United States Patent [19]

Jorgensen

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[54] **PLANT, PREFERABLY FOR ANAESTHESIA**

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[51] **Int. Cl.** **A61m 17/00**
[58] **Field of Search** 128/188, 142.2, 142.4, 128/145.8, 146, 146.3, 146.4, 142, 142.3, 145, 146.5; 417/151, 158; 73/200, 209

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[57] **ABSTRACT**

Anaesthetic gas is maintained in a closed system and exhausted in an area external to the area wherein the anaesthetic equipment is operated according to the disclosed apparatus. The apparatus for administration of anaesthesia includes a controlled source of anaesthetic gas, a mask, check valves on either side of the mask, carbon dioxide absorber, rubber bag, and means for removal of circulated anaesthetic gas from the system. Inlet and outlet from the system may be conveniently controlled thereby maintaining substantially the same pressure throughout the system. The apparatus disclosed provides that harmful anaesthetic gases exhausted from the system do not reach the ambient air surrounding the apparatus, thus the staff working in the area of the apparatus is protected from exposure to the gases.

6 Claims, 6 Drawing Figures

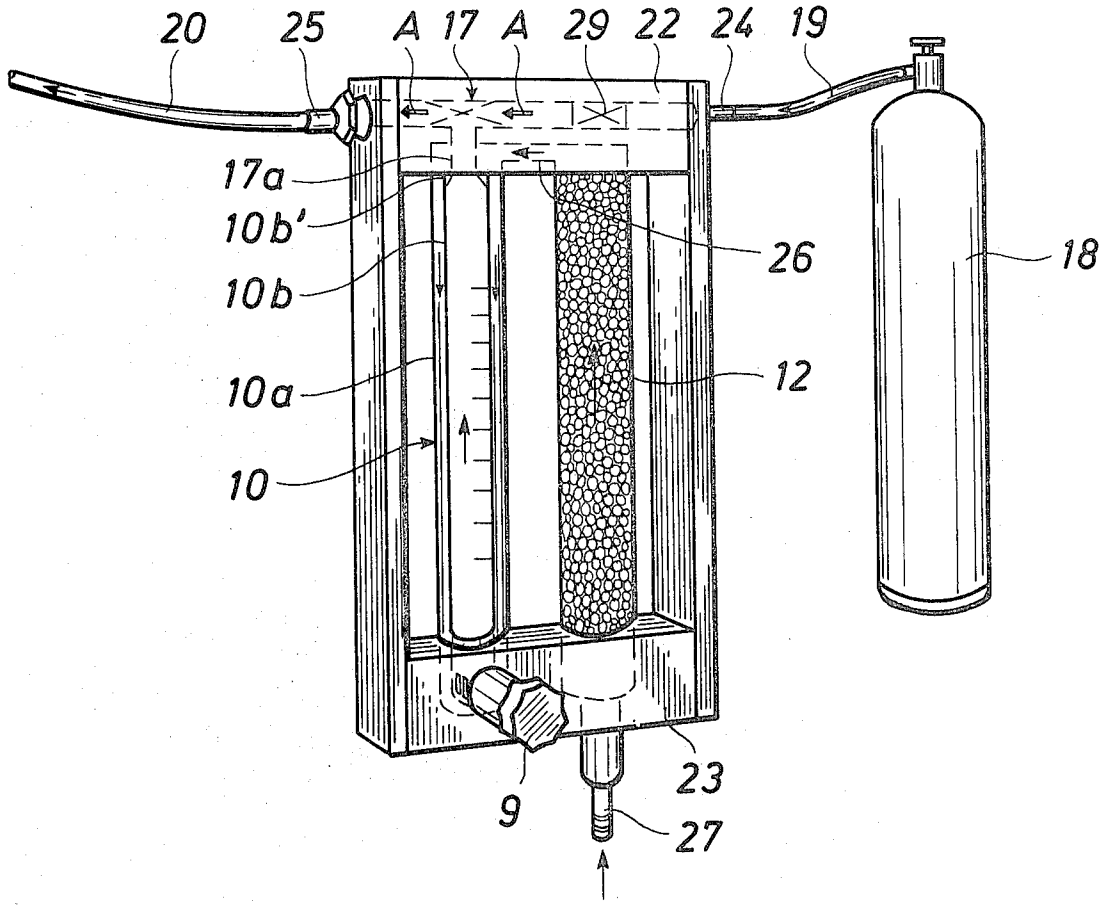
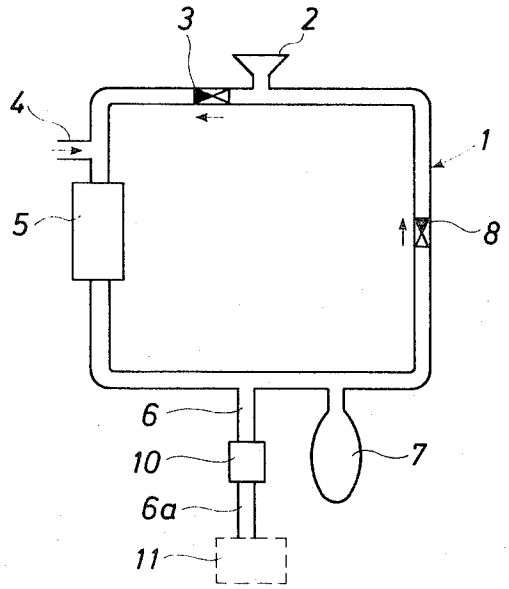


Fig. 1



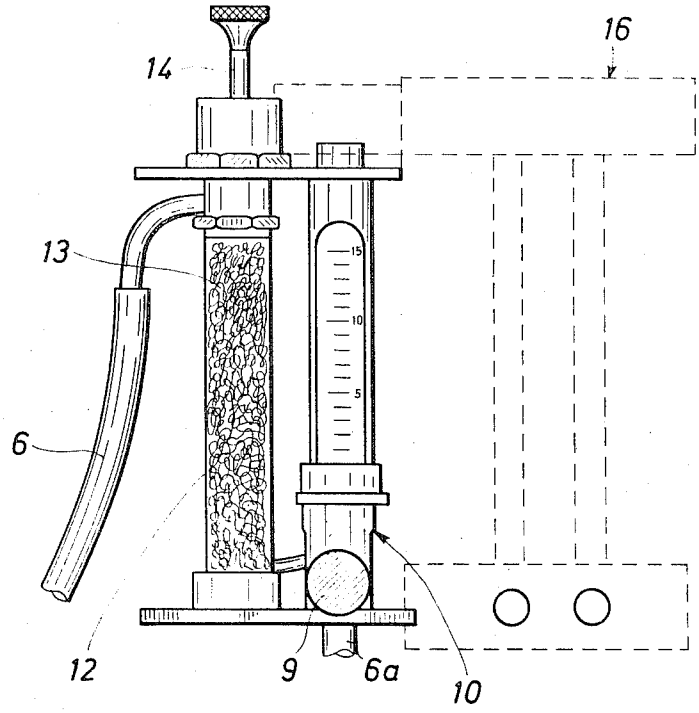


Fig. 2

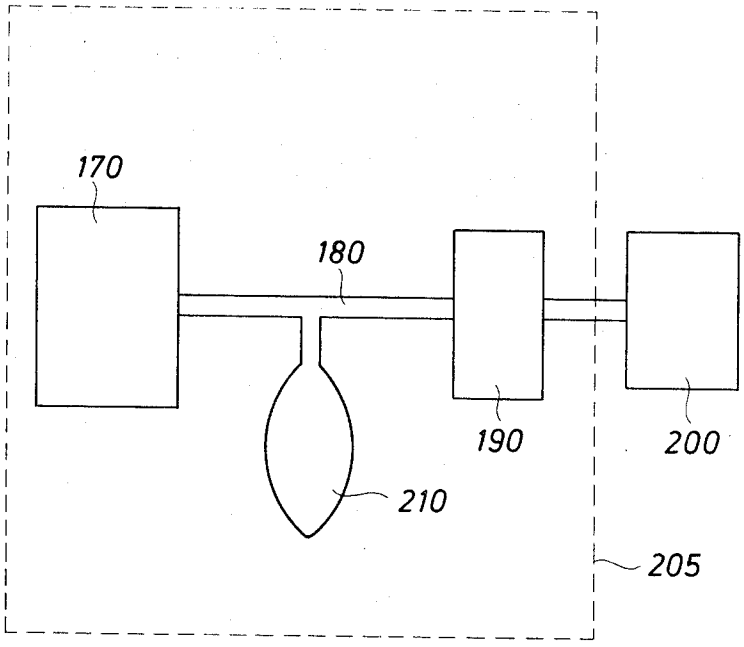


Fig. 3

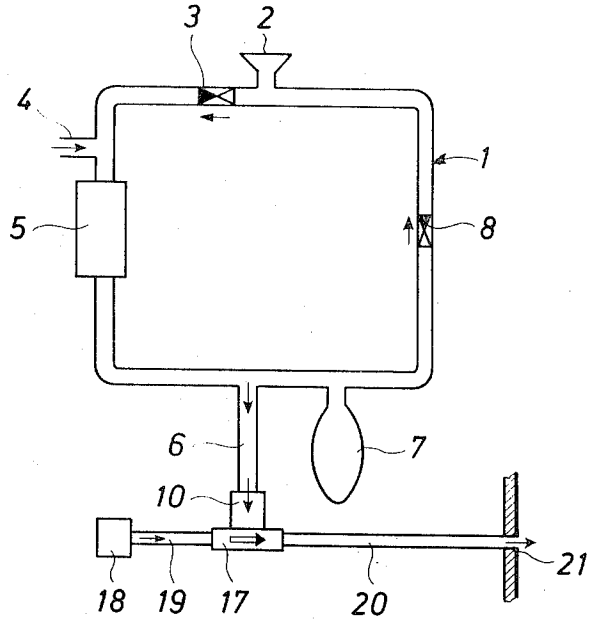
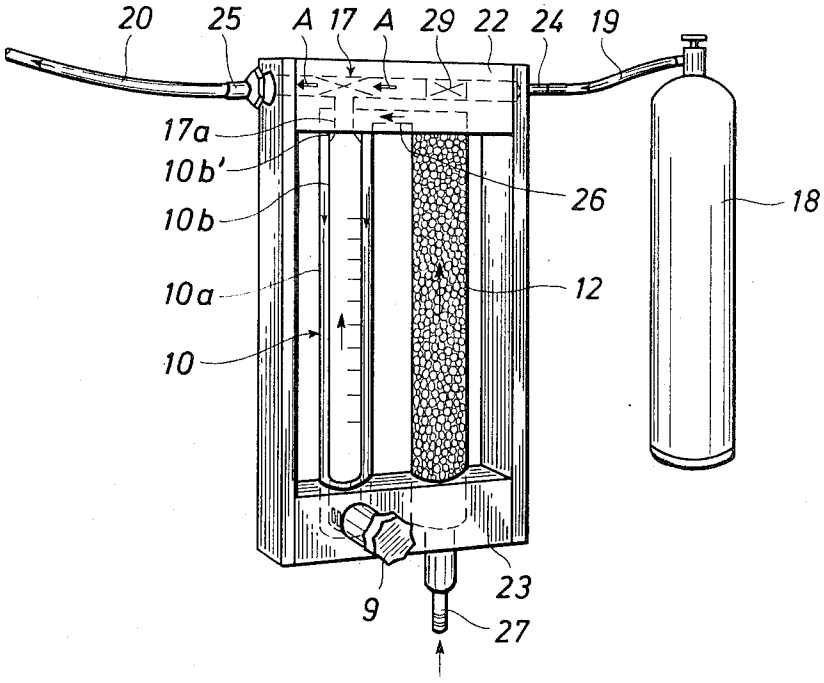


Fig. 4

Fig. 5


20
25
A
17
A
29
22
24
19
17a
10b'
10b
10a
10
26
12
18
9
23
27

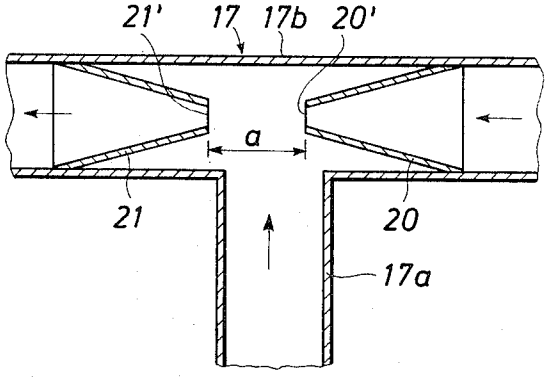

21'
17
17b
20'
a
21
20
17a

Fig. 6

PLANT, PREFERABLY FOR ANAESTHESIA

BACKGROUND OF INVENTION

The invention relates to a plant or apparatus preferably for anaesthesia including a pipe system to which there are connected an anaesthetic mask, an absorber for the absorption of the carbon dioxide of the expiration air, a rubber bag, check valves and an inlet for feeding the anaesthetic gas from a rotameter box.

A plant of this kind is already known, in which a respiration valve of the pop-off type is fitted in the pipe system at the rubber bag. In this valve the excess anaesthetic gas from the system will gradually pass out to the room in which the apparatus is used which is most undesirable as there is reason to believe that the anaesthetics generally used today have a teratogenetic effect. It has been found, for example that prolonged exposure to nitric oxide may bring about aplastic anaemia, and among American anaesthesiologists there seems to be a noteworthy death-rate due to malignant tumours in the blood cell forming organs. Studies of Danish anaesthesia staff has proven that the frequency of spontaneous abortion rose from 10 to about 20 per cent after employment in an anaesthesia department as compared to working in areas free from anaesthetics.

Also in anaesthesia plants with no respiration valve anaesthetic gases will escape. This has for instance been ascertained by the fact that members of hospital staffs who have stayed in a room where fluothane (bromochlorotic fluoroethane) anaesthesia is given will show detectable quantities of fluothane in their expiration air up to half an hour after they have left the room. Headaches and tiredness after a day's work in an operating room are known by all anaesthesiologists.

One would think that it would suffice to guide the anaesthetics gases down to floor level to get rid of them at head level, but this measure has not always proved to be adequate. The anaesthetics gases are capable of quickly spreading upwards thereby affecting those staying near the plant.

SUMMARY OF INVENTION

On this background, the purpose of the invention is to produce a plant of the above-mentioned kind which results in complete removal of the anaesthetic gas leaving the pipe system.

The plant according to the invention is characterized in that the pipe system, preferably near the rubber bag, has a branch pipe which is provided with parts for the controlled suction of the anaesthetic gases from the pipe system. In this way control is maintained of the anaesthetic gases which have left the pipe system of the plant, whereby those members of the hospital staff operating the device or being near it are prevented from being exposed to the injurious effect of the gases.

According to the invention the devices for controlled suction of the anaesthetic gases may comprise a flowmeter provided with a regulating valve, the outlet of the meter being connected with a vacuum producing or vacuum means, such as a vacuum pump or a central vacuum plant. Easy adjustment of the volume current desired to remove from the circuit is realized as well as during the adjustment of the valve it is easy to take readings of the flowmeter. The adjustment of the valve must be suited to the volume current of the anaesthetics gas which is fed from the rotameter box so that a balance is maintained between the volume current introduced and the volume current exhausted. Besides the flowmeter is easy to control.

As the flowmeter is only in contact with the expiration air of the patient, there will be no disinfection problem connected with the plant.

Further according to the invention, a humidity absorber may be inserted before the flowmeter, and the flowmeter may for instance be of the rotameter type or it may be a ball flowmeter. Hereby a marked reliability is achieved as the float or ball of the flowmeter is kept free from moisture.

Further according to the invention the humidity absorber may contain silica gel as known, and the quantity of this gel may be at minimum 20 g. This is sufficient for a flowmeter of the rotameter type will work perfectly for at least three hours under normal suction conditions. Also according to the invention the flowmeter may be built into the rotameter box whereas the humidity absorber is fitted adjacent to the box. In this manner it is easy to read the magnitude of the volume current removed and applied and also that the silica gel is easy to exhange. The exchange may be conveniently performed during the working of the plant.

According to the invention the plant may be arranged to work in connection with a respirator, the suction devices being fitted on the expiration side of the respirator, and also a reservoir bag may be fitted between the respirator and the suction devices. Thereby a most reliable working of the respirator and a careful removal of the expiration air is achieved.

Also according to the invention the humidity absorber may be fitted for an easy exchange by providing it with a quick clutch. Thus the humidity absorber is very easy to remove and replace with another when the absorbability of the gel contained has been used up. Usually, this will be shown when an indicator added to the gel changes color.

Further according to the invention the vacuum producing unit may be designed as an ejector suction unit and built together with the flowmeter at its outlet end, and the outlet end of the ejector suction unit may be connected to a piping carried to the nearest window or venting channel in the working room. In this way the suction can be carried out very smoothly as a result of the continuously flowing driving gas. In practice heat does not occur, and the unit is working completely independent of an electric power supply. Incidentally it must be observed that the anaesthetic gas leaving the flowmeter is not exhausted into the working room. Thus, the staff operating the plant is well protected against the anaesthetic gas.

According to the invention the ejector suction unit may consist of a mainly T-shaped pipe piece, the vertical part of which is tightly fitted to the outlet end of the flowmeter, and the horizontal part of which contains two mainly truncated cone-shaped jet bodies, The narrowest ends of these bodies face each other and have a mutual distance which generally is equal to the inside diameter of the vertical pipe part, and where the narrowest end of the jet body acting as jet pipe projects a just over the inside diameter of the vertical pipe part, and that the horizontal pipe part is provided with means for inlet and outlet, respectively of the driving gas. This ejector suction unit is both simple and reliable.

According to the invention additionall in the horizontal part of the T-shaped pipe piece a shut-off valve may

be inserted, such as a ball valve and this valve may be fitted upstream from the jet body formed by the jet pipe, in the supply direction of the driving gas. In this manner the suction unit is easy to start and stop without it being necessary to regulate the source from which the driving gas is supplied

Finally, according to the invention the injector suction unit may be arranged to work with a driving gas having a pressure of up to 6 atmospheres, which gas may for instance be compressed air, nitrogen or oxygen. The vacuum thus produced by the suction unit will be suitably high.

DESCRIPTION OF THE DRAWINGS

The invention is explained in the following with reference to the drawing where

FIG. 1 shows in outline an embodiment of the plant according to the invention intended for anaesthesia,

FIG. 2 a flowmeter provided with a regulating valve with humidity absorber,

FIG. 3 the plant according to the invention used in connection with a respirator,

FIG. 4 another embodiment of the plant according to the invention intended for anaesthesia, and in which the anaesthetic gas is removed by means of an exhaust suction unit,

FIG. 5 a flowmeter provided with a regulating valve with requisite humidity absorber and exhaust suction unit, seen in perspective, and

FIG. 6 part of the exhaust suction unit according to FIG. 5 in a large scale and longitudinally viewed.

DESCRIPTION OF PREFERRED EMBODIMENTS

The anaesthesia plant shown in FIG. 1 consists of a flow sytem **1**, in which are arranged an anaesthetic mask **2**, a check valve **3**, a pipe stub **4** for feeding fresh anaesthetic gas, a carbon dioxide absorber **5**, a branch pipe **6**, a rubber bag **7**, and another check valve **8**. When the plant is working, the anaesthetic gas will flow in the direction indicated by the arrows, the valve operator periodically compressing the rubber bag **7**.

In the branch pipe **6** devices are fitted for controlled suction of the anaesthetic gas from the system, and these devices are made up of a flowmeter provided with a regulating valve and a vacuum producing unit **11**, for instance a central vacuum plant or a vacuum pump.

FIG. 2 shows in detail how the flowmeter, which is of the rotameter type, is constructed. It has at the bottom a regulating valve **9**, which may be designed as a needle valve. This valve rests on, in a known manner, an inlet pipe communicated with a metering pipe extending up around the longitudinal axis of the flowmeter. The inside of this pipe communicates with an outer space around the metering pipe, and this outer space communicates with an outlet pipe **6***a* below the level of the valve **9**. The pipe **6***a* is connected with the vacuum unit **11**. The flowmeter is connected at its inlet end with a humidity absorber **12** in the form of a water absorber containing silica gel **13** (for example 20 grams) as an absorption means. The absorber is made of a thermoplastic material and has an open top and a perforated bottom. By means of the rod **14** it is possible to empty the water absorber. The anaesthetic gas coming from the pipe system **1** in FIG. **1** passes through the branch pipe **6** up to the top of the water absorber **12** whereupon it passes down through the silica gel. At the bottom end of the water absorber the gas runs into the flowmeter and passes next upwards through the metering pipe and back along its outer side. The float of the flowmeter will during this passage take up a certain position of equilibrium, it being partly affected by the gas and partly by gravitation. Readings of the flowmeter can then be taken. From the flowmeter the gas flows further on to the vacuum unit. It is observed that the vacuum unit supplies a constantly low suction, for instance 50 mm Hg. When a certain flow of anaesthetic gas is required to be removed from pipe system **1**, the regulating valve **9** is adjusted, until the flowmeter indicates the value desired. This value shall be of a suitable ratio to the flow of fresh anaesthetic gas, which from the rotameter box **16** is carried forward to the inlet **4** of the system **1**. As shown in FIG. **2**, the flowmeter may be combined with the rotameter box **16**. The water absorber **12** is placed outside the box as the silica gel must be easily exchanged. Such an exchange is required when a color indicator added to the silica gel shows that it no longer absorbes water. It is possible to replace the gel even if the plant is in operation. The humidity absorber may be provided with a quick clutch so that it is easy to remove and renew.

When the flowmeter is properly adjusted, the rubber bag **7** will not be completely filled as in the case of the usual system with a respiration valve. This means that the only resistance which the patient is respiring against is the resistance found in the check valves.

The above flow system **1** is shown in the form of a circuit. However, there is nothing to prevent the plant from consisting of a gas-conduction conduit to which the anaesthetic mask, and, if any, an absorber, a rubber bag and optionally one or more check valves are also connected with the suction devices.

The plant described above may be conveniently used in connection with a respirator **170**, which appears from FIG. **3**. A branch pipe **180** is partly connected to the expiration side of the respirator and partly connected to the suction devices in the form of a flowmeter **190** and a vacuum means **200**. The vacuum means **200** may be located in a room outside the one in which the respirator and the flowmeter are erected, which is indicated by means of the dotted line **205**. Between the respirator and the flowmeter a reservoir bag **210** is inserted for provisional storing of the expiration air from the patient, which air pulsating is carried out into the pipe **180**.

Instead of the flowmeter it will suffice in certain cases to use a throttle valve.

The embodiment of the anaesthesia plant according to the invention as shown in FIG. **4** consists as in FIG. **1** of a flow system **1** in which there is an anaesthetic mask **2**, a check valve **3**, an inlet **4** for feeding fresh anaesthetic gas, a carbon dioxide absorber **5**, a branch pipe **6**, a rubber bag **7** and another check valve **8**. When the plant is working, the anaesthetic gas will flow in the direction indicated by the arrows, the valve operator periodically compressing the rubber bag **7**.

In the branch pipe **6** suction devices are fitted in the form of a flowmeter **10** and an ejector suction unit **17**, the latter being fitted on the outlet end of the flowmeter. The ejector suction unit is fed with driving gas from a suitable driving gas source **18**, which is under pressure. This source may for instance consist of a pressure tank, as shown in FIG. **5**, but may also consist of a compressed air plant. The driving gas used in the unit **17** is drawn away via a piping **20** carried to the nearest win-

dow or a venting channel 21 in the working room, in which the plant is in operation.

In FIG. 5 is shown how the ejector suction unit 17 is built together with the flowmeter 10. As will be seen, the flowmeter is held in position between an upper and a lower bar 22 and 23 in a rectangular frame, and it consists as in FIG. 2 of a jacket pipe 10*a* and a metering pipe 10*b* placed inside the former. The top end of the metering pipe 10*b'*, the outlet end, is connected with a vertical pipe part 17*a* in a T-shaped pipe piece in the ejector suction unit. The horizontal part of this pipe piece carries, as shown in FIG. 6, the reference number 17*b*, and consists of two substantially truncated coned jet bodies 20 and 21, the narrowest ends of which 20' and 21' are facing each other. The distance a between these ends is substantially equal to the inside diameter of the pipe part 17*a*. As will be seen, the end 20' projects a little over the inside diameter of the pipe part 17*a*. In the pipe part 17*b*, a shut-off valve 29, as shown in FIG. 5, is inserted, such as a ball valve. At each end of the pipe part 17*b* there are stubs 24 and 25 for admitting and exhausting the driving gas.

Upstream from the flowmeter there is, as shown in FIG. 5, a humidity absorber 12 inserted which for instance may contain the silica gel. This absorber is connected by means of a pipe 26 to the space between the jacket pipe 10*a* and the metering pipe 10*b* of the flowmeter. The stub 27 of the absorber is connected with the branch pipe 6 shown in FIG. 4.

At the lower end of the metering pipe 10*b*, as shown (FIG. 5) a regulating valve 9 is inserted, whereby the flow of the anaesthetic gas through the metering pipe may be easily regulated or shut off. The flowmeter 10, being of the rotameter type, contains a float which, in a known manner, indicates the magnitude of the volume flow passing.

The apparatus shown in FIGS. 4–6 functions in the following way: When the plant is in operation, anaesthetic gas is fed to the pipe system 1 via the inlet 4 connected to the rotameter box. At the same time gas is being sucked out through the branch pipe 6, in a manner such that the variations of the anaesthetic gas pressure in the system 1 will be very small, probably less than one-half cm in a water column. The suction evacuation is brought about by means of an ejector suction unit 17, having driving gas passed therethrough as shown by the arrows A in FIG. 5. The driving gas, which may have a pressure approaching up to 6 atmospheres, is converted by the jet body 20 into a thin gas stream impinging upon the opening at the lower end 21' of the jet body 21 as this gas stream travels forward, it will expand creating a lower pressure. The lower pressure will have the effect of sucking the anaesthetic gas from the metering pipe 10*b* of the flowmeter. Before the anaesthetic gas has reached this stage, it has, as shown by the small arrows, passed through the silica gel in the absorber 12 so that it is rather dry. This will cause the flowmeter to work most precisely. The exhaust volume flow can be regulated either by the valve 9 or by reducing the pressure of the driving gas at the pipe stub 24.

As driving gas many different gases can be used, such as for instance compressed air, nitrogen or oxygen.

When the exhaustion is done in the way described above, there is no danger of the anaesthetic gases removed exploding as the gases will not be exposed to any significant amount of heat nor is the formation of sparks likely. Besides the exhaustion is carried out very smoothly, the driving gas passing continuously through the pipe piece 17*b*.

There are several other embodiments of the present invention. For example, the jet bodies 20 and 21 may have a larger or smaller vertex angle than the one shown. Also the distance between the bodies may be made shorter than shown.

The plants described above serve only to illustrate the invention and not to limit the scope thereof.

I claim:

1. Apparatus for the administration of anaesthetics comprising a closed system including a mask, inlet means, carbon dioxide absorption means, rubber bag, at least one check valve, inlet means, a branched pipe, a flowmeter, a regulating valve and a vacuum means,

said inlet means provided for the introduction of anaesthetic gas from a rotameter metering means into said system and communicated to said carbon dioxide absorption means;

said carbon dioxide absorption means for the absorption of carbon dioxide of the expiratory air and communicated to said branched pipe;

said branched pipe communicated to said rubber bag and said vacuum means for controlled suction and substantially continuous, uninterrupted exhaust of at least a portion of said anaesthetic gas from said system;

said vacuum means comprising a T-shaped ejector suction unit including an inlet and outlet means, a source of pressurized gas and an exhaust means communicated to said branched pipe of said system, said inlet and outlet means disposed from each other and containing therebetween a first and second truncated cone jet bodies spaced apart from each other, their narrow ends facing each other, said first cone contained in said inlet means and positioned such that the narrow end thereof extends over said exhaust means, said second cone contained in said outlet means, the distance between the narrow ends of said first and second cones being about equal to the inside diameter of said exhaust means, and said outlet means communicated from the operating room to a venting channel, wherein the pressurized gas passes between said first and second cones thereby creating suction and removing the anaesthetic gas from said exhaust means;

said flowmeter and regulating valve communicated to said branched pipe and communicated and attached to said exhaust means of said vacuum means, the downstream portion of said flowmeter defining said exhaust means;

said rubber bag for controlled administration of the anaesthetic gas to and communicated with said mask;

said check valve provided for one-way flow between and communicated with said rubber bag and said mask;

said mask for administration of the anaesthetic gas to the patient and communicated to said inlet means;

an additional check valve provided for one-way flow between and communicated with said rubber bag and said inlet means;

the entire system being closed such that at least a portion of the return anaesthetic gas leaving said mask is substantially continuously exhausted away

from the area in which said apparatus is operated.

2. Apparatus as claimed in claim 1 including a respirator, a reservoir bag communicated to the exhaust side of said respirator, said reservoir bag communicated with said vacuum means.

3. Apparatus as claimed in claim 1 wherein said inlet means is provided with a valve means for the control of said pressurized gas to said ejector suction unit.

4. Apparatus as claimed in claim 1 wherein a water absorption means is provided upstream from and communicated to said flowmeter.

5. Apparatus as claimed in claim 4 wherein said water absorption means includes silica gel.

6. Apparatus as claimed in claim 4 wherein said water absorption means is provided with a quick exchange means for rapid removal and replacement of the water absorption material contained therein.

* * * * *