

Jan. 17, 1961

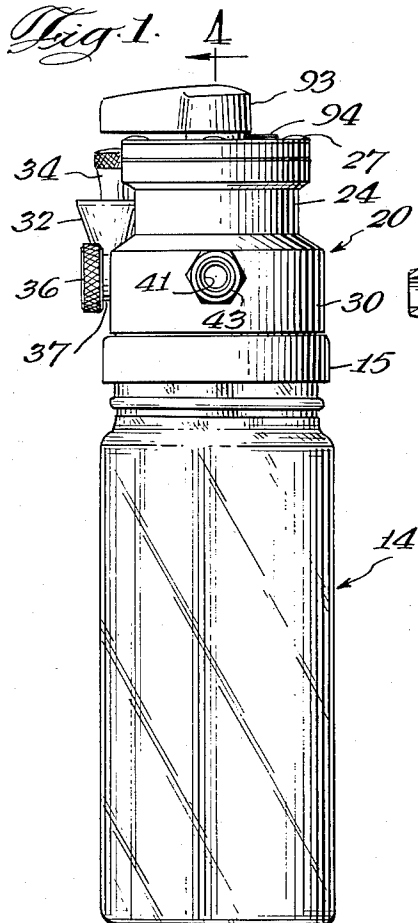
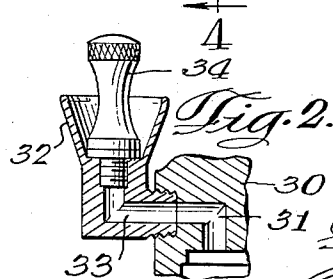
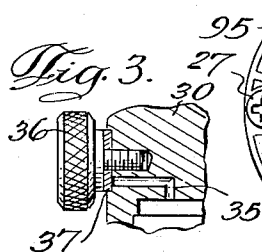
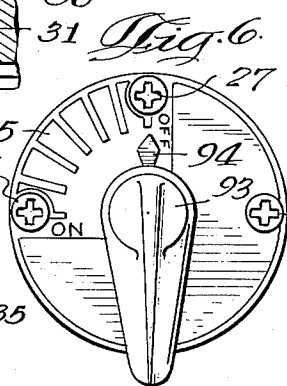
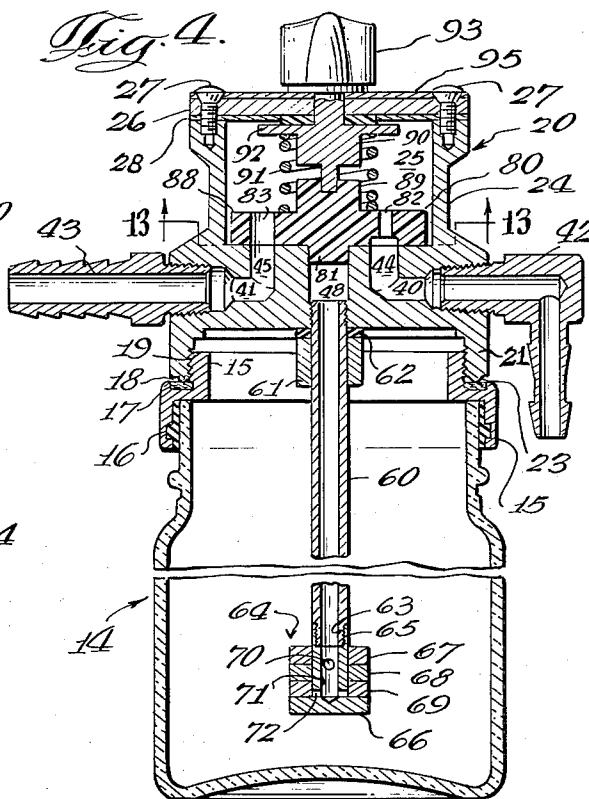
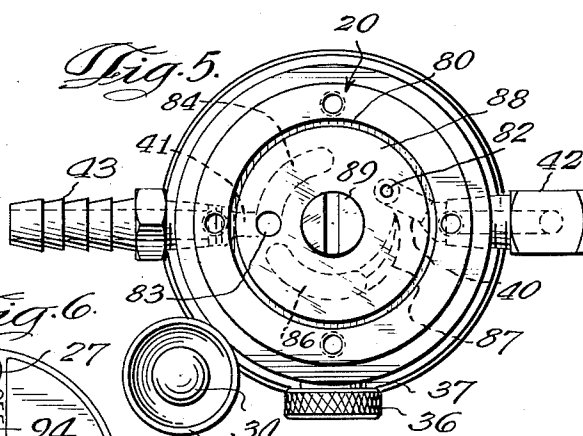
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2,968,474

VAPORIZER

Filed Sept. 25, 1957

3 Sheets-Sheet 1



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*Fig. 7.*

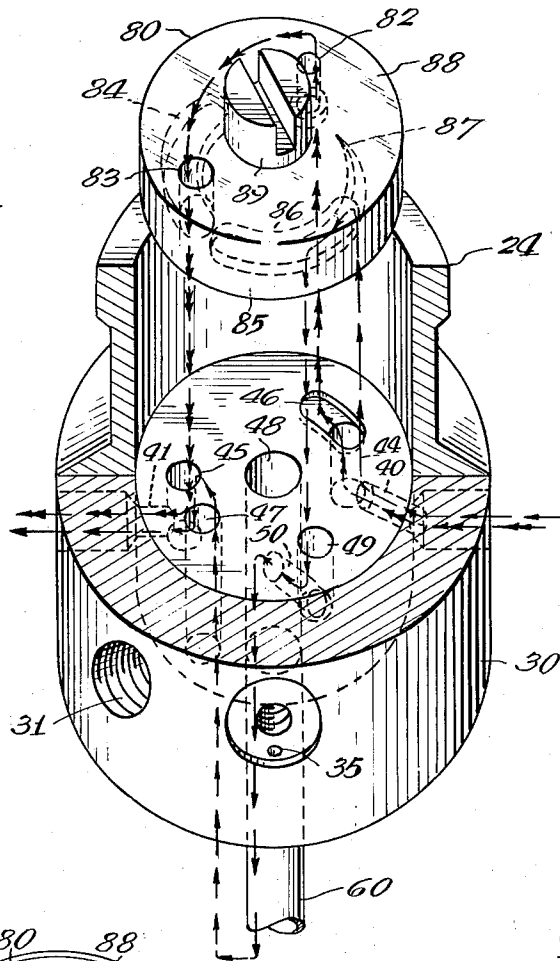


*Fig. 8.*

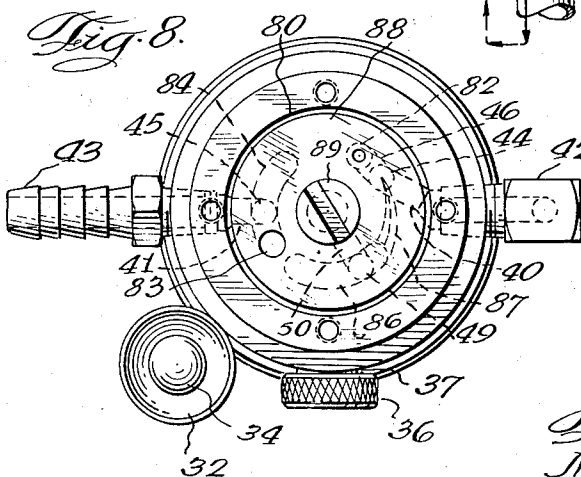
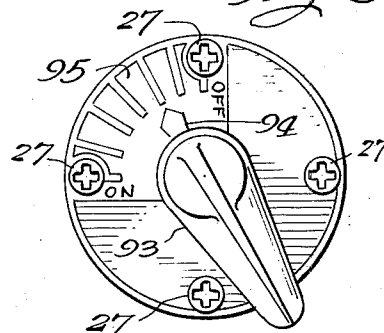


*Fig. 9.*



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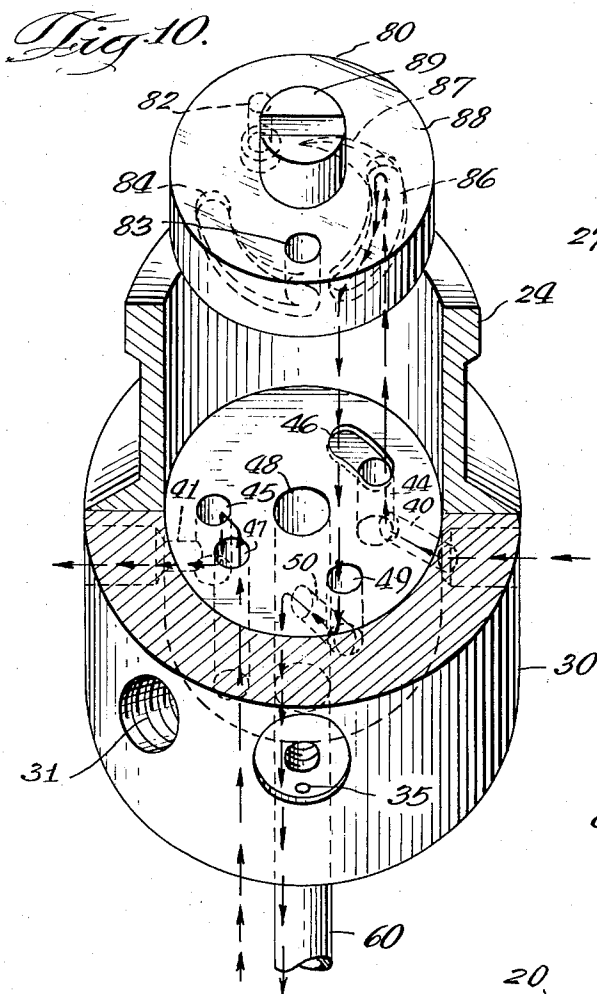
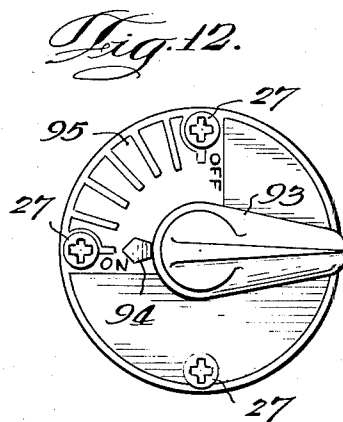
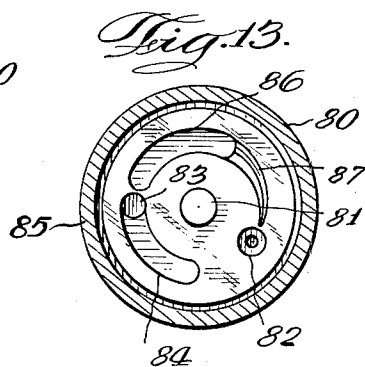
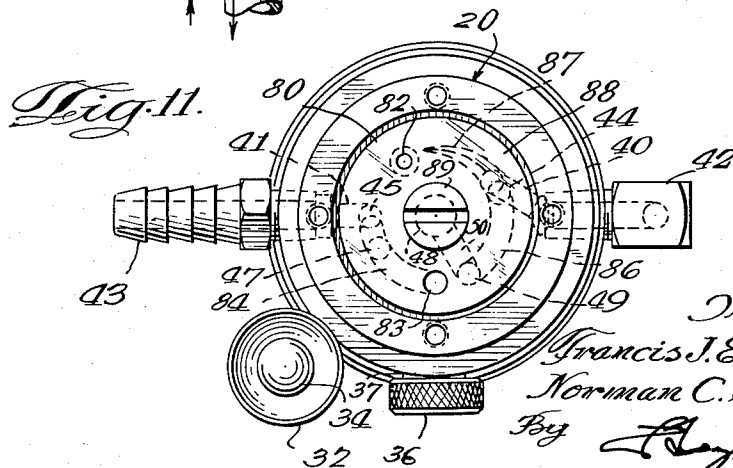
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VAPORIZER

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3 Sheets-Sheet 3



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2,968,474

## VAPORIZER

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Filed Sept. 25, 1957, Ser. No. 686,085

9 Claims. (Cl. 261—46)

This invention relates in general to apparatus for vaporizing liquids and more particularly to apparatus for controlling and regulating liquid-gas contact in the administration of gaseous fluids, vaporized liquids and the like.

Heretofore, vaporization of liquids, such as ether, for example, has been achieved by employing multi-valved, multi-chambered control mechanisms attached to oversized liquid containing vessels in which are telescoped perforated vessels for supporting evaporator wicks, foraminous materials or bulky contact plates generally of copper. Such devices are expensive, unwieldy, and do not lend themselves to ready, simple, and efficient operation.

Applicants have developed a novel, inexpensive, and compact device which achieves maximum vaporization simply, efficiently, and positively. The device essentially comprises a control unit embodying relatively movable members which are provided with passages and grooves. The control unit is associated with a container for liquid which contains a simple, highly efficient gaseous fluid diffusing apparatus. A knob on the control unit provides selective movement of the passages and grooves of the relatively movable members into various positions of register enabling a user to rapidly and positively perform three fundamental operations with the device; first, passing all gaseous fluid through the liquid in the container; second, by-passing selective portions of the gaseous fluid so that no contact is made with the liquid in the container while simultaneously passing the remainder of gaseous fluid into and through the liquid; and third, by-passing all of the gaseous fluid so that it makes no contact with the liquid in the container.

As an added feature, applicants have provided novel means in the control unit for relieving automatically any excessive pressures developed from vaporization of liquid in the container, thus eliminating danger of pressure caused explosions, especially when the device is employed in connection with highly volatile agents such as ether.

It is, therefore, an object of this invention to provide a vaporizing device of compact, inexpensive construction capable of ready and simple operation.

It is another object of this invention to provide a vaporizing device having a minimum of moving parts which is capable, by selective operation, of efficiently and positively passing all incoming gaseous fluids through a vaporizable liquid, or by-passing portions or all of the gaseous fluids so that no contact is made with the liquid.

It is still another object of this invention to provide a vaporizing device capable of selectively combining optimum amounts of gaseous fluid and vaporized liquid for delivery to a point of use.

Another, and perhaps less obvious, but none the less important, object of this invention is to provide a vaporizing device capable of efficiently and safely relieving any excessive pressures resulting from vaporization of liquid used in connection with the device.

These objects and additional advantages and features

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of this invention will become more readily apparent as the following description proceeds, taken in conjunction with the accompanying drawings wherein:

Fig. 1 is an elevational view of an embodiment of the invention.

Fig. 2 is a fragmentary sectional view illustrating the funnel and filling passage of the apparatus of Fig. 1.

Fig. 3 is a fragmentary sectional view of the bleed passage of the device of Fig. 1.

Fig. 4 is a sectional view along line 4—4 of Fig. 1.

Fig. 5 is a top plan view of the apparatus illustrated in Fig. 4 with the plate assembly and control knob removed.

Fig. 6 is a top plan view of the plate assembly and control knob illustrated in Fig. 4.

Fig. 7 is an exploded view partly in section of the valve arrangement in the control head unit with single headed arrows illustrating the passing of a portion of gaseous fluid through the liquid and double headed arrows illustrating the by-passing of another portion of gaseous fluid.

Fig. 8 is a top plan view similar to Fig. 5 illustrating the relative positions of the grooves and passages during the operation shown in Fig. 7.

Fig. 9 is a top plan view similar to Fig. 6 illustrating the position of the control knob during the operation shown in Fig. 7.

Fig. 10 is an exploded view partly in section of the valve arrangement in the control head unit illustrating with arrows the flow of all gaseous fluid through the liquid.

Fig. 11 is a top plan view similar to Fig. 8 illustrating the relative position of the grooves and passages during the operation shown in Fig. 10.

Fig. 12 is a top plan view similar to Fig. 9 illustrating the position of the control knob during the operation shown in Fig. 10.

Fig. 13 is a sectional view along line 13—13 in Fig. 4.

For convenience of illustration and description, a commercial application of applicants' invention in the form of a vaporizer for anesthetic purposes has been illustrated and will be described below. It will be understood, however, that the principles and apparatus involved may be related to other vaporizer devices for other purposes without departing from the spirit of the invention.

Referring now in greater detail to the drawings and more particularly to Figs. 1 and 4, the numeral 14 designates a container which preferably takes the form of a cylindrical jar and which may be calibrated if desired. The container 14 may be formed of glass, or other material, which is relatively chemically inert to such agents as ether and trichloroethylene, and yet is of sufficient strength to withstand normal pressures developed in the vaporization of such volatile substances.

The container 14 preferably is provided with a collar 15 having a sealing member 16 interposed between it and the container 14. The collar 15, in addition, is provided with an annular groove 17 adapted to receive a sealing gasket 18. The collar 17 preferably is reduced at one end and provided with an externally threaded portion 19.

A control head unit designated by numeral 20 and preferably provided with an internally threaded flange 21, is adapted to engage the correspondingly externally threaded portion 19 of collar 15. The edge of the flange 21 is provided with an integral annular ring 23, which cooperates with sealing gasket 18 to provide a positive gas seal between container 14 and control head unit 20 when the latter are in engagement.

Referring additionally to Figs. 1 and 4, the preferred embodiment of control head unit 20 is provided with a housing 24 forming a chamber 25, one wall of which is formed by a detachable closure plate 26. The closure plate 26 may be secured to housing 24 by screws 27. A sealing gasket 28 is provided between housing 24 and

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closure plate 26 to seal off chamber 25 from the atmosphere.

The flanged base 30 of housing 24 is provided with a passage 31 (see Fig. 2) communicating with the internal of container 14. A funnel 32, having communicating passage 33 and stopper 34, is secured to housing 24 for introduction of liquid into container 14 when the control head 20 is in place.

The base 30 of housing 24, in addition, is provided with a bleed passage 35 (see Fig. 3) also communicating with the internal of container 14. Bleed passage 35 permits gaseous fluid and vaporized liquid to escape from container 14 when liquid is introduced into the latter through funnel 32. A knurled screw 36 provided with a gasket 37 releasably closes the passage 35 and seals it from the atmosphere when the device is not being filled.

Referring now to Figs. 4, 7, and 10, the base 30 of housing 24 preferably is provided with aligned passages 40 and 41 each of which communicates with an inlet member 42 and a preferably barbed outlet stem 43, respectively. Inlet member 42 is adapted to receive a conduit or hose, not shown, for connection to a source of gaseous fluid under pressure, also not shown. Similarly, stem 43 is adapted to be connected to a conduit or hose for carrying off gaseous fluid or vaporized liquid to a point of use.

The base 30 of housing 24 is further provided with spaced through passages 44 and 45 transverse to and intersecting with passages 40 and 41, respectively, each communicating with chamber 25. Through passage 44 (see Figs. 7 and 10) opens into an arcuate groove 46 in the base 30. Another through passage 47 and a preferably axial through passage 48 also are provided in the base 30 and communicate with the internal of container 14 and chamber 25. The base 30 is still further provided with another passage 49 opening into chamber 25 and intersecting a transverse passage 50, the latter communicating with passage 48.

Threadedly connected to the base 30 and forming an extension of axial passage 48 is a tubular member 60 through which gaseous fluids entering inlet member 42 may be directed into the container 14 as will be described below. The tubular member 60 is provided with a hexagonal surface 61 allowing said member to be more easily engaged or disengaged from the base 30. A gasket 62 is provided between surface 61 and base 30 to insure a gas seal between the internal of container 14 and the axial passage 48. The lower end of the tubular member 60 preferably is provided with external threads 63 for engagement with a diffuser body 64 having an internally threaded tubular neck 65 and a substantially plain surfaced base 66.

The neck 65 of the diffuser body 64 receives one or more washer-like bodies such as 67, 68, and 69, and is provided with diametral outlets 70, 71, and 72 at the relatively movable contacting surfaces of the washer-like bodies. For a more complete description of this preferred diffuser body 64 and its operation, reference may be had to co-pending application Serial No. 608,873, filed September 10, 1956, and now Patent No. 2,902,269, issued September 1, 1959, of which this application is a continuation-in-part.

Returning again to control head unit 20, a valve member or spool 80 preferably is centrally positioned within chamber 25. The valve member 80 is provided with a stub shaft 81 adapted to be received in axial passage 48. Valve member 80 is preferably made of a lightweight chemically inert substance such as Teflon. This preferred material does not require lubrication and will not bind when valve member 80 is moved relative to the base 30.

Referring to Fig. 13, valve member 80 preferably is provided with spaced through passages 82 and 83, passage 82 being reduced to act as a metering device for

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incoming gaseous fluid. Passage 83 opens into an arcuate groove 84 in surface 85 of valve member 80. In addition, surface 85 is provided with an arcuate groove 86 having a comet tail-like tapering extension 87 of progressively varying depth. The function of grooves 84 and 86 will be treated in greater detail when the operation of the device is later discussed.

The upper surface 88 (see Fig. 4) of valve member 80 preferably is provided with a slotted stub shaft 89. A keyed stem or shaft member 90 extends through closure plate 26 and engages the slot of stub shaft 89. A compression spring 91 is interposed between the surface 88 and closure plate 26 about shaft 90. A flange 92 on stem 90 depresses spring 91 against the surface 88 of the valve member 80 when closure plate 26 is secured to housing 24. The bias thus exerted by spring 91 on valve member 80 is sufficient to provide a substantial gas seal between surface 85 and the base 30. On the other hand, the bias exerted by spring 91 is such that in the event excessive pressures develop in the container 14, the valve member 80 will be raised from its position in relation to base 30 thereby permitting expansion into chamber 25 of the gaseous fluid and vaporized liquid causing such pressures to exit via passages 44 and 40 and 45 and 41. This relief valve function of valve member 80 and spring 91 provides an important safety factor in the operation of the vaporizing device in that it prevents fracturing of the container 14 in the event that excessive pressures develop.

The rotational movement of valve 80 relative to base 30 of housing 24 is controlled by a knob 93 secured to stem 90. The knob 93 is provided with a pointer 94 which in cooperation with a suitably marked plate 95, indicates "on" and "off" positions of the device, in addition to indicating intermediate positions of control for gaseous fluid-vaporized liquid mixtures.

A stop pin, not shown, preferably depending from closure plate 26 is adapted to engage a recessed portion, also not shown, in the edge of flange 92 permitting the knob 93 to move the valve member 80 only to positions from full on to full off.

#### Operation

Having thus described the construction of the illustrated vaporizing device, a discussion of its operation follows. Applicants' vaporizer is susceptible of many uses. It has, for example, been found to present an extremely practical apparatus for humidifying inhalant gases as well as for vaporizing liquids more volatile than water, such as ethers and other volatile organic solvents. In regard to the last mentioned use, the apparatus has provided novel means for quickly and selectively controlling the administration of an anesthetic mixture including oxygen or pure gaseous fluid such as oxygen, best suited to all circumstances attending anesthesia and post-anesthesia conditions of surgical patients.

Referring to Figs. 10, 11, and 12, when it is desired to direct all of a gaseous fluid, such as oxygen, into and through a liquid, such as ether in container 14, to obtain maximum vaporization, the control knob 93 and pointer 94 are turned to the full "on" position illustrated in Fig. 12. In this position (see Figs. 10 and 11) arcuate groove 86 in surface 85 of valve member 80 is in register with through passages 44 and 49, and arcuate groove 84 is partly in register with through passage 45, and in full register with passage 47 in the base 30 of housing 24. As clearly indicated by arrows, oxygen, for example, enters inlet member 42, flows through intersecting passages 40 and 44 in base 30, into groove 86 in valve member 80 from where it is directed through intersecting passages 49 and 50 into axial passage 48 in base 30. The gas then flows through tubular member 60 to the diffuser body 64 (see Fig. 4) from whence it issues into the liquid in container 14. After the gas is diffused through the liquid in container 14, vaporized liquid carried in the

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gaseous medium flows through passage 47 in base 30, into arcuate groove 84 in valve member 80 from whence it is directed into and through intersecting passages 45 and 41 to outlet stem 43. Chamber 25 is filled with vaporized liquid during this operation by way of arcuate groove 84 and through passage 83 in valve member 80. This creates a balanced pressure condition in chamber 25 which aids the flow of vaporized liquid from the control head unit 20, but does not interfere with incoming gaseous fluid. It is obvious from the foregoing that this easily controlled operation of the device is employed to rapidly place a patient under the influence of anesthetics preparatory to surgery.

Referring now to Figs. 7, 8, and 9, an intermediate position of the valve member 80 with relation to the passages in base 30 of housing 24 is illustrated. In this position, groove 46 in base 30 is in register with passage 82 in valve member 80. Through passage 44 in base 30 is in register with a portion only of tapering extension 87 of arcuate groove 86 in valve member 80, and arcuate groove 86 in turn is in register with through passage 49 in base 30. In addition, through passage 83 and arcuate groove 84 in valve member 80 are in register with through passages 47 and 45, respectively, in base 30 of housing 24. As indicated by the single and double headed arrows, incoming gaseous fluid, such as oxygen, flows through intersecting passages 40 and 44 in base 30. A portion of the oxygen indicated by the double headed arrows, flows through groove 46 in base 30 and thence through passage 82 in valve member 80 into chamber 25. This part of the oxygen thus by-passes the liquid in container 14. The remainder of the incoming oxygen follows the path of the single headed arrows and is directed by tapered extension 87 of arcuate groove 86 in valve member 80 through groove 86 into intersecting passages 49 and 50, the communicating axial passage 48 in base 30 and tubular member 60 into the container 14. This portion of the oxygen is diffused into and through liquid in container 14 in the same manner as explained in the next preceding operation of the device in connection with full vaporization of the anesthetic by the gaseous medium. The vaporized liquid carried in the gaseous medium leaves container 14 through passage 47 in base 30 and flows into arcuate groove 84 in valve member 80 where it is combined with by-passed oxygen from chamber 25 entering groove 84 through passage 83 in valve member 80. The gaseous fluid-vaporized liquid mixture then flows through intersecting passages 45 and 41 in base 30, through outlet stem 43 from where it is conducted to a point of use. It will be noted that the control knob 93 can be moved through a considerable intermediate range and that, therefore, the degree of register of the various passages and grooves can be controlled to give the desired gaseous fluid-vaporized liquid mixture in accordance with the need of the patient. This quick and efficient control makes it possible for the operator to bring the patient rapidly to the optimum depth of anesthesia and to maintain such depth. When anesthesia is no longer required, pure gaseous fluid may be by-passed to the patient in the manner to be described.

Referring to Figs. 4, 5, and 6, when it is desired to by-pass liquid in container 14 and to administer gaseous fluid only to a patient, the control knob 93 and pointer 94 are turned to the "off" position as illustrated in Fig. 6. In this position, through passages 82 and 83 in valve member 80 are in register with passages 44 and 45, respectively, in base 30 of housing 24. Gaseous fluid, such as oxygen, under pressure, enters inlet member 42, flows through intersecting passages 40 and 44 in base 30, thence through passage 82 in valve member 80 into chamber 25. The gas then flows through chamber 25 into passage 83 in valve member 80, through passages 45 and 41 in base 30 of housing 24, and out stem 43 from which point it is directed by a suitable conduit to a point of use. This by-pass operation of the device is particularly valuable

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during surgery, for example, where it is observed that anesthesia is too deep and the respiration of the patient is dropping off. Pure gaseous fluid, such as oxygen, may be quickly directed to the patient by simply turning the control knob 93 to the "off" position. The immediate and desired result will be increased respiration thus partially overcoming the effects of the anesthetic. In addition, this by-pass operation of the device may be employed as a post-operative technique for bringing a patient wholly or partly back to consciousness. Such complete or partial elimination of the initial effects of anesthetics greatly contributes to the well-being of a patient following surgery.

Applicants' vaporizer obviously has uses other than in the medical field. The embodiment illustrated is a highly efficient vaporizer particularly adapted for medical anesthesia purposes. It will be understood that modifications will be apparent to those skilled in the art, and it is intended that all such modifications within the spirit of this invention are included within its scope, best defined by the appended claims.

We claim:

1. Apparatus for vaporizing liquids comprising, a container for liquid and a body member, said member having an inlet for gaseous fluids and being provided with at least one outlet, means extendible into said container for diffusing gaseous fluids through liquid in the container, means including a valve member, said member being movable relative to said body member to cooperate with said inlet and outlet to pass portions of said gaseous fluids and diffused gaseous fluids to the outlet, and pressure relief means including a spring adapted to exert a predetermined bias on said valve member, said bias being sufficient to provide a substantial gas seal between said valve member and said body member, but insufficient to prevent said valve member from being raised from its position relative to said body member to relieve any excessive pressures developing in said container.

2. Apparatus for vaporizing liquids comprising, a container for liquid and a body member, a pressure balancing means for uniform flow from said container including a chamber in said body member communicating with said container, said chamber having an inlet for gaseous fluids and an outlet for delivering said gaseous fluids to said container, said chamber being further provided with a second inlet for admitting vaporized liquids from said container for delivery to an outlet from said chamber, means in said container communicating with said chamber for diffusing gaseous fluids through liquid in said container, a valve member within said chamber, said valve member being adapted for rotatable movement relative to said body member and being provided with a plurality of passages and grooves, means including a spring adapted to exert bias on said valve member, a plate member for sealing said chamber from the atmosphere, and means connected to said valve member and extending through said plate member for moving said valve member relative to said body member to selectively place said inlets and outlets and said passages and grooves in various positions of register for passing portions of said gaseous fluids through liquid in the container and by-passing other portions of said gaseous fluids without contact with the liquid, or by-passing all of said gaseous fluids without contact with liquid in the container.

3. Apparatus for vaporizing liquids comprising in combination: a container for liquids; a control head mounted on said container; said control head having wall members defining a chamber therein, said chamber having a bottom wall in covering relation with said container; means to secure said control head to said container; an inlet passage extending from the exterior of said container through a wall of said chamber; an outlet passage extending through a wall of said chamber to the exterior of said container; at least two container passages extending from said chamber through said bottom wall to the in-

terior of said container; a tubular member connected to said control head in registration with one of said container passages and extending substantially to the bottom of said container; means mounted adjacent the lower end of said tubular member for uniformly diffusing gaseous fluids from said tubular member into liquid in said container; a valve member in said chamber, said valve member having passages therethrough and being selectively movable to connect said inlet passage to said outlet passage, said inlet passage to said outlet passage in combination with said inlet passage to the interior of said container and the interior of said container to said outlet passage, and said inlet passage to the interior of said container and the interior of said container to said outlet passage, said chamber being in communication with said container through one of said valve passages in said last named connection, whereby a balanced pressure condition exists between said chamber and said container facilitating a uniform flow of vaporized liquid out from said container; means to move said valve member to establish a selected one of said connections; and pressure relief means for said container comprising biasing means urging said valve member into covering relation with said container passages, said biasing means yielding when a predetermined pressure within said container is exerted through said container passages against said valve member, said valve member moving out of covering relation with said container passages under the influence of pressure, permitting its release.

4. Apparatus for vaporizing liquids comprising in combination: a container for liquids; a control head mounted on said container; said control head having wall members defining a chamber therein, said chamber having a bottom wall in covering relation with said container; means to secure said control head to said container; an inlet passage for gaseous fluids extending from the exterior of said container through a wall of said chamber; an outlet passage extending through a wall of said chamber to the exterior of said container; at least two container passages extending from said chamber through said bottom wall to the interior of said container; means in communication with said chamber through one of said container passages for diffusing gaseous fluids into liquid in said container; a valve member in said chamber, said valve member having passages therethrough and being selectively movable to connect said inlet passage to said outlet passage, said inlet passage to the interior of said container and the interior of said container to said chamber and said outlet passage, and said inlet passage to said outlet passage in combination with said inlet passage to the interior of said container and the interior of said container to said outlet passage; means to move said valve member to establish a selected one of said connections; and means including said valve member to relieve pressure within said container, said pressure relief means being automatically responsive to the attainment of a predetermined pressure level within said container.

5. Apparatus for vaporizing liquids according to claim 4 in which the pressure relief means includes a coil spring which encircles a stub shaft projecting downward from the top wall of said chamber and an aligned upwardly projecting shoulder portion of said valve member.

6. Apparatus for vaporizing liquids according to claim 4 in which the control head is provided with an opening through an exterior wall to receive liquids; a removable cap for said liquid opening, whereby said container may be replenished with liquid without removing the control head; a bleed passage through an exterior wall of said control head and a removable cover for said bleed passage, whereby pressure may be bled from the container's interior during a liquid filling operation.

7. Apparatus for vaporizing liquids according to claim 4 in which said valve member has a tapered groove of progressively increasing volume, and said inlet passage terminates in a groove cooperating with said tapered

groove to provide communication between said inlet passage and said container, said valve member being movable to register said grooves and arranged to provide a relatively wide variation in the degree of registration between said inlet passage groove and said tapered groove, the configuration of said tapered groove facilitating a relatively precise control over the quantity of gaseous fluid entering said container.

8. Apparatus for vaporizing liquid comprising a container for liquid and a control head, means for securing the head to the container, said head containing an inlet passage and an outlet passage terminating on the exterior of said container and at least two passages communicating with the interior of said container, a valve body provided with a pair of grooves and pair of passages at least one of the passages communicating with one of said grooves, means communicating said pair of passages in the valve body and a surface of the control head having a plurality of passages all communicating with the interior of said container, and pressure relief means for said container including means biasing said valve body into contact with said control head surface having passages, said biasing means exerting a predetermined force against said valve body adapted to provide a gas seal between said control head surface and said valve body but yielding when a predetermined pressure within the said container is exerted against said valve body, said valve body being manually movable in cooperation with said surface in one plane for selectively connecting: said inlet passage to said container and said container to said outlet passage; said inlet passage to said outlet passage; and said inlet passage to said container and said container to said outlet passage in combination with said inlet passage to said outlet passage; and automatically movable transversely in response to a predetermined pressure in said container to communicate all of said passages to the exterior of said control head.

9. In apparatus for vaporizing liquids to anesthetize patients, the apparatus being of the type having a container for liquid and a body member, said member having an inlet for gaseous fluids and another inlet for admitting vaporized liquids from said container and having at least one outlet, a tube extending downward from the body member, said tube having diffusion means at its lower end, and means including said inlets and outlet and a valve cooperating with said body member for selectively passing portions of gaseous fluids through liquid in the container and by-passing other portions of said gaseous fluids without contact with the liquid, or by-passing all of said gaseous fluids without contact with liquid in the container, the improvement comprising means for maintaining a uniform flow of vaporized liquid from said container including wall means extending from the body member to define a chamber in communication with the container and the outlet, and pressure relief means for the container including means exerting a predetermined bias to urge the valve against the body member in gas sealing relationship, said biasing means being adapted to yield under the influence of a predetermined pressure within said container permitting valve movement to relieve the pressure within the container.

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