United States Patent [19]

Nicholes

[11] **3,713,440**

[45] **Jan. 30, 1973**

[54] FILTRATION SYSTEM

[76] Inventor: **Paul S. Nicholes,** 330 South 1300 East, Salt Lake City, Utah 84102

[22] Filed: **Jan. 18, 1971**

[21] Appl. No.: **107,172**

[52] **U.S. Cl.** **128/188,** 55/379

[51] **Int. Cl.** **A62b 7/10**

[58] **Field of Search** ....128/188, 142.6, 140 R–142.5, 128/142.7, 145 R, 146, 214 C, 145.8, 145.5, 202; 55/376, 378, 379, 374, 503, 381, 382

[56] **References Cited**

UNITED STATES PATENTS

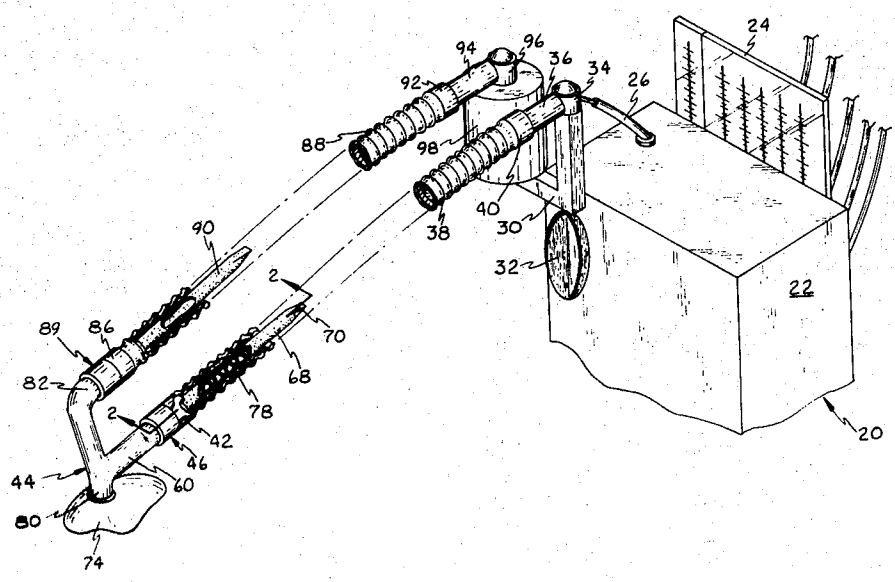
3,556,097	1/1971	Wallace	128/188
2,145,047	1/1939	Goldkamp	55/379 X
2,162,043	6/1939	Westlund et al.	55/379 X
3,443,366	5/1969	Schwab	55/376 X
3,204,391	9/1965	Schwab	55/374
3,493,115	2/1970	Koches	55/503
2,789,654	4/1957	Zurit	55/503 X
3,509,698	5/1970	Medcalf et al.	55/379 X

Primary Examiner—Richard A. Gaudet
Assistant Examiner—G. F. Dunne
Attorney—H. Ross Workman

[57] **ABSTRACT**

A filtration system, including apparatus and method for conventional anesthesia or respiratory therapy apparatus, the filtration system having tubular filters formed of fibrous material interposed in both the inspiratory and expiratory tubes. If either of the filters is directed counter to the flow of gas in the inspiratory or expiratory tubes, an internal support member may be used to maintain the inflated configuration of the filter. Attachment structure is provided to couple the filters to the anesthesia apparatus and to accommodate aseptic removal of the filters from the anesthesia apparatus.

6 Claims, 3 Drawing Figures



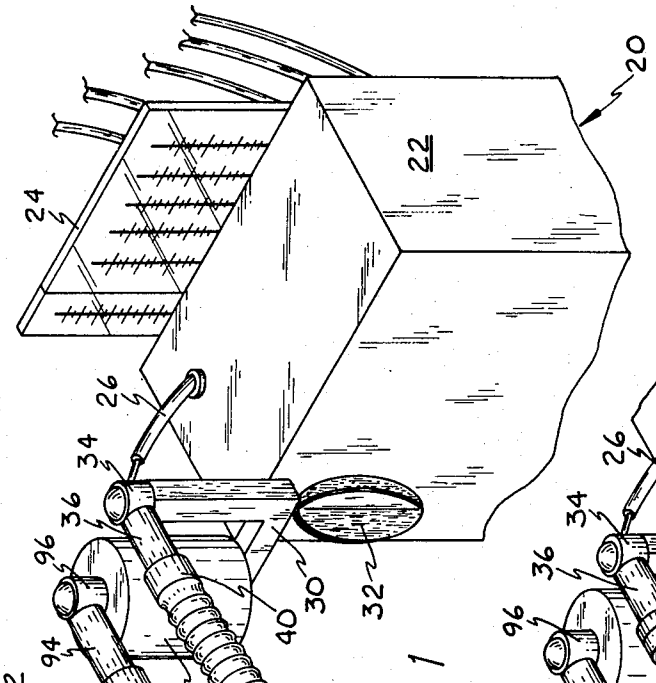


Fig. 1

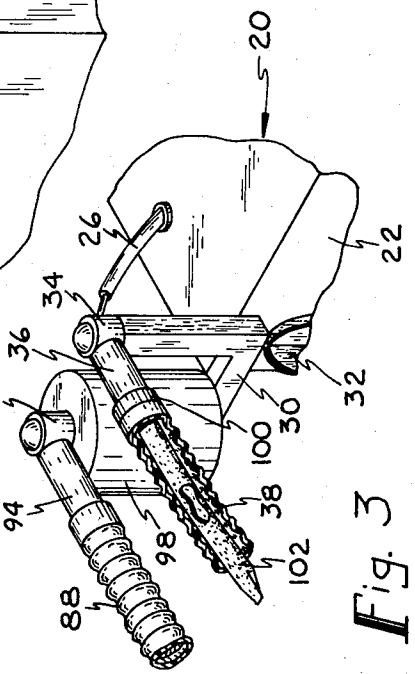


Fig. 3

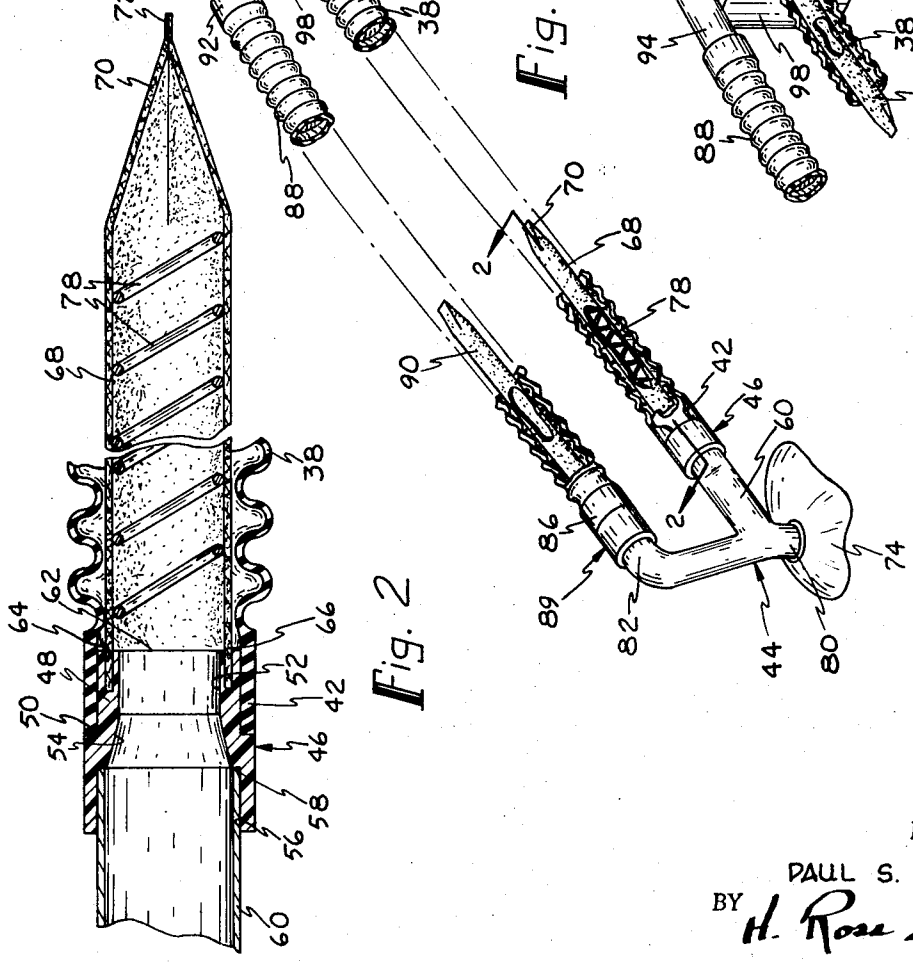


Fig. 2

INVENTOR.
PAUL S. NICHOLES
BY H. Ross Workman
HIS ATTORNEY

FILTRATION SYSTEM

BACKGROUND

1. Field of the Invention

The present invention relates to respiratory therapy and anesthesia delivery apparatus and more particularly to method and apparatus minimizing contamination of the anesthesia delivery apparatus or respiratory therapy equipment by a patient.

2. The Prior Art

Conventional apparatus for delivering anesthesia to a patient normally includes a source of anesthetic gas including delivery valves and gauges for measuring the amount of gas delivered and patient delivery structure including a breathing bag and inspiratory and expiratory delivery tubes. A canister of absorbent material is normally interposed between the expiratory tube and gas recirculation conduit so as to remove moisture and some carbon dioxide from the patient's exhalant. A face mask is conventionally joined to both the inspiratory and expiratory tubes.

In the normal operation of the apparatus, anesthetic gas is carried from the source through the inspiratory tube to be inhaled by the patient. Thereafter, the patient exhales carbon dioxide, moisture and a portion of the anesthetic gas not assimilated by the patient. Most of the exhalant passes through the expiratory tube, absorbent canister and through a conduit and valve system allowing the exhalant to be recycled through the inspiratory tube. This recycling allows the patient to be exposed again to the anesthetic gas which was not absorbed during prior inhalation.

Historically, patients with respiratory or nasal-pharyngeal infections or who have other types of communicable diseases, have contaminated the anesthesia delivery apparatus with pathogens originating in their respiratory tract. Although substantial efforts have been made to sterilize the anesthesia delivery apparatus such as by flushing the inspiratory and expiratory tubes with antiseptic, it has been found that one-way valves and conduit for recirculating the anesthetic gas are not easily sterilized without completely dismantling the anesthesia delivery apparatus. Dismantling is time consuming and expensive and is impractical where the demand for use is high.

In an effort to reduce cross-contamination between patients, several different types of filters have been used with anesthesia and respiratory-therapy equipment. One type is disclosed in U.S. Pat. No. 3,457,920 which includes an elongated tubular liner constructed from flexible plastic sheet material such as polyethylene and which is used to line the entire internal surface of the flexible expiratory tube. A more common type of filter is known as the Ohio filter described in an article written by John T. Martin and John A. Ulrich, A Bacterial Filter For An Anesthetic Circuit, Anesthesia and Analgesia, Volume 48, No. 6, November-December, 1969. The Ohio filter presents a filter interface within a plastic housing which is coupled to either the inspiratory or expiratory tube and the corresponding inspiratory or expiratory valve housing.

It has been found, however, that filters which completely line the inspiratory or expiratory tubes can be inserted and removed only with great difficulty. Moreover, the difficulty of removal of the filter increases the likelihood that organisms will find their way throughout the inspiratory and expiratory tubes during removal of the filter and, additionally, no protection is given to the valves and other portions of the anesthetic circuit from contamination. While there is some evidence to show that the Ohio filter protects most of the anesthetic circuit from contamination, if the filter is replaced regularly, there is no protection from contamination in the inspiratory and expiratory tubes. On the contrary, I have found that organisms can be cultured along substantially the entire length of the inspiratory and expiratory tubes even when the Ohio filter is used.

BRIEF SUMMARY AND OBJECTS OF THE INVENTION

The present invention, including method and apparatus, provides a system for filtering organisms originating with the patient for and isolating the anesthetic circuit and inspiratory and expiratory tubes from the organisms. Moreover, according to the presently preferred method and apparatus embodiments of the invention, maximum isolation of the organisms can occur while presenting as little resistance to gas flow as possible. The filter of the present invention is bacteriologically efficient and is not adversely affected by moisture.

It is, therefore, a primary object of the present invention to provide a novel filter for anesthesia or respiratory therapy equipment.

It is another primary object of the present invention to provide an improved method for minimizing cross-contamination and isolating organisms from the anesthesia or respiratory therapy equipment.

These and other objects and features of the present invention will become more fully apparent from the following description and appended claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary perspective view of an anesthesia apparatus, portions of which are shown schematically for ease of illustration and portions of the inspiratory and expiratory tubes being broken away to reveal presently preferred filter embodiments of the invention;

FIG. 2 is a longitudinal cross-section taken along line 2—2 of FIG. 1; and

FIG. 3 is a fragmentary perspective view of another presently preferred position of the filter embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The Embodiments of FIGS. 1 and 2

Although the present invention has application to numerous varieties of respiratory therapy equipment as well as anesthesia delivery apparatus, for ease of illustration, the presently preferred embodiments are described in relation to anesthesia delivery apparatus. FIG. 1 schematically illustrates anesthesia delivery apparatus generally designated 20 comprising a cabinet 22 which normally contains various kinds of anesthesia and other gas in compressed form. Alternatively, the source of anesthesia or other compressed gas may be a

remote source used by coupling delivery apparatus to an outlet in a wall as is conventional in many hospitals. The cabinet 22 also contains portions of the anesthesia circuit accommodating recycling of the anesthesia exhaled by the patient.

A plurality of gauges which may comprise an anesthesiometer are represented at 24, the gauges being of any suitable type such as columns of mercury. The gauges individually represent the amount and/or pressure of various anesthetic gases, such as nitrous oxide and other nonanesthetic gases such as oxygen which gases are communicated through the cabinet 22. An inlet tube 26 projects out of cabinet 22 and communicates the selected gas or mixture of gases to a one-way flutter valve (not shown) carried within the valve housing 34. The flutter valve housing 34 is carried upon a bracket 30.

A gas bag or respirator 32 is mounted upon the bracket so as to be in communication with the one-way flutter valve in housing 34. Conventionally, the flutter valve housing 34, as shown in the illustrated embodiment, has an outwardly projecting coupling site 36. A corrugated inspiratory tube 38 is attached to the coupling site 36, tube 38 being formed of flexible rubber so that the tube 38 may be bent in any desired direction. The inspiratory tube has a female attachment site 40 which is press-fit upon the coupling 36 and, at the remote end, another female attachment site 42 which, until this present invention, coupled directly to the hollow face mask coupling or Y-piece 44.

However, in the illustrated embodiment of the invention, the coupling 42 is press-fit onto an adapter 46 as best illustrated in FIG. 2. The adapter 46 has a diametrally reduced portion 48 which presents a shoulder 50. The female coupling 42 is press-fit upon the reduced portion 48 so as to abut the shoulder 50. The adapter 46 has a through-bore 52 which is tapered outwardly at 54. The bore 52 is annularly enlarged at 56 so as to form an annular shoulder 58. The annularly enlarged portion 56 forms a female coupling which is press-fit over one branch 60 of the Y-piece 44 (see FIG. 1). The branch 60 is preferably seated tightly against the shoulder 58 so as to prevent escape or loss of anesthetic gas.

The diametrally reduced portion 48 of the adapter 46 presents a leading end 62 having an annular recess 64 formed therein. The recess opens at the end 62 and receives one end 66 of a tubular filter 68.

The filter 68 is preferably formed of fibrous material. One suitable fibrous material which has been found successful is formed of a paper mat with a mixture of different types of fibers interspersed in the paper mat. Preferably, glass fibers having an average diameter of approximately one micron are mixed with other common types of support fibers carried by the paper mat.

It has been found, according to the present invention, that when fibrous material is used to form the filter, surprisingly effective filtration of organisms occurs without obstructing the flow of air, anesthetic and other gases through the filter.

The free end 70 of the filter 58 is folded forwardly to close the opening of the tube and the opening is sealed at 72, for example, with a heat seal or adhesive bond. The sealed end 70 terminates intermediate the length of the tube 38. When the filter 68 is oriented as shown in FIG. 1, it has been found that the fibrous material forming the filter 68 has the tendency to collapse when a partial vacuum is developed in the branch 60 of the Y-piece 44. This partial vacuum is caused when the patient (not shown) inhales with the face mask 74 properly positioned over the face. As the patient inhales, gas is drawn through the inspiratory tube 38 and the increased pressure of the gas together with the decreased pressure inside of the filter 68 tends to collapse the filter.

If desired, the tubular configuration of the filter 68 may be maintained with an internal support. Although any suitable internal support could be used, in the illustrated embodiment a helical coil of metal wire 78 is placed interior of the filter 68. The helical wire coil 78 has the advantage of maintaining the generally tubular configuration of the filter 68 even when the inspiratory tube 38 is bent at various angles in the vicinity of the filter 68. Clearly, if desired, the coil 78 could be disposed exterior of the filter 68 and anchored to portions of the filter in such a way as to prevent the filter from collapsing.

Referring again to FIG. 1, the hollow Y-piece 44 is coupled to the face mask 74 at the stem 80, as is conventional. Further, the Y-piece has a second branch 82 which is press-fit into adapter 84. Preferably, adapter 84 is substantially the same as adapter 46. The remote coupling end 86 of the expiratory tube 88 is press-fit onto the adapter 84 and a tubular filter 90, also formed of fibrous material similar to that of filter 68, is mounted in the adapter 84 and projects generally coaxially through the expiratory tube 88. As shown in FIG. 1, the filter 90 is not provided with an internal support structure. Although an internal support structure could be provided for the filter 90, it has been found that exhalation through the Y-piece 44 by the patient (not shown) causes the filter 90 to be inflated, there being greater pressure inside of the filter 90 than outside in the expiratory tube 88. Thus, maximum surface for filtration is naturally presented without requiring an artificial or secondary support force to maintain the filter 90 in tubular configuration. Apart from the absence of a support member on the interior of the filter 90, filter 90 is substantially the same as filter 68.

The expiratory tube 88 terminates in a female coupling 92 which is press-fit over extension 94 forming part of valve housing 96. Valve housing 96 circumscribes the expiratory one-way valve (not shown). As illustrated, valve housing 96 is mounted near a canister 98 which is normally filled with a conventional absorbent such as a soda-lime absorbent. Although the filters 68 and 90 are illustrated as projecting into the respective expiratory and inspiratory tubes only a short distance, the filters 90 and 68 may be any desired length not exceeding the length of the expiratory or inspiratory tubes, respectively. The length of the filters 90 or 68 depends on the surface area needed to properly filter exhalant from the patient.

The Embodiment of FIG. 3

The embodiment of FIG. 3 is similar to the embodiment of FIG. 1, like parts being designated with like numerals throughout. The FIG. 3 embodiment differs from the FIG. 1 embodiment in that the extension 36 attaches directly to an adapter 100 which is, in turn, press-fit into the inspiratory tube 38. A tubular filter

102 is directed away from the inspiratory flutter valve in housing 34 toward the face mask (see FIG. 1). Because anesthetic gas is drawn through the filter 102 toward the face mask 74 (FIG. 1) when the patient inhales, the tubular filter 102 will tend to inflate during use making support structure such as the helical coils 78 unnecessary even in the inspiratory tube 38. However, it should be appreciated that upon exhaling by the patient, the filter 102 will protect only that part of the anesthetic circuit which is behind the adapter 100. Thus, unless the filter 58 (FIG. 1) is also used, it is possible that the inspiratory tube 38 as well as the Y-piece 44 and mask 74 will become contaminated.

It is contemplated that filter 102 (FIG. 3) would be used in those circumstances in which the inspiratory and expiratory tubes are completely disposable. Thus, even though pathogens may collect in the inspiratory tube 38, the filter 102 will prevent contamination of the inspiratory valve in housing 34 and other portions of the anesthetic circuit. If a similarly oriented filter (not shown) is placed in the expiratory tube 88 the apparatus 20, except the inspiratory and expiratory tubes, will be protected from contamination.

Each time a new patient is to use the anesthetic apparatus 20, the inspiratory and expiratory tubes 38 and 88 may be removed at the extensions 36 and 94 and new ones attached to the respective extensions. Where the inspiratory and expiratory tubes are not to be used as disposables, it is presently preferred that the filters 68 and 90 be used since filters 68 and 90 isolate the inspiratory and expiratory tubes from contamination from the patient.

The Method

According to the presently preferred method embodiment of the invention, the tubular filter 90 is oriented in the expiratory tube 88 so that the filter 90 is inflated as the patient exhales. The formation of the tubular filter of fibrous material has proved to be surprisingly effective in isolating the expiratory tube 88 from the patient's organisms even in the presence of natural moisture from the exhalant.

It is also presently preferred to orient the filter 68 coaxially within the inspiratory tube 38 so that the closed end 70 is directed away from the mask 74 and Y-piece 44 toward the inspiratory valve in housing 34. This orientation isolates the inspiratory tube 38 from the patient's organisms.

As part of the presently preferred embodiment of this invention, a way is provided whereby the tubular filters may be inserted into and removed from the inspiratory or expiratory tubes without contaminating the tubes with organisms which may have accumulated in the filters. For example, referring again to FIG. 2, it can be appreciated that the filter 68 may be removed from the inspiratory tube 38 by grasping the adapter 46 in one hand and the female coupling end 42 of the inspiratory tube 38 in the other hand and gently separating the two coupling members. When the members are separated, the filter 68 may be telescopically removed from the inspiratory tube without at any time exposing the interior of the filter 68 to the interior of the inspiratory tube 38. The filter 68 may then be discarded with the Y-piece 44 and face mask 74 or, alternatively, the adapter 46 may be separated from the branch 60 of the Y-piece 44 and discarded separately.

If the inspiratory tube 38 is to be disposable, the filter 102 may be oriented in the opposite direction so as to protect the extension 36, inspiratory flutter valve contained in housing 34 and other portions of the anesthetic circuit from contamination. As shown in FIG. 3, asepsis of the anesthetic circuit can be preserved by removing the adapter 100 simultaneously with the inspiratory tube 38 and discarding both together.

The invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive and the scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed and desired to be secured by United States Letters Patent is:

1. Gas delivery apparatus comprising a source of gas; inspiratory conduit means for conducting gas from the source to a patient; one-way valve means in the conduit causing one-way displacement of gas to the patient; expiratory conduit means for conducting exhalant from the patient; and a face mask coupling, the improvement comprising:

two elongated tubular filters each having one closed end which, along with a substantial portion of the length of the filter, is disposed within each of the inspiratory and expiratory conduits, each filter being generally concentric with at least part of the length of its corresponding inspiratory or expiratory conduit; and

means aseptically sealing each filter adjacent an end of the corresponding conduit proximate the face mask coupling to isolate the gas delivery apparatus from the patient.

2. Apparatus as defined in claim 1 wherein each of said tubular filters is formed of fibrous material comprising paper mat and glass fibers.

3. Apparatus as defined in claim 1 wherein at least one of said filters comprises support structure for maintaining the filter in tubular configuration even when exposed to a pressure differential across the filter.

4. Apparatus as defined in claim 1 wherein both filters open toward the patient and isolate the entire internal surfaces of the inspiratory and expiratory tubes from the patient.

5. Apparatus as defined in claim 1 wherein at least one filter opens away from the patient.

6. Gas delivery apparatus comprising a source of gas; inspiratory conduit means for conducting gas from the source to a patient; one-way valve means in the conduit causing unidirectional displacement of gas from the source to the patient; a first elongated tubular bacterial filter formed of fibrous material having one closed end mounted in the inspiratory tube between the patient and the one-way valve; expiratory conduit means for conducting exhalant from the patient; sorbent means receiving exhalant from the expiratory conduit; a second elongated tubular bacterial filter formed of fibrous material and having one closed end mounted in the expiratory tube between the patient and the sorbent means; and means accommodating removal of the first

and second tubular filters and replacement by other similar filters.

* * * * *