaseous mixture comprising:

collecting said exhausted portion of said gaseous mixture externally of said circular path;
 extracting said anesthetic agent from said collected gas externally of said circular path; and,
 readmitting said extracted anesthetic agent into said circular path to recombine said anesthetic agent with said gaseous mixture that is being supplied to the patient.

2. A method as defined in claim 1 wherein said step of extracting said anesthetic agent is preceded by the step of extracting water vapor from said collected gas.

3. The method as defined in claim 2 wherein said step of extracting said water vapor from said collected gas comprises:
 cooling said collected gas to a temperature wherein the water vapor in said gas condenses to the liquid phase.

4. A method as defined in claim 3 wherein said step of cooling said gas to condense said water vapor comprises:
 passing said collected gas through a condenser; and
 maintaining said condenser at a temperature that approximates 0° C.

5. The method as defined in claim 2 wherein said step of extracting water vapor from said selected gas comprises:
 passing said gas through a scrubber having a relatively high affinity for water vapor.

6. The method as defined in claim 5 wherein said scrubber is formed from silica-gel.

7. In a method for supplying a gaseous mixture to an uptake station, said gaseous mixture including an inhalation anesthetic agent, the improvement comprising, in combination:

supplying a carrier gas to a vaporization station;
 combining the vaporized phase of said anesthetic agent with said carrier gas at said vaporization station thereby to form a mixture of said carrier gas and anesthetic agent;
 conducting said gaseous mixture along a first path to said uptake station thereby to enable a patient to inspire a portion of said gaseous mixture as it flows past said uptake station;
 conducting the uninspired portion of said gaseous mixture and the gases expired by the patient away from said uptake station along a second path;
 extracting said anesthetic agent from said gas conducted along said second path; and
 readmitting said extracted anesthetic agent to said vaporization station.

8. In a method of supplying a gaseous mixture including a component anesthetic agent by providing a circular path for conducting substantially unidirectional gaseous flow past an induction station at which gases may be inspired from or expired into said circular path and in which a portion of the gaseous mixture expired into said circular path is exhausted from said circular path, the improvement comprising, in combination:

supplying a carrier gas to a vaporization chamber which is in communication with said circular path;
 vaporizing said anesthetic agent at said vaporization station and combining said vaporized anesthetic with said carrier gas thereby to form an anesthetic bearing carrier gas;
 conducting said gaseous mixture from said vaporization station to said circular path to enable said anesthetic agent to flow to said induction station;
 collecting that portion of said gaseous mixture which is exhausted from said circular path;
 extracting the anesthetic agent from said collected gaseous mixture; and
 readmitting said extracted anesthetic agent into said circular path.

9. A method as defined in claim 8 wherein said extracted agent is readmitted at said vaporization station.

10. A method as defined in claim 8 wherein the step of extracting the anesthetic agent from said collected gaseous mixture

is preceded by the step of extracting water vapor from said collected portion of said gaseous mixture.

11. A method as defined in claim 8 wherein the gas expired into said circular path at said induction station includes a component of carbon dioxide and wherein said method further comprises:

eliminating said carbon dioxide from said gas flowing through said circular path.

12. A method as defined in claim 8 wherein said step of readmitting said extracted anesthetic agent into said circular path comprises:

conducting said extracted anesthetic agent to a secondary vaporization station;

supplying a carrier gas to said secondary vaporization station;

vaporizing said extracted anesthetic agent within said secondary vaporization station thereby to form a secondary mixture of carrier gas and anesthetic agent; and

conducting said secondary mixture from said secondary vaporization station into said circular path.

13. An apparatus for delivering an inhalation anesthetic agent comprising:

circular gas flow conduction means;

gaseous exchange means interposed along said circular conduction means for enabling gas to be inspired from and expired into said circular conduction means;

means for vaporizing said anesthetic agent and for combining said vaporized anesthetic agent with a carrier gas, thereby to form a first gaseous mixture;

means communicating said vaporizing means with said circular conduction means to enable said first gaseous mixture to flow into and through said circular conduction means;

means for effecting substantially unidirectional flow of gas within said circular conduction means in a direction that will cause said first gaseous mixture to flow from said vaporizing means to said gaseous exchange means;

means interposed along said circular conduction means downstream of said gaseous exchange means, for exhausting from said circular conduction means a portion of a second gaseous mixture flowing from said exchange means;

means for collecting said exhausted second gaseous mixture externally of said circular conduction means; and

means for extracting the component of anesthetic agent from said collected, second gaseous mixture while said second gaseous mixture is external of said circular conduction means.

14. An apparatus as defined in claim 13 further comprising:
 means for readmitting said extracted anesthetic agent into said circular conduction means.

15. An apparatus as defined in claim 14 wherein said means for readmitting said extracted anesthetic agent into said circular conduction means comprises:

means communicating said anesthetic extracting means with said vaporizing means.

16. A device as defined in claim 13 further comprising:
 means for extracting water vapor contained within said second gaseous mixture before said anesthetic agent is extracted therefrom.

17. An apparatus as defined in claim 16 wherein said means for extracting said water vapor and said anesthetic agent comprises:

means for cooling said second gaseous mixture to a temperature wherein substantially all of the water vapor present therein is condensed to the liquid phase; and

means for thereafter cooling the remaining components of said second gaseous mixture to a degree wherein said anesthetic agent is condensed into a liquid phase.

18. An apparatus as defined in claim 16 wherein said means for extracting said water vapor from said gaseous mixture comprises a silica-gel scrubber.

19. An apparatus as defined in claim 13 wherein said means for extracting said anesthetic agent from said second gaseous mixture comprises:

means for cooling said second gaseous mixture to a temperature wherein said anesthetic agent is condensed to its liquid phase.

20. An apparatus as defined in claim 19 further comprising: means for extracting water vapor contained within said second gaseous mixture before said anesthetic agent is extracted therefrom.

21. An apparatus as defined in claim 20 wherein said means for extracting said water vapor comprises:

means for cooling said second gaseous mixture to a temperature wherein substantially all of the water vapor present therein is condensed to the liquid phase.

22. An apparatus as defined in claim 20 wherein said means for extracting said water vapor from said gaseous mixture comprises a hygroscopic material through which said second gaseous mixture is passed.

23. An apparatus as defined in claim 14 wherein said means for readmitting said extracted anesthetic agent to said circular conduction means comprises:

secondary anesthetic vaporizing means;

means for delivery said extracted anesthetic agent to said secondary vaporizing means;

means communicating a secondary carrier gas to said secondary vaporizing means, thereby to form a third gaseous mixture;

means communicating said third gaseous mixture from said secondary vaporizing means to said circular conduction means.

24. An apparatus as defined in claim 13 wherein said means for extracting the component of anesthetic agent from said collected, second gaseous mixture further comprises:

means for extracting water vapor contained within said second gaseous mixture at substantially the same time as said extraction of said anesthetic agent therefrom.

25. An apparatus as defined in claim 24 wherein said means for extracting said water vapor and said anesthetic agent at substantially the same time comprises:

a condensing chamber;

means for communicating said second gaseous mixture to said condensing chamber;

means maintaining said chamber at a reduced temperature level at which the water vapor in said second gaseous mixture will freeze immediately into minute ice particles and wherein the anesthetic agent in said second gaseous mixture will condense to the liquid phase; and

means for separating said ice particles from said condensed anesthetic agent.

26. An apparatus as defined in claim 25 wherein said means for separating said ice particles and said condensed anesthetic agent comprises:

a filter disposed within and at the bottom of said chamber said filter being adapted to block said ice particles but to enable said anesthetic agent to pass therethrough; and means enabling said filtered anesthetic agent to be collected.

27. In apparatus as defined in claim 25 further comprising: means for readmitting said extracted anesthetic agent to said circular conduction means.

28. A method as defined in claim 1 further comprising: extracting the water vapor from said collected gas at substantially the same time as said extraction of said anesthetic agent therefrom.

29. A method as defined in claim 28 wherein said step of extracting said anesthetic agent and said water vapor from said collected gas at substantially the same time comprises:

subjecting said collected gas to rapid temperature drop to a degree wherein said water vapor condenses into fine ice particles and wherein said anesthetic agent is condensed to the liquid phase; and

separating said solidified ice particles from said condensed anesthetic agent.

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