Oct. 10, 1939.

P. W. GEBAUER

CATHETER FOR BRONCHOSPIROMETRY

Filed Nov. 26, 1938

INVENTOR
Paul W. Gebauer

By Willis O. Avery
This invention relates to surgical accessories and particularly to a special catheter for use in broncho-spirometry and for other purposes.

The invention aims to provide a compact multi-tubed structure adapted to be readily inserted in the respiratory passages of a patient, with minimum difficulty and discomfort, for conducting gaseous materials between each of the lungs, individually, and respective, separate spirometers, and further aims to provide simple but assuredly effective means for occluding the respiratory passages at appropriate points for sealing the lungs from each other and from the outside atmosphere, whereby the functional capacity of each lung may be determined separately and simultaneously.

The invention may be readily understood by referring to the accompanying drawing, of which—

Fig. 1 is an elevation showing a catheter embodying the principles of the present inventions in a preferred form; Fig. 2 is a vertical section taken on line 2—2 of Fig. 1; Fig. 3 is a vertical section taken on line 3—3 of Fig. 1; Fig. 4 is a vertical section taken on line 4—4 of Fig. 1; Fig. 5 is a vertical section taken on line 5—5 of Fig. 1; Fig. 6 is a horizontal section taken on line 6—6 of Fig. 5; Fig. 7 is a fragmentary elevation of a catheter generally similar to the catheter of Figs. 1–6, but embody a curved distal end; and

Fig. 8 is a diagrammatic view illustrating the manner in which the present catheter is employed in carrying out differential broncho-spirometry upon a patient.

The invention contemplates a catheter adapted to be inserted in the respiratory passages of a patient and having two longitudinal passage-ways or conduits with separate openings adapted to communicate respectively with the two lungs, and also includes two separate sealing means so positioned on the catheter as to seal the lungs from each other and from the outside atmosphere and force breathing through the respective conduits of the catheter.

Such a catheter as illustrated in the drawing comprises a relatively long tubular structure adapted to extend from a point outside the mouth of a patient, through the mouth and trachea, to a point at least within the main bronchus of one lung. One opening 11 is provided in the wall of the tubular structure 10 at a point adjacent the distal end which will be positioned within the bronchus of one lung, as by leaving the entire end of the catheter open as illustrated. A second opening 12 is provided in the wall of the tubular structure 10 at a point proximal to the first opening and in a position adapted to communicate with the other lung. The lumen of the tubular portion 10 is divided into two separate fluid conduits 13 and 14 by means of a septum 15 extending from the proximal end of the tubular portion 10 to a point 16 between the two openings 11 and 12 at which point the septum 15 curves toward and is attached to the wall of the tube to form a closed end for one of the conduits 13. The two fluid conduits 13 and 14 diverge at the proximal end of the tubular portion and terminate in separate tubular extensions 17 and 18, respectively, adapted to be connected to any appropriate fluid conductors such as conductors leading to separate spirometers.

For sealing the respiratory passages about the inserted catheter, two inflatable collars 19 and 20, are provided encircling the tubular structure longitudinally spaced-apart positions, one collar 19 being located adjacent the distal end of the catheter between the two openings 11 and 12, and the second inflatable collar 20 being located proximal to the opening 12 so that the opening 12 is located between the two inflatable collars while the opening 11 is distal to both collars.

For inflating the collars 19 and 20, a relatively small inflating duct 21 is provided extending longitudinally through the walls of the tubular structure 10 from a point adjacent the proximal end to both inflatable collars 19 and 20, communicating openings 22, 23 being provided through the walls of the tubular structure 10 and beneath the inflatable collars 19, 20, respectively, for conducting inflating fluid thereto.

At the proximal end of the catheter, the inflating duct 21 diverges from the tubular structure and terminates in a tubular extension 24 adapted to be connected to any suitable apparatus for injecting fluid under pressure.

For facilitating entrance of the catheter into the main bronchus of a lung, the distal end of the tubular structure 10 desirably is preformed with a permanently-set arcuate configuration as indicated at 25 in the modified form of the catheter illustrated in Fig. 7, the catheter being otherwise similar in construction to the catheter illustrated in Figs. 1–6. The most satisfactory
arculate configuration appears to be obtained by gently curving the distal end of the catheter from a point distal to the opening 11 so that the distal tip of the catheter is directed at an angle of approximately 60° to the axis of the rest of the tubular portion 10, although no particular curvature is essential.

In order to facilitate ready passage of the catheter through the tortuous channels of the mouth, trachea and bronchi with minimum difficulty and discomfort, the entire catheter preferably is made essentially of a flexible soft rubber or analogous composition, although it is to be understood that other materials, such as conventional fabric, metal or wire reinforcements, may be associated with the essentially rubber structure so long as the essential flexibility of the rubber is not destroyed. The catheter desirably has a one-piece, unitary structure to avoid all possibility of parts becoming disconnected or separated while in use, although satisfactory catheters obviously may be fabricated by assembling separate pre-formed parts of rubber or other flexible material and cementing or otherwise connecting the parts in proper relation. Procedures for manufacturing such structures are well known in the rubber industry and form no part of the present invention.

In the use of the present catheter for carrying out differential broncho-spirometry, the catheter is passed through the respiratory passages of a patient, as indicated in Fig. 8, until the distal end of the catheter including the inflatable collar 19 is positioned within the main bronchus of one lung, usually the left lung. The second inflatable collar 20 will then be positioned within the trachea 32. Using any suitable device, air or other inflating fluid is injected through the tube 24 and duct 21 until the collars 19 and 20 have been inflated sufficiently to seal the bronchus and trachea, respectively, about the catheter, the inflated collars conforming readily to irregularities in the passageway walls to effect an assuredly effective seal which is maintained as by clamping the tube 24. When the collars have been inflated, the patient, of course, breathes through the catheter, the left lung receiving and discharging gases through the opening 11 and the communicating tubes 14 and 18, while the right lung receives and discharges gases through the opening 12 and the communicating tubes 13 and 17. The tubular extensions 17 and 18 are connected to separate spirometers which measure characteristic factors concerning the intake and discharge gases and afford a basis for calculating the functional capacity or efficiency of each lung separately and simultaneously. The spirometer itself of course is a known apparatus.

The present invention is especially useful in examinations conducted as a preliminary to treating a patient suffering from pulmonary tuberculosis when it is vitally important to know accurately the relative functional efficiencies of the two lungs in order that the character and extent of treatment which may safely be undertaken on either lung can be reliably judged. The catheter obviously is capable of other uses however.

Numerous modifications and variations in details of construction and materials embodied in the catheter for broncho-spirometry as hereinabove described may be made without departing from the spirit and scope of the invention as defined by the appended claims.
two separate longitudinal conduits communicating respectively with the aforesaid two openings, the proximal ends of said conduits being adapted to be connected with appropriate fluid conductors, said catheter being flexible throughout.

5. A catheter for differential broncho-spirometry adapted to be inserted in the respiratory passages of a patient for conducting gaseous materials to and from the lungs separately and simultaneously, said catheter comprising a tubular structure adapted to extend at least from the mouth of a patient to a point within the main bronchus of one lung, an inflatable collar encircling the tubular structure at a position adjacent the distal end thereof and adapted to be positioned within the said bronchus, a second inflatable collar encircling the tubular structure at a position proximal to the first collar and which will be positioned within the trachea when the first collar is positioned within the bronchus of one lung, said collars being adapted when inflated to seal the respective respiratory passages when inflated, inflating duct means for conducting inflating fluid to said collars, the walls of said tubular structure having one opening distal to both collars and a second opening between the two collars, a septum dividing the lumen of said tubular structure into two separate longitudinal conduits communicating respectively with the aforesaid openings, said conduits and said inflating duct diverging at the proximal end of the catheter and terminating in three separate tubular extensions adapted to be connected with appropriate fluid conductors, said catheter having an essentially integral unitary structure embodying rubber as the principal constituent and being flexible throughout.

10. A catheter for differential broncho-spirometry adapted to be inserted in the respiratory passages of a patient for conducting gaseous materials to and from the lungs separately and simultaneously, said catheter comprising a tubular structure adapted to extend at least from the mouth of a patient to a point within the main bronchus of one lung, the distal end of said structure having a pre-formed and permanently-set arcuate configuration for facilitating entrance into the said bronchus, an inflatable collar encircling the tubular structure at a position adjacent the distal end thereof and adapted to be positioned within the said bronchus, a second inflatable collar encircling the tubular structure at a position proximal to the first collar and which will be positioned within the trachea when the first collar is positioned within the bronchus of one lung, said collars being adapted when inflated to seal the respective respiratory passages, a single inflating duct extending longitudinally through a wall of said structure and communicating with both of said collars for conducting inflating fluid to the collars, the walls of said tubular structure having one opening distal to both collars and a second opening between the two collars, a septum dividing the lumen of said tubular structure into two separate longitudinal conduits communicating respectively with the aforesaid openings, said conduits and said inflating duct diverging at the proximal end of the catheter and terminating in three separate tubular extensions adapted to be connected with appropriate fluid conductors, said catheter having an essentially integral unitary structure embodying rubber as the principal constituent and being flexible throughout.

PAUL W. OBERAUER.