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BRONCHOSCOPE HAVING MEANS FOR PRODUCING MECHANICAL  
VIBRATIONS IN THE BRONCHIAL TRACT  
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3,315,663

FIG. 1.

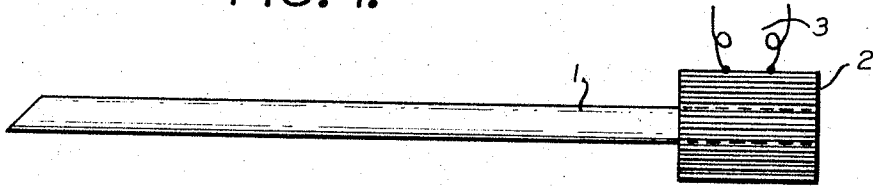


FIG. 2.

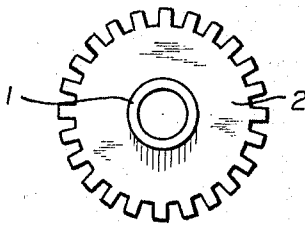


FIG. 3.

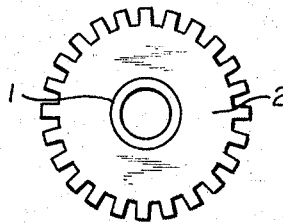


FIG. 4.

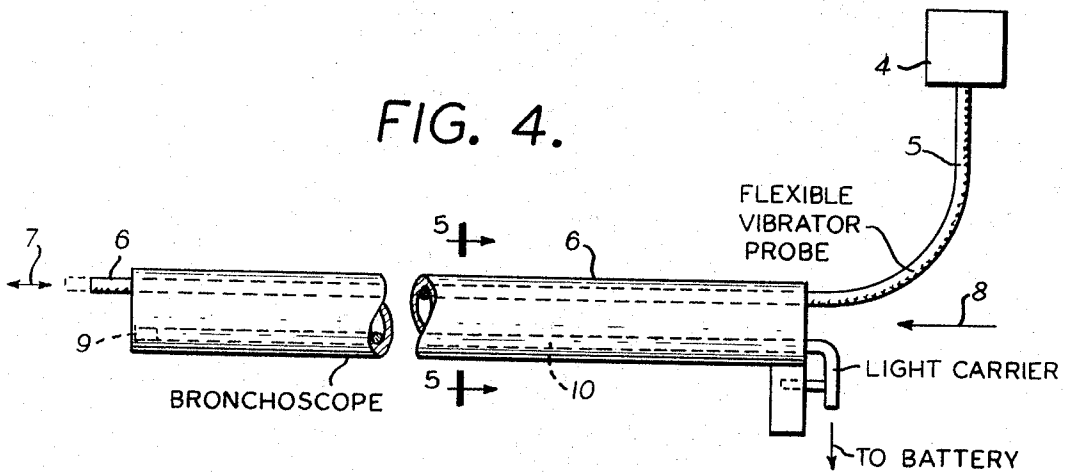
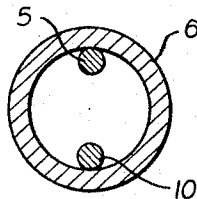


FIG. 5.



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**BRONCHOSCOPE HAVING MEANS FOR PRODUCING MECHANICAL VIBRATIONS IN THE BRONCHIAL TRACT**

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 9 Claims. (Cl. 128-4)

This invention relates to an apparatus for the application of mechanical vibrations to the human interior especially to the respiratory tract.

It is one of the objects of the invention to facilitate removal of mucus from the human respiratory tract by rendering such mucus more mobile or less viscous by means of applying mechanical vibrations directly to the mucus.

Another object of the invention is to combine a bronchoscope, endoscope or any similarly shaped tubular insert of more or less standard construction or dimensions with a mechanical or electro-mechanical vibrator attached thereto or formed thereon to permit during observation of the respiratory tract to subject the mucus to certain shearing, stirring, or other type of vibratory forces to increase its mobility and facilitate its removal.

Still another object of the invention is to apply while subjecting the mucus to such forces a liquid preferably a saline or other solution which mixes with the mucus and serves as a coupling between the vibrating element and the mucus, thereby further increasing mobility and facilitating removal.

A more specific object of the invention is to apply these shearing or stirring vibratory forces by means of an elongated element or tubing either formed of the bronchoscope or endoscope or supported inside thereof and extending therefrom into the respiratory passages, so that the elongated element while vibrating can be moved and adjusted from the outside while the respiratory tract is under observation through the endoscope or a similar tube when inserted in the respiratory tract together with a light source permitting such visual observation.

Still further, an object of the invention is to couple the vibrating element whether in the form of a bronchoscope tube itself or in the form of an additional tubing inserted into the bronchoscope, with an electro-mechanical vibration source for example an element consisting of magnetostrictive material which will be excited to the desired pulsations, vibrations or shearing movements by an electromagnetic system cooperating therewith in otherwise well known manner and also arranged outside at the upper end of the bronchoscope without, however, obstructing access to the opening of the bronchoscope and thereby observation of the respiratory tract during such vibrations.

These and other objects of the invention will be more fully apparent from the drawings annexed herewith in which FIG. 1 represents an example of realization of the invention in front elevation, and FIGS. 2 and 3 corresponding side views from opposite directions. FIG. 4 shows another embodiment of the invention in a similar elevation and FIG. 5 a cross section at a predetermined point of the device.

In investigations and experiments underlying the invention it has been found that the mucus of the human respiratory tract may be rendered more mobile, less viscous and more easily removed from the bronchial tree after it has had certain shear forces applied to it for certain lengths of time. This has been accomplished in vivo and in vitro, using many types of shearing devices. Ultra sound waves of the order of frequency of 20,000 c.p.s. have been found effective in vivo and in vitro in bringing about these changes.

As apparent from FIG. 1, a bronchoscope or endoscope of more or less standard construction, i.e. of a length of about 50 cm. and inner diameter of about 9 mm., as schematically indicated at 1, is provided at the proximal end with a tubing schematically indicated at 2 and consisting of a fluted nickel magnetostrictor.

This magnetostrictively active element is excited to vibrations in otherwise well known manner by means of a magnetic coil or coils schematically indicated in FIG. 1 at 3, and supplied from an amplifier and power source not shown with power of a frequency to reproduce sonic and preferably supersonic vibrations of predetermined frequency, say of the order of 20,000 c.p.s. which are transmitted through bronchoscope tube into the respiratory tract at desired positions thereof and exposed to visual observation through tube 1.

Magnetostrictive element 2 has a cross-section as indicated in FIG. 2 including a number of teeth contributing to the vibrations desired to produce the shearing or stirring action in accordance with the invention. Another side view of tube 1 from opposite direction is indicated in FIG. 2.

It is of course possible without departing from the scope of this disclosure to make the entire tube 1 instead of only an end portion thereof of magnetostrictive material or to cause tube 1 to vibrate in any other desired manner, for example by coupling its end to any type of electromagnetic or electrodynamic transducer.

In the embodiment of the invention shown in FIGS. 4 and 5, a magnetostrictive device of otherwise well known construction and schematically indicated in FIG. 5 at 4, is coupled to a flexible probe schematically indicated at 5 and extending through bronchoscope 6 into the interior of the respiratory tract, its distal end projecting from bronchoscope 4, as schematically indicated at 6 and movable up and down and even sidewise as schematically indicated in FIG. 5 by arrows 7.

Vibrating probe 5 may be made of glass, plastic, or metal such as titanium. It should be flexible in order to permit transmission of the magnetostrictive vibration of the source of vibration or the vibration producing magnetostrictive element, electromagnetic armature or electrodynamic coil to the desired portion of the respiratory tract in order to produce there the desired shearing or stirring movement and the desired increase of mobility of the mucus.

The flexibility of vibrating probe 5 is also desired to permit the probe when emerging from bronchoscope 6 to be bent around at 7, so as to permit operation of the vibrating probe 5 without obstructing visual observation through the bronchoscope 6 in direction of arrow 8.

Simultaneously with vibrating probe 5 there is inserted in otherwise well known manner in bronchoscope 6 a light carrier in the form of a small light schematically indicated at 9 and connected over an electrical connection schematically indicated at 10, to a battery or any other power source not shown.

In accordance with a modification of the invention, vibrating probe 5 may itself consist partially or wholly of magnetostrictive material and be directly excited by an electromagnetic field to the desired vibrations without departing from the scope of the invention.

Such a magnetostrictive device coupled to a small diameter long metal probe was successfully passed down a bronchoscope into the bronchi of many experimental dogs without ill effects clinically or histologically.

This was done on an adult male human as well and viscosity decrease was documented quantitatively, and this demonstrates the feasibility of combining a bronchoscope or other endoscope with a source of vibratory energy to transmit this energy into the human respiratory tract with the purpose of rendering mucus more easily

removed iatrogenically or more easily raised by the patient himself.

In accordance with a further feature of the invention, a saline solution or other solutions, may be lavaged into the bronchi simultaneously with application of sound energy and especially supersonic frequencies to aid in the mechanical coupling of the probe to the mucus to increase heat dissipation, to accomplish lavage of mucus, and to facilitate energy transfer to more distal points in the tract than those actually contacted by the probe.

Such solution may be applied either through a bronchoscope such as shown in FIGS. 1 and 2, and/or through a bronchoscope as shown in FIGS. 4 and 6, or through the vibrating probe 5 itself, which may be designed in the form of a tube.

In an embodiment according to FIGS. 1, 2 and 3, in which the endoscope or bronchoscope becomes a vibratable element, the contact point is limited to the larger bronchi.

According to the embodiment of FIGS. 4 and 5 wherein a separate wire or tubular probe is inserted down the tract in the endoscope and is connected to a remote vibrating energy source, the wire or tubular probe can be extended beyond the limit of the endoscope itself and thereby enter smaller caliber airways.

In all these cases the entire device and especially the probe itself is to be constructed in an explosion-proof manner with Underwriter approval of suitable materials to give good energy transfer, for example: glass, titanium. Furthermore, the design should permit easy manoeuvrability by the endoscopist.

The use of vibration frequencies in the audio range (below 20,000 c.p.s.) is also disclosed as feasible. In this case, audio generators may be employed as energy sources.

While the invention has been described and illustrated by using specific materials and specifically shaped and arranged elements, the invention is not limited thereto, but may be applied in any other appropriate manner without departing from the scope of this disclosure.

I claim:

1. A bronchial insert comprising an elongated viewing tube dimensioned to be received in the bronchi of an individual, said tube having proximal and distal ends and permitting visual observation of its distal end from said proximal end, said proximal end having vibratable means associated therewith for causing vibrations to be produced throughout the entire length of said tube including said distal end and the space adjacent thereto, so as to cause mucus accumulated in said space to reduce its viscosity.

2. A bronchial insert according to claim 1 wherein said vibratable means is an elongated element extending through said tube in the direction of the axis of said tubing and means at said proximal end for causing said element to vibrate.

3. A bronchial insert according to claim 1, wherein said vibratable means consists of a flexible rod arranged inside said bronchial insert and having a cross-section which is small compared to the cross-section of said insert to enable said visual observation.

4. A bronchial insert according to claim 3, wherein said rod is a tubing longitudinally adjustable with respect to said bronchial insert.

5. A bronchial insert according to claim 1, wherein said vibratable means is at least partially formed of magnetostrictive material.

6. A bronchial insert according to claim 1, where said vibratable means includes a vibratable element at the proximal end of said bronchial insert, and said, vibratable means includes pulse producing means, and means arranged along said insert to transmit energy from said pulse producing means to said element.

7. A bronchial insert according to claim 1, comprising means for passing through said bronchial insert to said vibratable means, a liquid adapted to dissolve into the mucus, acting as a transmission medium between vibratable means and mucus.

8. A bronchial insert according to claim 1, where said vibratable means is coupled to magnetostrictive means arranged at the proximal end of said bronchial insert and cooperating with said magnetostrictive means to vibrate; said magnetostrictive surrounding said proximal end of said insert so as to permit observation of its distal end from its proximal end.

9. A bronchial insert according to claim 1 and further comprising a light source attached to said tube to enhance said visual observation through said tube.

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