United States Patent [19]

Mazal

[11] **3,815,606**

[45] **June 11, 1974**

[54] **ENDOTRACHEAL CATHETER**

[76] Inventor: **Charles N. Mazal,** Roma 19, Mexico 6, D.F., Mexico

[22] Filed: **Sept. 21, 1972**

[21] Appl. No.: **290,964**

[52] **U.S. Cl.** **128/351**

[51] **Int. Cl.** **A61m 16/00,** A61b 17/24

[58] **Field of Search** 128/142.2, 145.5, 147, 128/351

[56] **References Cited**

UNITED STATES PATENTS

3,017,880	1/1962	Brook	128/145.5
3,060,927	10/1962	Gattone	128/145.5
3,175,557	3/1965	Hammond	128/351
3,730,179	5/1973	Williams	128/145.5

FOREIGN PATENTS OR APPLICATIONS

1,113,065	8/1961	Germany	128/147

OTHER PUBLICATIONS

Beattie et al., Resuscitation of the Asphyxiated Newborn Infant, in Jour. Amer. Med. Assoc. 152^{3}: 21 – 221. 1953.

Mann, Method and Machine for Resuscitation of the Newborn, in Jour. Amer. Med. Assoc. 152^{14}: 1333 – 1335. 1953.

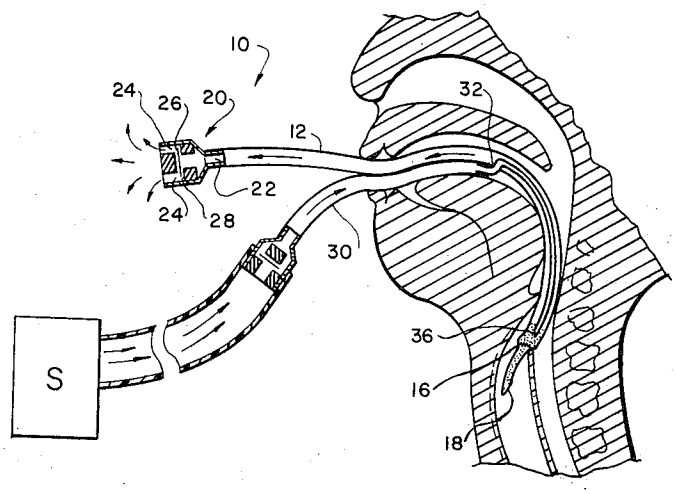
Primary Examiner—Channing L. Pace

Attorney, Agent, or Firm—Burton, Crandell, Polumbus & Harris

[57] **ABSTRACT**

An endotracheal catheter especially useful for the application of mechanical respiration or the administration of anesthetic gases to newborn infants. A pliable hollow outer tube is formed with a main body portion of constant diameter having a reduced diameter relatively short end section at one end. When inserted into the trachea, the shoulder at juncture of the main body and end section of the outer tube is seated at the upper end of the trachea. A second tube, of a diameter approximately equal to that of the reduced diameter end section of the first tube is passed through the side wall of the main body of the first tube at a location spaced longitudinally of the first tube from the shoulder. The second tube exends through the main body portion of the first tube and terminates at an open end located within the main body closely adjacent the shoulder so that a space of only relatively small volume exists within the first tube between the open ends of the two tubes. One-way check valves employing a light easily actuated valve member may be mounted at the opposite ends of the respective tubes.

4 Claims, 2 Drawing Figures



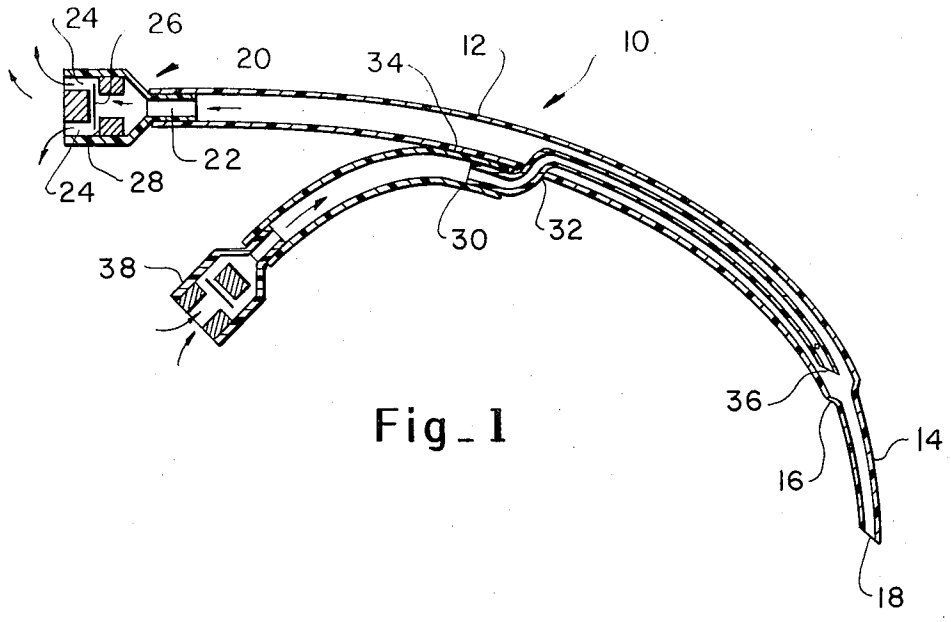

24
26
20
34
12
10
22
24
28
30
32
38
36
14
16
18

Fig_1

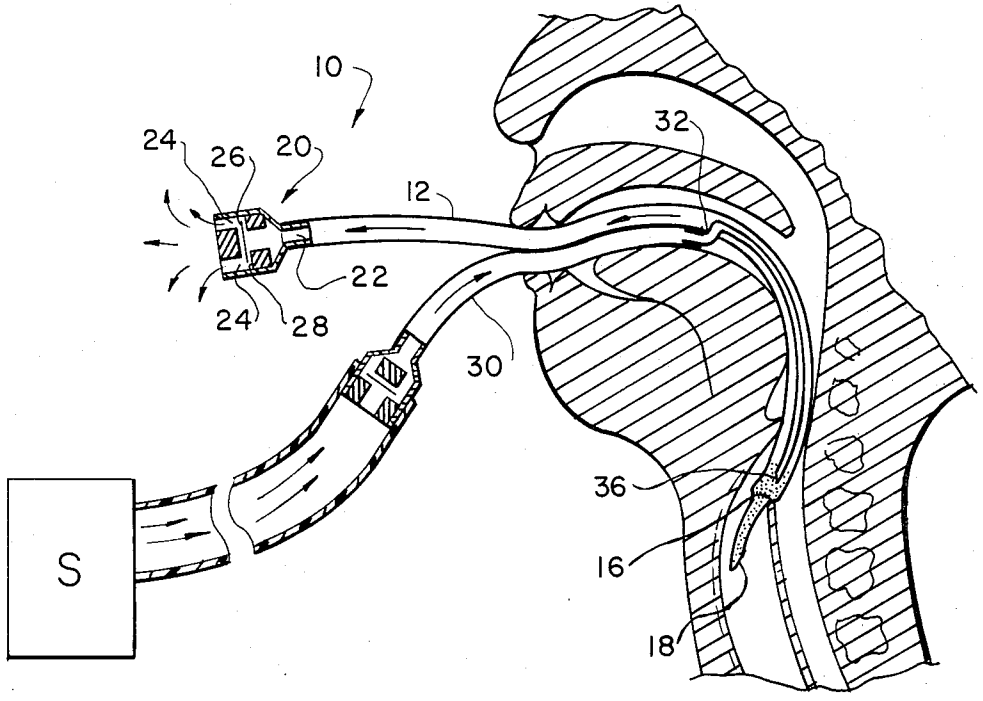

10
24
26
20
12
32
22
24
28
30
36
16
18
S

Fig_2

ENDOTRACHEAL CATHETER

BACKGROUND OF THE INVENTION

The application of mechanical respiration or the administration of anaesthetic gases presents special problems in newborn infants, particularly those which are premature or are of very low corporal weight. A term described as "dead space" is a determining factor in these cases and what this term refers to is the space between the actual lungs and supply of fresh air, or oxygen. The physiological "dead space" is, of course, the entire tract comprising the nasal or mouth cavity, the trachea and the bronchial tubes. With the mouth closed, the "dead space" of a premature infant weighing two kilograms is approximately 3.5 cubic centimeters. When it is considered that the total respiratory volume of a child of this weight is between 15 and 20 cubic centimeters and that each normal breath would renew 8–12 cubic centimeters of air in the lungs, then it is an important consideration not to increase the physiological "dead space" while attempting to administrate gases to the infant. Until now, it has been extremely difficult and in some cases, impossible, to apply mechanical respiration to a premature infant undergoing chest surgery. The "dead space" of the tubes and valves or facemask has been considerably higher than eight cubic centimeters and, if added to the physiological "dead space" of the infant, it is apparent that the infant would be inhaling very much the same gases that he had just exhaled which in short time would lead to suffocation. The most used method in these cases is to perform a tracheotomy—an incision in the trachea—through which a small tube is passed directly to the trachea, thereby bypassing the physiological "dead space" of the patient in the upper trachea, larynx, pharynx, mouth or nasal cavity. The placement of a "tracheotomy tube" does help to reduce the "dead space" but, even so, the cumbersome method used to pass fresh air through that tube and to retrieve the "spent air" through the same orifice has necessitated the use of connectors and valves, the "dead space" of which borders on the limits of a full-term infant and usually exceeds the limits of a premature infant.

The present invention is directed to the provision of an endotracheal catheter system having a "dead space" which is less than the physiological "dead space" of most premature or full-term infants and which is compatible with present methods of mechanical respiration and administration of anaesthetic gases to infants.

SUMMARY OF THE INVENTION

In essence, the present invention contemplates the employment of two telescoped tubes, the outermost of which is formed with a shoulder from which projects a relatively short reduced diameter end section. The end of the inner of the two tubes terminates within the outer tube closely adjacent the aforementioned shoulder. In the administration, for example, of an anaesthetic gas, the gas is fed through the inner tube and discharged from the end section of the outer tube which is inserted into the trachea of the patient. Exhalation by the patient passes into the end section of the outer tube and is conducted through the space between the outer and inner tubes to the discharge end of the outer tube. Flow of exhaled gases into the inner or supply tube is prevented by a one-way check valve in this latter tube

which seats immediately upon the sensing of reversed flow in this tube. By this arrangement, the inner or gas supply tube is kept filled with gas at all times, while the interior of the outer tube is free to accept the flow of exhaled gases. The dead space of this system is represented only by that relatively small volume, mainly the interior of the end section of the outer tube, which exists between the end of the outer tube and the adjacent end of the inner tube.

Other objects and features of the invention will become apparent by reference to the following specification and to the drawings.

IN THE DRAWINGS

FIG. **1** is a cross sectional view of an endrotracheal catheter embodying the present invention; and

FIG. **2** is a cross sectional view showing the catheter of FIG. **1** inserted into the trachea of a patient.

Referring to the drawings, a catheter embodying the present invention includes a main or outer tube designated generally **10** which is preferably formed from a pliable, nontoxic or chemically inert material such as polyethlene or polyvinyl chloride. Main tube **10** includes a main body portion **12** of constant diameter and wall thickness which is formed at its operative or distal end (right-hand end as viewed in FIG. **1**) with a relatively short reduced diameter end section **14** which merges with main body portion **12** at shoulder **16.** The open end of end section **14** is beveled as at **18** to facilitate the insertion of end section **14** into the trachea, shoulder **16** providing a seat engagable with the upper end of the trachea, see FIG. **2,** to indicate that end section **14** is inserted into the trachea, thus avoiding inadvertent gas discharge into the esophagus.

For some application of the catheter, a schematically illustrated one-way check valve **20** is mounted in the end of main tube **10** remote from end section **14** to permit the flow of gas only outwardly from this remote end of the tube. Where such a one-way check valve is employed, it is essential that the valve have an extremely low actuating pressure, particularly where the catheter is to be used on a newborn infant. One form of valve suitable for this purpose is schematically illustrated at **20** as having a centrally located inlet passage **22** at one end and two or more outlet passages **24** which are offset from inlet passage **22.** A lightweight disc **26** is loosely received within a chamber **28** commonly communicating with both inlet passage **22** and outlet passages **24.** When the pressure within main tube **10** exceeds that in outlet passages **24,** the disc shifts to the left as viewed in FIG. **1** and gaseous flow occurs around the edges of the disc from inlet passage **22** into outlet passages **24.** When the pressure in outlet passages **24** exceeds that within inlet passage **22,** the disc shifts to the right as viewed in FIG. **1** to overlie and seal the left-hand end of inlet passage **22.** By using a very lightweight and loosely fitting disc **26,** seating or unseating of disc **26** can be accomplished by an extremely small differential pressure.

A second tube **30** has a leading end portion **30***a* of an external diameter less than the internal diameter of main body portion **12** and the leading end portion **30***a* of the tube **30** is passed through the side wall of main body **12** at a location **32** longitudinally spaced from shoulder **16** by a fairly substantial distance. This longitudinal spacing is selected to provide maximum convenience in inserting the catheter. The second tube **30**

has a trailing end portion **30***b* received on the external end of the leading end portion **30***a*, and the outer walls of the trailing end portion **30***b* and the main tube **10** are hermetically sealed to each other at the approximate location where tube **30** passes through the wall of tube **10.** Preferably, the trailing end portion **30***b* of tube **30** is bonded to tube **10** as at **34** for at least a short distance along the exterior of tube **10** to minimize strain on the seal. The trailing end portion **30***b* of tube **30** which is disposed at the exterior of main body **12** is of a larger diameter than the leading end portion **30***a* of tube **30** inside main body **10** to minimize resistance to the flow of gases.

Tube **30** extends freely through main body portion **12** and terminates at an open end **36** located within main body **12** closely adjacent shoulder **16.**

Tube **30** is employed as the source or inlet of gases to be supplied to the tube and, in most applications, is fitted with a one-way check valve **38** at its external or inlet end. Check valve **38** is of construction similar to that of check valve **20,** except that valve **38** is oriented to permit flow into but not out of, tube **30.**

In use, the catheter is inserted into the patient's trachea as shown in FIG. **2,** and a source S of gas which is to be inhaled is connected to the external end of tube **30.** In some applications, the gas to be inhaled is supplied under pressure, while in other cases the inhalations of the patient are relied upon to aspirate gas through tube **30.** The gas to be inhaled is supplied from source S (FIG. 2), passes through tube **30,** is discharged at discharge end **36** and then passes through end section **14** of main tube **10** into the trachea. When the patient exhales, the exhaled gas passes into end section **18** and thence through main body portion **12** of main tube **10** to be discharged through one-way check valve **20** or in those cases where no valve **20** is employed, directly to atmosphere. In some applications it may be desirable to employ a light spring in check valve **20** biasing this valve to its closed position to assure that the path of least resistance to flow from tube **30** is toward opening **18.** Exhaled gas does not pass into end **36** of tube **30** to any substantial extent, because the pressure of the exhaled gas promptly seats or closes check valve **38.** Thus, at the commencement of a subsequent inhalation, the only exhaled gas which is returned to the patient is that relatively small volume of gas indicated by dots in FIG. **2** which occupies the interior of end section **14** and that relatively small portion of main portion **12** which is between end **36** of tube **30** and the end section **14.** This volume is relatively small as compared to the physiological dead space of the patient.

While one embodiment of the invention has been described in detail, it will be apparent to those skilled in the art that the disclosed embodiment may be modified. Therefore, the foregoing description is to be considered exemplary rather than limiting, and the true scope of the invention is that defined in the following claims.

I claim:

1. An endotracheal catheter comprising a first pliable hollow tube having a main body portion of a first diameter extending the major portion of the length of said tube, an integral relatively short reduced diameter end portion on said first tube extending coaxially from one end of said main body to one end of said first tube and defining an annular seating shoulder at the juncture of said main body and end portion, a second hollow tube having one end located externally of said first tube, said second tube projecting through the side wall of said first tube into the interior of said main body portion at a location spaced longitudinally of said main body portion from said shoulder and extending longitudinally through the interior of said main body portion to terminate at an open end located within said body portion closely adjacent said shoulder, the external diameter of that portion of said second tube within said main body portion being less than the internal diameter of said main body portion to establish an annular flow passage through said main body portion externally of said second tube.

2. An endotracheal catheter as defined in claim **1** further comprising a first one-way check valve means at the end of said main body portion remote from said end portion accommodating fluid flow out of said main body portion through said remote end, and second one-way check valve means at the end of said second tube opposite said one end thereof accommodating flow into the last-mentioned end of said second tube.

3. The invention defined in claim **2** wherein said one-way check valves each comprise a housing having an internal chamber with a first passage at one end and a second passage offset from said first passage at its other end, and a thin lightweight valve disc floating in said chamber adapted to seat upon and overlie the first passage upon flow of fluid from the second passage toward the first passage.

4. An endotracheal catheter comprising hollow first and second tubes, said second tube having a first portion extending longitudinally within said first tube, said first tube having a main body portion with an internal diameter greater than the external diameter of said second tube, a radially inwardly extending shoulder at one end of said main body portion of said first tube, a relatively short end section integrally joined by said shoulder to the main body portion of said first tube and projecting coaxially therefrom to terminate at a beveled outer end, said second tube terminating at one end in a discharge opening located within said main body portion closely adjacent said shoulder.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,815,606 Dated June 11, 1974

Inventor(s) Charles N. Mazal

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Abstract, line 14, "exends" should read --extends--.

Column 2, line 5 "dead space" should read --"dead space".

Column 3, line 51 and 52 "dead space" should read --"dead space"--.

Column 4 line 19 after "said" insert --main--.

Signed and sealed this 18th day of February 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.