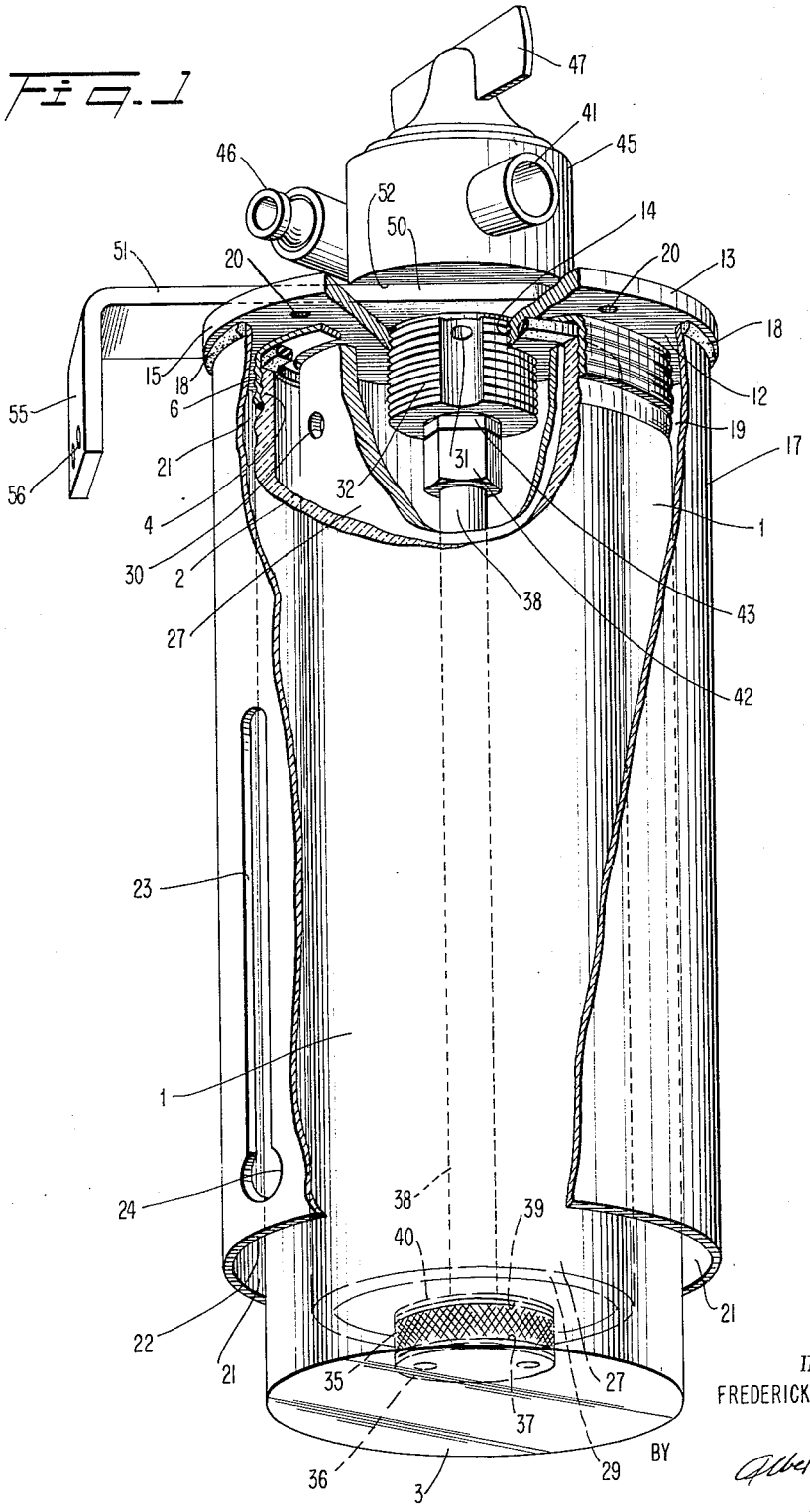
Nov. 2, 1965 F. CAPARRELLI 3,215,140

VAPORIZING OF LIQUID ANESTHETIC

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Fig. 1



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Fig. 2

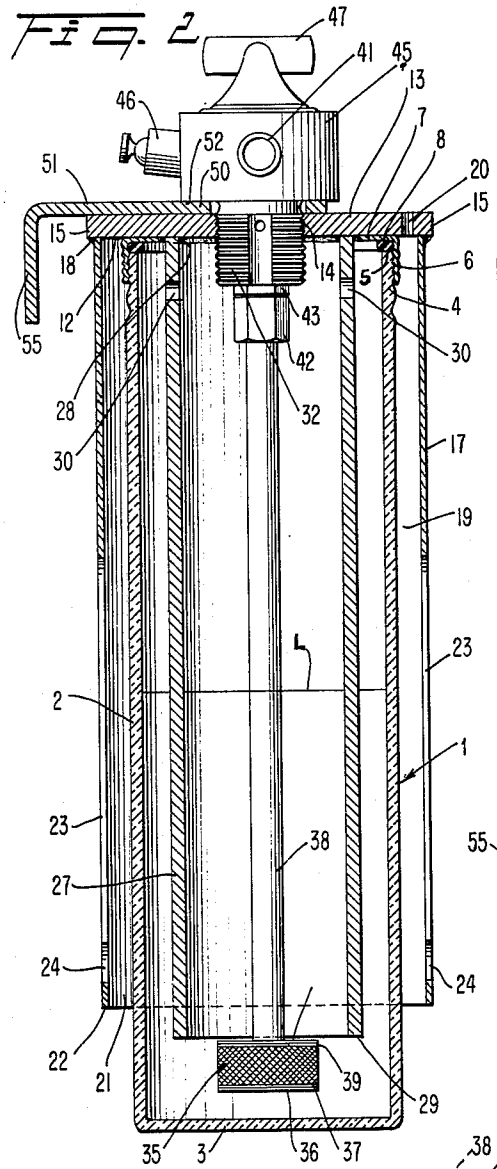


Fig. 3

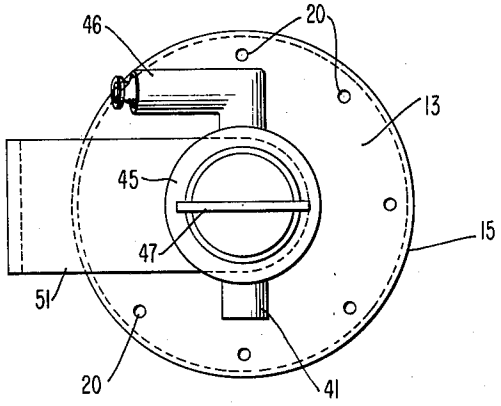


Fig. 4

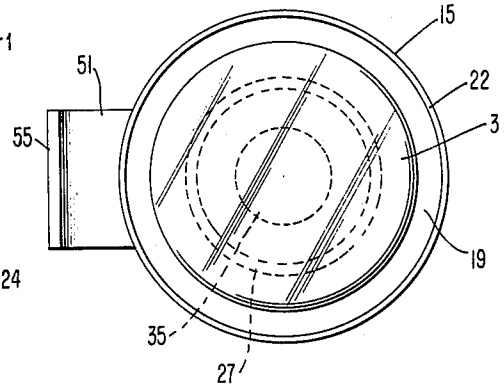
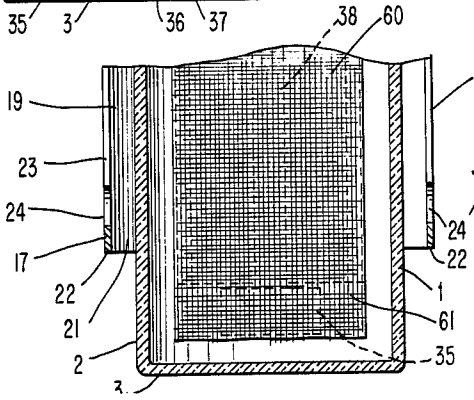


Fig. 5



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VAPORIZING OF LIQUID ANESTHETIC

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Filed Aug. 30, 1962, Ser. No. 220,486
5 Claims. (Cl. 128—188)

This invention relates to anesthesia apparatus and is particularly concerned with method and apparatus for facilitating the vaporizing of liquid anesthetic.

In the vaporizing of an anesthetic, normally liquid, at room temperature and below, such as ether, for use in anesthetizing a patient, the practice generally followed involves the passing of anesthetic gas in contact with the liquid anesthetic to be vaporized. Commonly the gas is passed over or through the liquid on the way to the patient and the flow of it is controlled in order to vaporize the liquid at the desired rate. Then the vapor of ether or other liquid entrained in the gas, commonly oxygen, is mixed with other gases with the resultant mixture being passed to the patient.

The maintaining of a precise control of the anesthesia mixture and the providing of effective vaporization is rendered difficult by the cooling of the ether as the vaporization proceeds. This is due to heat being taken from the surrounding area to provide the necessary heat of vaporization for the ether. However, without replenishment of such heat, the surroundings providing it cool off, the temperature of the ether drops and the rate of vaporization of the ether accordingly slows down.

The efforts that have been made to overcome this have involved various drawbacks. Heating devices are not looked upon favorably in such close association with oxygen and ether vapors due to explosion hazards. The procedure where the operating room personnel wrapped the ether bottle in towels soaked in hot water was a poor makeshift. A fairly effective one where the ether bottle was surrounded by a substantial mass of copper is heavy and expensive. The apparatus and method of this invention, however, provide a solution to this problem and do so in a simple, economical manner while at the same time materially reducing the weight and bulk of the construction. This is done in such a manner as to render the apparatus usable not only as a replacement for existing bulky, costlier constructions, but also to render it fully usable with light weight portable anesthesia apparatus. The previous vaporizers involving heat sinks can not be used because of their weight and bulk.

The solution provided by the instant invention has several aspects not heretofore appreciated for overcoming the prior art drawbacks. In the first place, though the structure does have an element surrounding the container of anesthetic liquid, in the nature of a heat sink, the structure goes right to the heart of the problem by having a more effective element positioned right in the liquid. This interior element serves as a direct heat exchanger. In addition to this, the whole vaporizer is so arranged in heat transfer relationship with respect to the anesthesia apparatus on which it is mounted, that the whole of the anesthesia apparatus serves as a source of heat, or heat sink, for the maintenance of substantially constant temperature within and around the liquid to be vaporized.

It is, accordingly, the principal object of the invention to provide improvements in apparatus for the vaporization of an anesthetic liquid.

Another object is to provide an improved method for the vaporization of an anesthetic liquid.

Still another object is to provide for the replacement of heat lost in the vaporization of a liquid anesthetic by simple, relatively light weight economical apparatus.

A further object is to maintain the temperature of the

anesthesia liquid by direct heat exchange from a source thereof.

A still further object is to greatly increase the effective heat sink available for maintenance of desired temperature in a liquid anesthetic vaporizer.

Further and more detailed objects will in part be obvious and in part be pointed out as the description of the invention taken in conjunction with the accompanying drawing proceeds.

In the drawing:

FIG. 1 is a perspective view of the apparatus of the invention and for carrying out the method thereof with parts being broken away in order to show the interior construction and arrangement.

FIG. 2 is a vertical section of such apparatus.

FIG. 3 is a top plan view of the complete apparatus shown in section in FIG. 2.

FIG. 4 is a bottom plan view thereof; and

FIG. 5 is a fragmentary vertical section illustrating a somewhat modified feature of the invention.

Referring now in detail to the features shown on the accompanying drawing, a generally cylindrical glass bottle, indicated at 1 is provided, having a side wall 2, a bottom 3, and a threaded exterior 4 adjacent its open upper end 5. This glass bottle is the container which holds liquid ether to be vaporized. In this instance, for the purposes of illustration, the level of the liquid in the container is shown at L, though it is of course to be understood that this will be varied up or down as refilling and vaporization take place.

For ready removal and replacement, the threaded portion 4 of the bottle wall 2 is engaged with the threaded side wall 6 of the screw cap. This screw cap has an annular inturned portion 7 between which and the end 5 of the bottle there is compressed a gasket 8 of suitable vapor resistant material. Leather is one material which is effective for this purpose, though others may be employed as desired. Thus it will be apparent that the bottle 1 can be readily removed for cleaning and refilling and can be easily replaced by screwing the upper end 4 thereof into the threaded portion 6 of the screw cap. When screwed up tight therein a vapor-proof joint is made by the compression of the gasket 8. The gasket 8 is of course secured to the screw cap so that it remains in place there at all times.

The annular portion 7 of the screw cap is brazed, or otherwise secured in tight sealing engagement with the undersurface 12 of a relatively thick annular header member 13. This member extends from a screwthreaded inner opening 14 to an outer periphery 15. Closely adjacent its outer periphery the member 13 has a cylindrical metal sleeve 17 secured thereto as indicated at 18. This sleeve 17 surrounds the side wall 2 of the bottle 1 in outwardly spaced relation with respect thereto, leaving an air space 19 therebetween. At its upper end the air space 19 is in communication with a plurality of holes 20 formed at spaced intervals around the header 13, as best seen in FIG. 3.

Turning back to FIGS. 1 and 2, it will be seen that the passage 19 opens out at 21 between the side wall 2 of the bottle 1 and the bottom free edge 22 of the sleeve 17. In addition, as best seen in FIGS. 1 and 2, the sleeve 17 has circumferentially spaced, longitudinally extending slots 23 formed therethrough. These slots commence with an enlarged lower end 24 closely adjacent the bottom edge 22 of the sleeve 17. The slots 23 extend for a substantial portion of the height of the sleeve 17 and serve several purposes. The most obvious one of these is to enable observation of the liquid level with the anesthetic in the glass bottle 1. The slots 23 also perform an additional function which is to allow air to flow therethrough out of the passage 19 in addition to the air flowing out of the

bottom end 21 of that passage. Such air enters through the holes 20 in the header 13 and flows downwardly due to the cooling off of the ether in the bottle as some of it evaporates. This air tends to warm up the glass bottle 1 as well as the sleeve 17 and accordingly assists in replacing the heat lost as a result of the vaporization of the ether in the bottle 1.

More importantly, from the heat exchange standpoint, the invention goes to the heart of the problem of keeping up the temperature of the ether in the bottle 1, or, in other words, restoring the heat loss due to the heat of vaporization required for vaporizing the ether, by providing a direct heat exchange member in the form of a metal cylinder 27 which seats down within the bottle 1. Accordingly, the cylinder 27 normally extends well down within the ether in that bottle. The cylinder 27 is secured at the upper end 28 by brazing or other heat exchange interconnection to the undersurface of the header 13 at a position spaced radially inwardly with respect to the inner wall of the bottle side 2. This cylinder 27, in direct heat exchange relationship with the ether in the bottle 1, has a wall of substantial thickness. As here shown its thickness is several times that of the outer sleeve 17. It, accordingly, has substantial heat capacity and hence ability to control the temperature of the ether. Furthermore, the cylinder 27 extends downwardly to a position 29 below the lower end 22 of the sleeve 17 and down to the oxygen bubbler shortly to be described.

Adjacent its upper end, the cylinder 27 is provided with a ring of holes 30 therethrough extending around its circumference to enable gas and entrained ether vapor to flow therethrough. Such gas and vapor may thus flow inwardly from the zone between the bottle 2 and the cylinder 27 in order to flow away to the patient through the outlet port 31 provided in the valve nipple 32 shortly to be described.

At this point it is important to note that the header 13, the sleeve 17 and the inner heat exchange cylinder 27 are all formed of material of high heat capacity and conductivity. Preferably such material is copper, though other materials having the same capabilities to more or less degree can of course be employed. Silver has characteristics rendering it superior to copper but to use it for this purpose would be uneconomical. It is also important to note that the securing of the sleeve 17 and the cylinder 27 to the header 13 are effected in such manner that heat flow from one to the other proceeds easily and without interruption. Accordingly as heat may be supplied to the sleeve 17 from the exterior thereof, or by means of air flowing down through the passageway 19 interiorly thereof, that heat can readily flow into the header 13 joining the heat picked up by the header from surrounding atmosphere in flowing down into the heat exchange cylinder 27 where the heat is given off in direct heat exchange relationship with respect to the ether within the bottle 1.

In the form of FIGS. 1 and 2, oxygen or other suitable vaporizing gas is introduced into the ether into the bottle 1 to bubble up therethrough from adjacent the bottom of the bottle by means of an element generally considered as a "bubbler" and illustrated at 35. This bubbler is commonly a small cylinder formed of a gas pervious material of which a product made by the Moraine Products Division of the General Motors Corporation and sold under the trademark "Porex" is a commonly preferred material. This is understood to be a sintered body made up of minute spheres or other elements of bronze, which when sintered adhere and provide a body which is sufficiently porous to allow the escape of gas therethrough. Furthermore, this body provides a small additional source of heat positioned within the ether and giving off heat thereto.

The cylindrical bubbler 35 is suitably held by a bottom cap 36 and a gasket 37 onto the lower reduced end of the hollow vertical rod 38. The rod 38 conducts the gas down through the center of the bottle 1 and emits it inside of the bubbler 35 through holes in its reduced threaded periphery. The cap 36 screws onto the first few threads of the reduced end of the rod 38 below the holes therein and tightens a gasket 37 against the lower face of the bubbler. This in turn tightens the upper face of the bubbler 35 against the gasket 39 positioned between the bubbler 35 and the flange 40. Accordingly, any escape of gas has to be out through the side wall of the bubbler 35. Inasmuch as this bubbler is positioned below the bottom end 29 of the heat exchange cylinder 27, the gas bubbles emitted will rise through the ether within that cylinder as well as through the ether surrounding that cylinder so as to vaporize that ether and then carry that vapor out through the port 31 and through the outlet line 41 through suitable tubing to the patient.

The gas pipe 38 is suitably secured to the valve nipple 32 and is locked in place by means of a pair of nut-like members 42 and 43. The opening through the pipe 38 communicates with a continuing opening through the multiport valve head 45 and is put in communication with the gas inlet passage 46 in one position of the valve member 47. In the other position of the valve member 47 the passage from the gas inlet to the interior of the gas pipe 38 is shut off and instead a by-pass passage is opened directly from the inlet 46 to the outlet 41 so that oxygen or other gas being used can flow directly from the inlet to the outlet without passing down into the bottle 1.

Another important function served by the valve chamber 45 is to act as a clamping member for clamping the inner end 50 of the mounting bracket 51 to the vaporizer. This it does by means of the flat bottom surface 52 of the housing 45 engaging the bracket portion 50 and clamping it against the upper surface of the header 13 when the screw threaded nipple 32 is screwed down into the threaded opening 14 in the header 13 formed to receive it. It will be noted that there is accordingly not only tight engaging between the portion 50 of the bracket underlying the housing 45 and the upper surface of the header 13, but also the bracket is in engagement with the header 13 all the way out to the periphery 15 of that header.

At its outer end the bracket here shown is turned downwardly at 55 in spaced relationship with respect to the outer sleeve 17 of the vaporizer, and is formed with a pair of holes 56 therethrough to enable it to be secured to the body or chassis of the anesthesia apparatus. The bracket 51, like the other metal parts of the vaporizer just described, is also preferably made of copper so that it provides heat conductivity and emissivity. Thus it has surprisingly been found in accordance with tests run on this apparatus that by so bracketing the vaporizer to the complete anesthesia apparatus the whole of the anesthesia apparatus may be made to serve as a heat sink and does so serve. Accordingly, any heat loss through vaporization of the ether is replaced from a wide ranging source of very substantial heat capacity. Hence, the method involving tapping the heat sink capacity of the whole anesthesia apparatus and transmitting that heat to a copper cylinder of substantial volume in direct heat exchange relationship with the ether enables the temperature of the ether to be maintained by light weight economical apparatus. The outer cylinder and header of the apparatus of course contribute to this. Furthermore, the temperature is maintained by the utilization of apparatus of extreme simplicity, economy, weight and reduction in size as against what was heretofore thought necessary.

In FIG. 5 the structure of the vaporizer is just the same as that shown in the previous forms, but with an addition thereto. This addition takes the form of a fabric sleeve, 60, which fits over and is drawn up over the outer surface of the heat exchange cylinder 27. This sleeve extends from well up near the row of holes 30

all the way down the outer surface of the cylinder **27** and hangs below the lower end **29** of that cylinder in open ended portion which extends down to a position just below the bubbler **35**. This downwardly extending portion is shown at **61** in FIG. 5. This fabric sleeve is formed of material capable of acting as a wick, the lower part of the wick is in the liquid ether and the upper part is exposed to the gas above the liquid level, which gas has bubbled up through the ether. Liquid ether from the lower part of the wick will, accordingly, work up the wick by capillary action and be exposed to the gas in the wick portion above the wick level. Accordingly, the vaporization of ether is enhanced by the wick-like sleeve in addition to the ether vaporized by the bubbling oxygen up therethrough. The wick **61** will, of course, fit the heat exchange cylinder **27** snugly enough to hold itself in place thereon.

Though in the foregoing specific apparatus has been disclosed embodying the invention and for carrying out the method of the same, it is of course to be understood that such is for illustrative and not limiting purposes and that workers skilled in the art may well introduce modification and variations of the instant disclosure without departing from the spirit or scope of the invention. Also though ether and oxygen have been referred to as the anesthetic liquid and anesthetizing gas, respectively, it is of course to be understood that these references are for illustrative and not limiting purposes.

Speaking more generally, since certain changes in carrying out the above method and the construction set forth which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A vaporizer for use in anesthesia comprising, a header formed as a wide annulus of metal of high heat conductivity, a cylindrical container having an open upper end readily removably mounted in sealing engagement on one face of said header, a first metallic cylinder of high thermal conductivity and having a wall of substantial thickness extending down into said container from said one face of said header to a position closely adjacent the said bottom end of said container and in spaced relationship with respect to the wall of said container, a second metallic cylinder of high thermal conductivity extending from said one face of said header, said second cylinder surrounding said container and being positioned in outwardly spaced relation with respect thereto, a gas conduit extending downwardly from said header centrally of said container, a bubbler member secured on the end of said gas conduit remote from said header and positioned no higher than the lower end of said first cylinder for emitting gas into said liquid, valve means positioned on the other face of said header and

having a nipple extending through said header, with an inner extending beyond said one face of said header, said gas conduit being mounted on said inner end of said nipple, said valve means being formed to put a source of gas in communication with the interior of said gas conduit and means providing for the exit of gas and vapor from said container.

2. A vaporizer as in claim **1**, said outer cylinder being formed with vertically extending slots extending through the wall thereof at spaced circumferential positions around said cylinder and said header being formed with holes therethrough in communication with the space between said outer cylinder and the side wall of said container whereby ambient air is caused to flow in through said holes, downwardly through said space and outwardly through said slots to replace cooled air therein with ambient air of room temperature and to assist in restoring the heat lost in said container resulting from vaporization of liquid therein.

3. A vaporizer as in claim **1** and including, a mounting bracket formed of metal of high thermal conductivity, said mounting bracket having one end thereof clamped between said valve housing and said header and having the other end thereof extending outwardly of said header for mounting said vaporizer on apparatus forming a substantial heat sink whereby said bracket will transmit heat from said heat sink to said header and to said first cylinder.

4. A vaporizer as in claim **1**, said exit means for gas and vapor being an outlet port formed in the side wall of said nipple and said valve member being provided with an outlet conduit in communication with said outlet port, said inner cylinder adjacent the upper end thereof being formed with a ring of holes therethrough providing for the flow of gas and vapor exteriorly thereof through said holes to said outlet port.

5. A vaporizer as in claim **1**, said means for mounting said container in tight sealing engagement against one face of said header including a screw cap and a gasket seated therewithin, said container being exteriorly threaded adjacent the open end thereof and said exterior threads being in threaded engagement within said screw cap.

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