ANESTHETIC VAPORIZER APPARATUS

Forrest D. Hamn, Madison, Wis., assignor to Air Reduction Company, Incorporated, New York, N. Y., a corporation of New York

Application November 8, 1955, Serial No. 545,734
11 Claims. (Cl. 126—188)

This invention relates to apparatus for administering inhalation anesthetics to patients and more particularly to apparatus for vaporizing and administering the vapors of volatile liquid anesthetic agents in admixture with air or oxygen.

Certain volatile agents, such as for example, trichloroethylene, have been found to be relatively difficult to vaporize as compared to the more volatile liquid anesthetics such as ethyl ether. Consequently, it is sometimes difficult with ordinary vaporizing apparatus to produce concentrations of these vapors that are satisfactory for induction or for maintaining a patient, in a state of anesthesia or analgesia. One of the objects of the present invention is to provide an improved anesthetic vaporizer apparatus which is particularly adapted to vaporize liquid anesthetic agents of relatively low volatility and to administer controlled mixtures of such anesthetic vapors with air oxygen.

Certain aspects of the present invention are more specifically concerned with vaporizers of the portable type that are of relatively compact construction and are intended to be held in the hand of the patient or, in some instances, strapped or otherwise secured in some manner to the patient. These vaporizers are particularly useful and have found wide acceptance in the fields of obstetrics and dentistry largely because of the physical and psychological comfort they accord to the patient and because of the permissibility for enlisting the cooperation of the patient during treatment. Thus, the patient has a greater freedom of movement than is afforded with the conventional stationary type anesthetic vaporizing and administering apparatus. The patient in response to directions from the doctor or dentist may act in concerted effort during treatment, without the usual encumbrances of stationary anesthetic apparatus. The location of the portable vaporizers in the immediate vicinity of the field of treatment also facilitates the adjustment of the anesthetic apparatus for control of the anesthetic concentrations delivered to the patient.

In spite of the several advantages of the portable vaporizers for certain fields of application, however, there are certain inherent deficiencies, as yet not satisfactorily overcome, which detract from the potential utility of this type apparatus. Thus, for example, the movements of the vaporizer, occasioned by the actions of the patient, produce displacement of the liquid reservoir therein causing a varying output of anesthetic concentrations to the patient which has heretofore necessitated readjustment of the vaporizer settings for maintenance of stable mixtures. The splashing of the liquid in a vaporizer, also, potentiates the access of the liquid to the gas delivery passages, thus requiring the provision of suitable means for preventing inadvertent occlusion of these passages, and for preventing spillage of the liquid supply. Furthermore, in certain special applications, such as in the head-mounted type portable vaporizer used in dentistry, the conventional arrangements of such apparatus for conveyance of the patient's tidal exchange gases have given rise to certain objections. In particular, the apparatus heretofore available has not been completely satisfactory due to the characteristic construction in which the exhalation gases are discharged immediately in the patient's facial area, where these gases cause discomfort to the dentist or other person whose close proximity to the patient is necessitated during treatment.

It is a further object of the present invention, therefore, to provide improved apparatus of the portable type for the volatilization of liquid anesthetic agents which is capable of producing and delivering inhalation mixtures containing controlled concentrations of volatilized anesthetic vapors and which is adapted to maintain such controlled mixtures substantially uniform during administration.

It is a further object of the present invention to provide such apparatus for the administration of anesthetic mixtures wherein the inhalant anesthetic mixtures may be controlled and maintained substantially uniform, independently of the position and manner of movement of the vaporizer.

It is a further object of the present invention to provide an improved, portable, anesthetic vaporizer apparatus having an anti-splashage construction which is effective to retain the volatile liquid agent and prevent occlusion of the gas delivery passages regardless of the orientation and movement of the vaporizer encountered in use.

A still further object of the present invention is to provide an improved portable vaporizer apparatus of the head-mounted type which is of an especially compact construction and designed to overcome the problems of adequate vaporization, control of anesthetic mixtures, and spillage of the liquid agent mentioned above.

It is a further object of the present invention to provide such an improved head-mounted type vaporizer apparatus wherein the patient's exhalation gases are effectively discharged away from the patient's facial area to avoid accumulation of such gases in this zone for the greater comfort of the attendants whose close proximity is required.

It is a still further object of the present invention to provide anesthetic administering apparatus of the type herein described having improved means of particularly compact construction for the formation of relatively concentrated anesthetic vapor-air mixtures and for controllably effecting the dilution of such mixtures prior to administration to the patient.

These and other advantages and features of the present invention will be better understood by referring to the following description of a preferred embodiment of the invention and the accompanying drawings illustrative thereof in which:

Fig. 1 is a side elevation in section illustrating, as preferred embodiment of the present invention, a head-mounted vaporizer apparatus, including a vaporizer body and an inhaler, which is adapted to be worn on the head of a patient, as shown;

Fig. 2 is a vertical section view taken substantially along the line 2—2 in Fig. 1, looking in the direction of the arrows.

Fig. 3 is a view in reduced scale illustrating the vaporizer apparatus, showing the manner in which it is worn by the patient, and illustrating permissible angular changes of position;

Fig. 4 is a sectional plan view taken along the line 4—4 in Fig. 1, looking in the direction of the arrows, showing the cylindrical construction of the vaporizer body and the arrangement of the cylindrical wick in the vaporizing chamber;

Fig. 5 is a sectional plan view taken along the line...
5—5 in Fig. 1, looking in the direction of the arrows, showing the intake ports of the annular shaped mixing valve; and,

Fig. 6 is a sectional plan view taken along the line 6—6 in Fig. 1, looking in the direction of the arrows, showing the partitioned construction of the inhaler body and the visible upper sides of the inhalation and exhalation back valve assemblies.

Referring now to the drawings, an anesthetic vaporizing apparatus representing a preferred embodiment of the present invention is shown in Figs. 1, 2 and 3, designated generally by the numeral 10. As best seen in Fig. 3, the vaporizer apparatus, basically, comprises a cylindrical vaporizing chamber 12 and an inhaler 14 in which the patient breathes. Appropriate control of the anesthetic mixtures is afforded by means of a mixing valve hereinafter described, the external accessible portion of which is shown at 18, forming a circumferentially extending rib projecting through the side wall of the vaporizer container where it is, at all times, readily accessible for adjustment.

The internal construction and details of the vaporizer are best seen in Figs. 1, 2 and 4 to 6. Referring now to Fig. 1, it may be seen that the container 11 comprises a substantially cylindrical shell having at its upper end a perforated cover plate 19 and having arranged substantially along its central longitudinal axis a pair of concentric gas conducting tubes 20 and 22. The tubes 20 and 22 are joined by spacing rings 24 and 26 in the annular space therebetween and rest at their lower ends on a plate 28 which together with a cup-shaped shell form a bottom closure for the vaporizer container 11. As may best be seen in Fig. 2, a partition 32 is arranged in the bottom shell of the container which effectively divides the space therein to form an inhalation chamber 34 and an exhalation chamber 36 through which the inhalation and exhalation gases respectively pass as shown in said manner as will hereinafter be described. The central tube 22 opens through the plate 28 and connects at its lower end with the exhalation chamber 36. To accommodate the lower end of the tube member, the dividing partition 32 is provided with a cylindrical offset 38, seen also in Fig. 6, at the center thereof. At its upper end the tubular member 22 opens to the atmosphere through a flared portion 40 that rests against the underside of the perforated cover 19 at the top of the container. The central tubular member thus provides an exhalation passage through which gas is delivered from the exhalation chamber 36 at the bottom of the vaporizer container upwardly therethrough, and discharged to the atmosphere.

Beneath the perforated plate 19 and surrounding the flared portion of the central tube is provided a space 42 which receives atmospheric gases through the openings of perforated plate 19. This chamber 42 is the upper, open end of a concentric tube 44 formed between the concentric tubes 20 and 22. This passage bottoms on the annular spacing ring 24 which separates the upper annular passage from the lower passage 46, also formed in the annular space between the tubular member 22 and the wall of the outer tube 28 above the dividing partition 24 and a second similar series of circumferentially spaced openings 48 are formed below said dividing partition. These openings connect the upper and lower annular passages 44 and 46 respectively with the space 50 between the tubular member 20 and the cylindrical walls of container 11. This space, confined at its upper end by a plate 52 and at its lower end by a plate 54, constitutes the vaporizing chamber in which is placed a supply of the liquid agent to be vaporized. A spout 56 having a closing cap 58 in the plate 52 for charging the vaporizing chamber with a desired amount of the liquid agent which preferably is added so as to fill the annular vaporizing chamber 50 up to the level indicated by the dotted line 60. It will be seen that in the arrangement thus provided atmospheric gases are delivered from the directly 42 the top of the vaporizer container, downwardly through the annular inhalation passage 44 between the tubular members, thence through openings 47 into the vaporizing chamber 50, from whence the atmospheric gases substantially saturated with the volatilized vapor pass from the chamber 50 through the lower openings 49 into the lower annular inhalation passage 46.

Arranged within the annular vaporizing chamber 50 to facilitate the volatilization of the liquid agent therein is a cylindrical wick 62 that is spaced inwardly from the side wall of the container 11. The cylindrical wick 62 is spaced from the internal surface of any suitable material such as wool felt, extends from the top to the bottom of the vaporizer chamber and is provided at each of its ends with serrations 64 that permit a short length at each end of the wick to be flexed outwardly toward the sides of the container as seen at 65. By appropriately spacing of the cylindrical wick from the side walls of the container 11, as shown, in conjunction with the placement of not more than the prescribed liquid supply in the vaporizing chamber, extreme angular orientations of the vaporizer container may take place substantially without introducing or immersing the central vaporizing portion of the wick 62 in the liquid supply, the liquid under such circumstances occupying the space between the wick and the side wall of the container. On the other hand, immersion of at least a portion of the wick in the liquid is always assured by the outer peripheral edge of the wick 62, forming a space within the vaporizing chamber in which circulation of the inhalation gases, delivered to the chamber, is limited. Thus, the effective vaporizing area of the wick with which the circulated atmospheric air comes into contact constitutes that portion of the cylindrical wick bounded by the upper and lower skirt members 66 which area is prevented, substantially, from immersion in the liquid anesthetic supply as described above.

Each of the skirt members on which the wick is seated, is also provided with openings 68 through which the liquid agent is permitted to flow from one end of the vaporizing chamber to the other during filling or emptying. A series of baffles, including symmetrical upper and lower baffle members 79 and a centrally disposed baffle member 72, are arranged within the vaporizing chamber to direct the flow of inhalation gases therethrough. These baffles communicate with the exit orifice by passages extending downwardly from the inlet opening 47 are conducted into the vaporizing chamber, is inclined in an upward direction. Conversely, the corresponding inner circumferentially spaced between the lower baffle 70 and central baffle 72, through which the gas when the vaporizing chamber are conducted to the exit openings 48, is inclined in a downward direction. It will be
noted that the outermost projecting portions of the baffles 70 extend a greater distance laterally than do the projecting portions of the baffles 72. Thus, any liquid passing up or down through the vaporizing chamber, as it cascades over the baffle members, or liquid splashed due to movements of the vaporizer, is prevented from flowing into the gas passages between the baffles and has no access to either of the gas passage openings of the vaporizing chamber. The arrangement which is thus provided as described above, for vaporizing the liquid anesthetic in the chamber 59 constitutes a substantial improvement over the vaporizing means hereinbefore described, inasmuch as it seriously provides for the lateral movement of the wick, including the area from which the vapors are given off due to displacement of the liquid in the vaporizing chamber, alters the effective vaporization rate and thus changes the concentration of the anesthetic vapor in the vaporizing chamber during the circulation of the inhalation gases thereby.

The relatively concentrated anesthetic vapor-air mixture formed in the vaporizing chamber and carried into the lower annular passage 46 is subsequently delivered to a mixing chamber 74 formed within a mixing valve 75 disposed at the bottom of the cylindrical vaporizer container within a cavity between the plate members 25 and 54. The concentric anesthetic gas mixture is metered into the mixing valve chamber through an elongated slot like aperture 76 in the lower end of the outer tube 20 and a corresponding intake valve port 78, as best seen in Fig. 5. The aperture 76 and intake valve port 78 are arranged to be in registry with one another in varying degrees according to the angular setting of the mixing valve, thereby affording means for regulating the volume flow of the concentrated anesthetic vapor mixture into the mixing valve chamber. Similarly, an aperture 80 in the form of an elongated slot is also best seen in Fig. 5 and is formed in the wall of the cylindrical container 11 which is disposed to cooperate with a corresponding air intake valve port 82 such as to regulate the flow of air from the atmosphere into the mixing chamber. The aperture 80 and air intake port 82 likewise are arranged to register with one another to an extent depending upon the angular setting of the mixing valve. As seen in Fig. 5, the mixing valve is illustrated in its "off" position in which the aperture 76 and the anesthetic mixture intake port 78 are positioned respectively so as not to overlap, thereby closing the opening from the annular passage 46 and the mixing valve chamber. Corresponding to this position of the valve, the aperture 80 and air intake port 82 are in registry thus affording the maximum opening for delivery of air to the mixing chamber. It will be seen that by rotating the mixing valve in a counterclockwise direction, as viewed in Fig. 5, that the respective apertures come into registry with the bottom of the aperture 76 and valve port 78, becomes increasingly larger whereas the air intake opening determined by the overlapping of the aperture 80 and air intake port 82 becomes successively smaller. At the maximum setting of the mixing valve the aperture 76 and mixing valve port 82 come into registry for providing the maximum volume intake of the anesthetic vapors. The "off" position of the mixing valve and the position corresponding to its maximum setting are determined by means of a stop 84 seen in Figs. 1 and 5, which is adapted to engage with stop pins 86 and 88 respectively, in the "off" and "maximum" positions of the mixing valve. This is accomplished by means of stop member 84, fastened to the lower fixed portion of the vaporizer by means of a screw 90 which extends upwardly over the manual adjusting rim 18 of the mixing valve in which the stop pins are seated and obstructs the rotation of the valve beyond the predetermined limits. The mixing valve 75 is formed such that the mixing chamber 74 is open at the bottom of the valve, facing bottom plate 28 forming the bottom closure for the valve cavity. An accurately shaped, elongated slot 92 seen in Fig. 5, in the bottom plate 28 provides an opening from the mixing chamber to the inhalation chamber 34. Referring now to Fig. 2, it will be seen that the inhalation chamber communicates with one leg 92 of the inhaler 12 through an inhalation check valve 94. The inhalation check valve is of conventional construction including a nozzle type valve seat 95, a disc valve element 96 adapted to cooperate therewith to permit gas to flow in only one direction and a cage 97 which is provided to retain the valve disc while permitting its movement toward or away from the valve seat. Upon inhalation the valve disc 96 moves away from the valve seat as seen in Fig. 2, as gas flows downwardly through the inhalation leg 92 of the inhaler. A series of elongated circumferential slots or grooves are formed in the valve cage to enable the inhalation gases to flow around the valve disc. These grooves are not visible in the inhalation valve 94. However, substantially identical grooves 98, formed in the exhalation valve 100 in the opposite leg 102 of the inhaler, are seen in Fig. 6 of the drawings. The exhalation valve 100, as best seen in Fig. 2, is identical in all respects to the inhalation valve, including a valve seat 99', valve disc 96' and cage 97', except that it is in respect to the inhalation valve so as to allow the passage of gas only in the direction from the exhalation leg 102 of the inhaler device to the exhalation chamber 36.

The nasal mask 16 carried by the inhaler is secured thereto by means of a threaded adaptor 104, Fig. 1, which has a shoulder recess 106 over which the inner end of the mask is stretched and elastically seated. It will be seen in this figure of the drawing that the lower end of the adjustable head strap 14 is accommodated on the threaded portion of the adaptor 104 and clamped between the adaptor and the inhaler body 12 to secure the entire vaporizer assembly to the head strap apparatus is mounted and secured to the head of the patient. Having now described the construction and arrangement of the vaporizer apparatus illustrated in the drawings, the operation thereof is as follows:

The vaporizer container is first charged by adding a quantity of volatile liquid anesthetic such as trichloroethylene. Preferably after the wick has been allowed to become saturated, the excess liquid is emptied from the container through the pouring spout so that a predetermined measured quantity of a reserve liquid supply may be added, filling the vaporizing chamber substantially up to the level of the line 60 seen in Fig. 1. The vaporizer may then be mounted on the patient's head as seen in Fig. 3, the locking nut 15 being loosened to permit the adjustable strap 14 to be adjusted until the nasal mask 16 is seated comfortably over the patient's nasal passages and when the patient's head is in an upright position, the vaporizing container is disposed substantially vertically at the front of the patient's face above the level of the mouth. It will be seen that this arrangement provides the vaporizer directly adjacent to the area in which the dentist will work while at the same time avoiding interference with access to the patient's oral cavity. As soon as the nasal mask has been properly arranged, the patient may commence breathing through the nasal
7 passages. Immediately upon inhalation, the inhalation gases are delivered downwardly through the inhaler into the nasal mask as represented by the arrows shown in Fig. 1. During this phase of the breathing cycle, gases are prevented from passing through the exhalation conduit by the exhalation check valve which is closed due to the pressure of the expelled air in the inhaler produced by the patient's breathing effort. The gas mixtures delivered to the patient upon inhalation is dependent upon the setting of the mixing valve 75. Assuming that the valve is initially in "off" position, only atmospheric air will be delivered to the patient which is inspired through the intake valve port 82 into the valve chamber 74 and thence into the inhalation chamber 34 through the slotted opening 92 from whence the gases are conducted to the patient through the inhaler and nasal mask. In this position of the mixing valve, the anesthetic vapor intake port 78 is closed. When it is desired to administer anesthetic mixtures to the patient, the mixing valve is rotated to bring the anesthetic port 78 of the mixing valve into registry with the opening 68, communicating with the lower end of annular inhalation passage 46. When this is done atmospheric air is drawn inwardly through the perforated plate at the top of the vaporizer thence downwardly through the upper annular passage 44 and into the vaporizing chamber 50 as represented by the arrows in Fig. 1. Air in the vaporizer chamber together with the volatilized vapors of the liquid anesthetic agent therein are drawn outwardly through the exit openings 48 of the chamber into the lower annular passage 44 from whence such relatively saturated anesthetic vapor air mixtures are conducted to the valve mixing chamber. The concentration of the anesthetic vapor administered during inhalation by the patient is controlled by setting the relative openings of the intake ports 78 and 82 of the mixing valve which control the rate at which the anesthetic vapor mixtures received from the vaporizing chamber to form the desired inhalation concentrations. It will be noted that at the "maximum" setting of the mixing valve an overlap of the air intake port 82 and the aperture 80 exists thereby insuring at all times during the operation of the vaporizer, a uniform supply of air and admixture with the anesthetic vapors delivered to the patient.

During exhalation, the direction of flow of the gases through the vaporizer is reversed. The slight positive pressure produced by the patient during exhalation, forces the gases to flow from the nasal mask outwardly thence into the inhaler as indicated by the direction of the arrows in Fig. 1, and thence upwardly through the exhalation valve into exhalation chamber 56. From this chamber the exhalation gases are forced upwardly through the exhalation tube 22 out of the top of the vaporizer through the perforated plate 19. The passage of the exhalation gases through the vaporizer container is represented by the arrows pointing in an upward direction within the exhalation tube 22 seen in Fig. 1. During the exhalation phase, passage of the exhalation gases through the inhalation circuit of the vaporizer is prevented by the action of the inhaler check valve wherein the valve disc is forced upwardly and seated against the valve seat thereof. It will be seen that as the patient breathes, the inhalation and exhalation gases will be delivered through the vaporizer appearing successively during the respective phases of the breathing cycle as above described.

During the dental or medical treatment for which the anesthetic agent is being administered, it may be desirable to have the patient's position altered. This may involve, for example, a tilting of the patient's head to an extreme rearward angle as represented by the dotted outline in Fig. 3 wherein it will be seen that the vaporizer also is tilted correspondingly. Regardless of any such angular adjustment of the position of the vaporizer or of sudden movements by the patient that may occur, the apparatus hereinabove described, will continue to function without varying the anesthetic mixtures from the prescribed setting of the mixing valve and without danger of occluding the inhalation and expiratory passages with the liquid supply. In addition, it will be noted that the patient's exhalation gases are at all times discharged upwardly through the top of the vaporizer and effectively directed away from the patient's face and accordingly away from the persons attending him. In referring particularly to Fig. 1, it will be seen that the inhalation and exhalation gases transported through the vaporizer pass countercurrently through the vaporizer. The relatively warm exhalation gases flow upwardly through the central tubular conduit 22 while the cooler atmospheric gases are drawn downwardly through the surrounding annular passages 44 and 46. The arrangement of these passages centrally within the vaporizer container, in addition to the advantages hereinbefore mentioned, also serves to warm the incoming gases and the surrounding vaporizer housing such as to facilitate the volatilization of the liquid anesthetic. As a result, the vaporizing apparatus is more suitably adapted for the administration of certain liquid agents, such as trichloroethylene, that are relatively difficult to vaporize at room temperatures in ordinary vaporizing apparatus.

It will be understood that the apparatus herein specifically described and illustrated in the accompanying drawing, is merely a preferred embodiment of the present invention and that various modifications and changes may be made therein without departing from the spirit of the invention as described in the following claims.

I claim:
1. An anesthetic vaporizer comprising a substantially cylindrical vaporizing chamber adapted to hold a predetermined supply of volatile liquid anesthetic therein, means for passing a carrier gas through said chamber to form a gaseous mixture with the volatilized anesthetic, a cylindrical wick in said chamber, said wick being spaced inwardly from the side walls of said chamber and arranged such that only the ends thereof are immersible in said liquid in any position of said vaporizer to effectively render the central portion thereof non-immersible, said wick having at least at its lower end a radially extending portion extending into the cylindrical sidewall of said chamber, and means defining a confined space in said chamber substantially limiting the contact of said carrier gas to said non-immersible portion of said wick.
2. Apparatus for the administration of inhalation anesthetic mixtures comprising a container, adjacent inhalation and exhalation passages therein, separated by a heat conducting partition and formed by two concentric tubes, said inhalation passage being formed in the annular space therebetween and said exhalation passage being formed inside the inner of said concentric tubes, a vaporizing chamber in said container in which a supply of liquid anesthetic agent is adapted to be placed and volatilized, means connecting said inhalation passage with said vaporizing chamber through which atmospheric gases are delivered thereto to form relatively concentrated anesthetic vapor-air mixtures, means for relatively diluting said mixture with air and delivering said relatively diluted mixture to the user, and means for receiving gases exhaled by the user and discharging said exhalation gases to the atmosphere through said exhalation passage.
3. Apparatus for administering inhalation anesthetic mixtures according to claim 2 wherein said container comprises a substantially cylindrical member, said concentric tubes are disposed longitudinally therein and open to the atmosphere at one end thereof, and said vaporizing chamber is formed in an annular space between the
Apparatus for administering inhalation anesthetic mixtures according to claim 3 wherein said means for diluting the relatively concentrated anesthetic vapor mixtures formed in said vaporizing chamber comprise adjusting variable valve port communicating with said vaporizing chamber and a second variable valve port communicating with the atmosphere and wherein said means for conducting said relatively diluted anesthetic vapor-air mixtures to the user and for receiving the user's exhalation gases includes an inhaler means disposed at the bottom of said container.

Apparatus for administering inhalation anesthetic mixtures according to claim 4 wherein said adjustable volume means includes an annular valve element surrounding the outer of said concentric tubes, disposed between said tube and the wall of said container.

Apparatus for administering inhalation anesthetic mixtures comprising a substantially cylindrical container, concentric inner and outer tubes disposed substantially axially in said container, an inhalation passage formed in the annular space between said tubes and an exhalation passage formed by said inner tube, both of said passages being open to the atmosphere at one end of said container, means forming a vaporizing chamber between the wall of said container and said outer tube adapted to hold a supply of volatile liquid anesthetic and to volatilize said liquid therein, inlet and outlet openings in the wall of said outer tube through which atmospheric gases conducted through said inhalation passage are permitted to circulate through said vaporizing chamber, a mixing chamber, means connecting said mixing chamber with the outlet openings of said vaporizing chamber, means connecting said mixing chamber with the atmosphere independently of said vaporizing chamber, valve means operable for adjusting the relative proportions of the gases delivered through said respective connecting means to said mixing chamber, and means including an inhaler for delivering inhalant anesthetic vapor-air mixtures from said mixing chamber to a patient and for receiving exhalation gases and discharging the same through said exhalation passage to the atmosphere.

Apparatus for administering inhalation anesthetic mixtures comprising a substantially cylindrical container, concentric inner and outer tubes disposed substantially axially in said container, an inhalation passage formed in the annular space between said tubes and an exhalation passage formed by said inner tube, both of said passages being open to the atmosphere at the top of said container, means forming a vaporizing chamber between the wall of said container and said outer tube adapted to hold a supply of volatile liquid anesthetic and to volatilize said liquid therein, inlet and outlet openings in the wall of said outer tube through which atmospheric gases conducted through said inhalation passage are permitted to circulate through said vaporizing chamber, means forming a valve cavity at the lower end of said container between said outer tube and the wall of said container, an opening in the lower end of said outer tube connecting said valve cavity with the lower end of said annular inhalation passage, an opening in the wall of said container connecting said valve cavity with the atmosphere, a rotatable valve element disposed in said valve cavity having separate valve ports operatively associated with the openings comprised with said cavity and serving to cooperate therewith for varying the relative proportions of the gases delivered therethrough, a mixing chamber for receiving the relatively proportioned gases delivered through said valve ports, means for delivering such proportioned gas mixture to a patient for inhalating and means for delivering said proportioned gas mixture to the lower end of said inner concentric tube, whereby said gases are exhausted through said exhalation passage to the atmosphere.

Apparatus for administering inhalant anesthetic mixtures according to claim 7 wherein said adjustable volume element comprises a hollow annular member rotatable around said outer concentric tube having an annular cavity therein forming said mixing chamber and having openings in the inner and outer walls thereof adapted to register with said openings in said outer tube and in the wall of said container.

Apparatus for administering inhalant anesthetic mixtures according to claim 8 wherein said valve cavity is defined by longitudinally spaced upper and lower plate members extending between said outer tube and the wall of said cylindrical container, said annular mixing valve cavity is open at the bottom thereof in confronting relation to said bottom plate, said bottom plate having first and second openings therein, respectively, which receive the lower end of said inner concentric tube and register with said mixing valve cavity, and said means for conducting said inhalation gas mixtures and said exhalation gases to and from a patient include separate doors which connect, respectively, with said openings in said bottom plate member.

Apparatus for administering inhalant anesthetic mixtures according to claim 9 wherein said ducts are embodied in an inhaler housing positioned at the bottom and supporting said container and having means associated therewith for mounting said apparatus on the head of a patient.

Apparatus for administering inhalation anesthetic mixtures according to claim 7 wherein a plurality of baffle means are carried by said outer tube which extend radially outwardly therefrom in said chamber, said baffle means being constructed and arranged, in cooperation with said chamber inlet and outlet openings, effectively to prevent gravitational flow of liquid from said chamber to either of said openings.

References Cited in the file of this patent

UNITED STATES PATENTS

686,270 Dewees Nov. 12, 1901
2,499,734 Edmondson Mar. 7, 1950
2,677,370 Newton May 4, 1954

FOREIGN PATENTS

2,869,540 Germany Jan. 15, 1930