

July 10, 1962

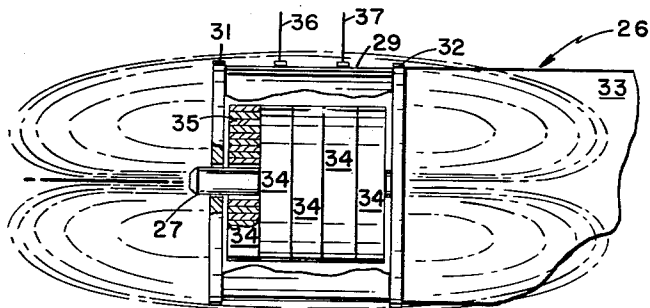
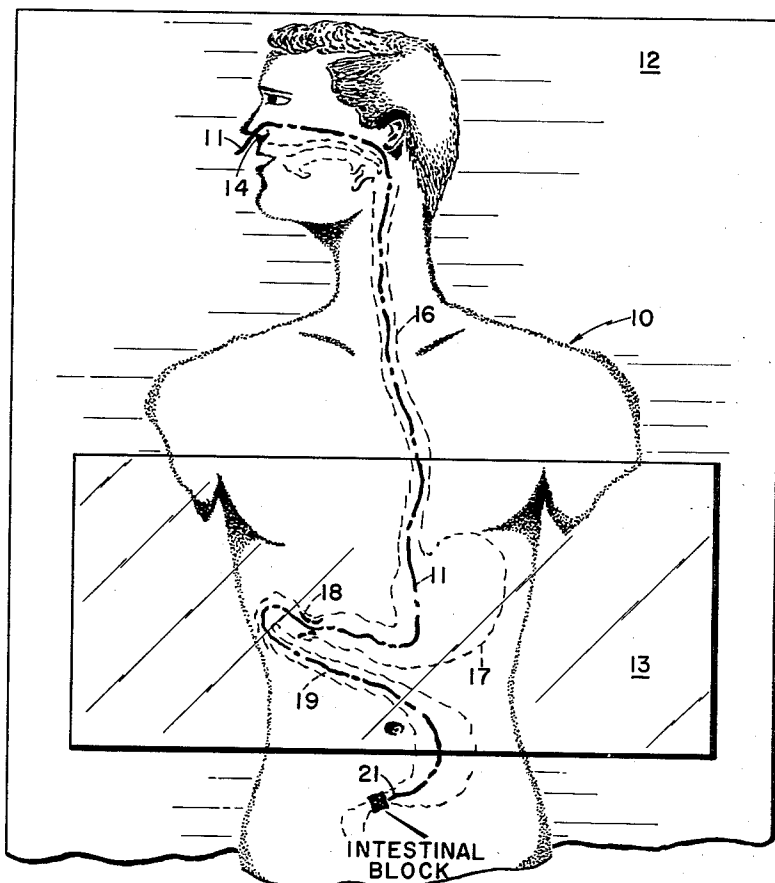
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3,043,309

METHOD OF PERFORMING INTESTINAL INTUBATION

Filed Sept. 29, 1959

2 Sheets-Sheet 1



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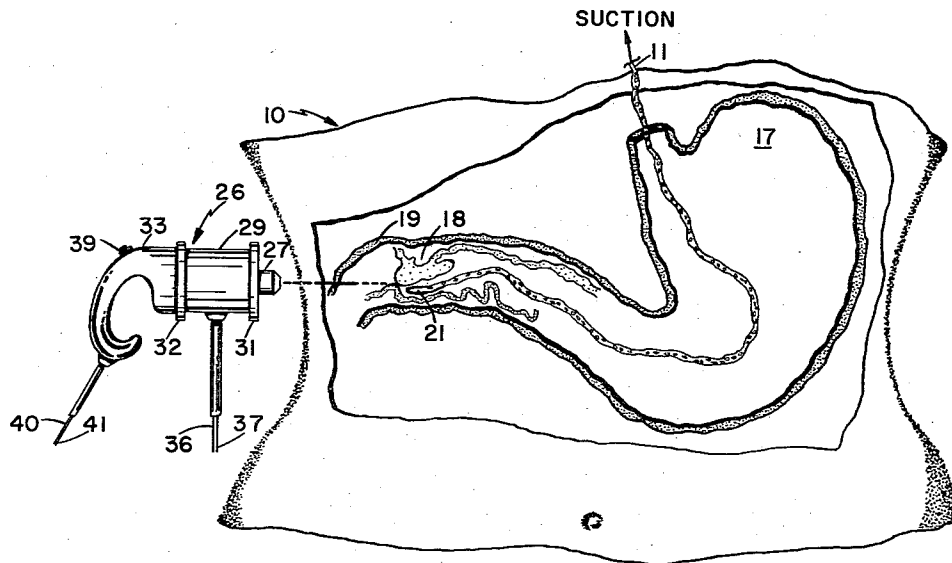


Fig 2

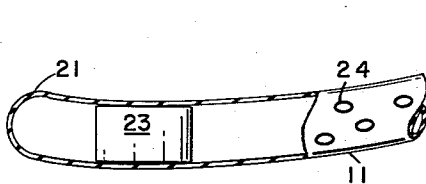


Fig 3

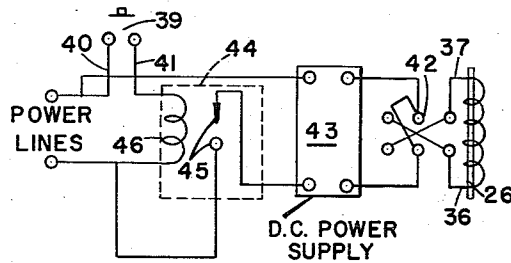


Fig 5

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1

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METHOD OF PERFORMING INTESTINAL INTUBATION

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This invention relates to an intubation procedure and more particularly an apparatus used in performing intestinal intubation.

Very frequently there will develop in the intestines a block which prevents food and waste products from passing from the stomach and the intestines to the outside of the body. Food and waste products build up gases as a consequence of increased bacterial activity in the digestive tract behind the block. The gases distend, or expand, the digestive organs greatly, giving rise to an extremely painful and dangerous condition. While it is possible to perform surgery to remove the block with the patient in a distended condition, the operation is considered to be extremely hazardous. A preferred procedure is to decompress the digestive system by inserting a perforated tube into the digestive system, and applying a suction force at the exterior end of the tube to remove the trapped gases, the food and waste products causing the distended condition. The procedure just discussed is commonly called decompression by means of intestinal intubation.

It is extremely simple to insert a flexible tube into the stomach. However, if the block is in the intestinal system the tube must be made to pass from the stomach into the intestinal system. At the junction of the stomach and the entrance to the intestines, there exists a ring-like muscle surrounding a passage defined by the junction, called the pylorus. The pylorus acts as a valve for controlling the movement of food from the stomach to the duodenal portion of the intestine. Normally, the pylorus obstructs the passage between the stomach and the intestinal tract. To pass the tube from the stomach to the intestinal tract, the pylorus must be made to act and open the passage.

There are several ways in which the pylorus can be made to open. In the natural digestive process, the stomach produces an acid which causes the pylorus to open. Attempts have been made to insert liquids which are chemically identical and have the same concentration as the acid which is produced by the stomach during a normal digestive operation. However, these efforts have not been too successful since the pylorus is apparently able to discriminate between a normal digestive product and a synthetic substitute.

The practice most widely used consists of inserting a tube into the patient's stomach and permitting the peristaltic and churning action of the stomach to bring the tip of the intubation tube in contact with the pylorus. It appears that the pylorus is sensitive to mechanical contact and responds to the contact by dilating, or opening the passage between the stomach and the intestines. The basic technique just described has been refined in several ways, namely: (1) weighting the tip of the intestinal tube to make use of a gravitational effect on the weighted end for moving it into the stomach and to contact the pylorus; (2) the medical profession has also used an intubation tube which increases the peristaltic actions of the stomach by means of an inflated balloon; and (3) water jets have also been employed for carrying the tube through the pylorus and intestinal tract.

Most of the modifications or refinements of the basic technique have not been generally successful and are not used extensively. The medical profession today relies

2

almost entirely on the basic technique of permitting the normal churning action of the stomach to carry the flexible tube to the pylorus. The degree of success incident to this procedure is dependent largely, and sometimes solely, on the continuous efforts of the attending physicians and for the most part depends on a chance passage of the tube from the stomach to the pylorus.

A normal intubation operation, as generally practiced today is a time consuming operation, frequently requiring hours to days, for the tube to make a complete passage from the stomach to the region of the block in the intestinal tract. Current methods are also not considered too reliable from several other standpoints. Natural abnormalities in the stomach construction, or abnormalities induced by the distended condition of the patient, often makes it impossible to intube the patient. Where a patient is having difficulty intubing by the conventional natural process, a decision to operate may have to be made without waiting for decompression because of the seriousness of the patient's condition. Furthermore, since the patient is frequently X-rayed to determine whether he has been intubed, prolonged exposure to hazardous radiation may occur.

It is an object of the present invention to provide an intestinal intubation method which avoids the limitations and disadvantages of prior intubation devices.

It is another object of this invention to provide an intestinal intubation method which greatly facilitates and greatly shortens an intubation operation.

It is still another object of the invention to provide an intestinal intubation method which includes means for guiding the intubation tube to the pylorus for stimulating the pylorus, causing it to open the passageway between the stomach and the intestines.

It is still another object of the invention to provide an intestinal intubation method which utilizes a magnetic means in conjunction with an intubation tube for intubing a patient.

It is another object of the invention to provide an intestinal intubation method utilizing an inexpensive, reliable and an easily operated apparatus for guiding the intubation tube in its passage through the stomach to the intestinal tract.

It is yet another object of the invention to provide an electromagnetic means designed and constructed for use in intubing a patient.

It is yet another object of the invention to provide electromagnetic means for an intubation apparatus which generates an optimum magnetic field intensity in a predetermined direction for attracting a magnetic means positioned at a distance from the electromagnetic means.

Finally it is an object of the invention to provide an intubation apparatus including an electromagnetic means which includes features making it especially suitable for manual manipulation during an intubation operation.

An important aspect of this invention is to provide a method for performing intestinal intubation which comprises securing magnetic member to the tip of an elongated, X-ray opaque, flexible tube. The tip and tube are then passed through the esophagus to the stomach of a patient. Preferably, the stomach region is then illuminated by means of X-rays, and the tube is observed on fluoroscopic screen. A maneuverable magnetic field is then applied to the magnetic material to direct the tip, to which the magnetic material is secured, to the pylorus valve in the stomach.

Another aspect of this invention is to provide an intubation apparatus comprising a highly flexible intubation tube which is adapted to pass through the intestinal tract of a patient. The intubation apparatus also includes magnetic means, comprising preferably a magnet, positioned in the tip of the intubation tube. Finally, the intubation

apparatus includes means for generating a magnetic field which couples the magnetic means in the intubation tube and develops an attractive or repulsive force on the magnetic means, whereby the intubation tube can be directed in a predetermined direction.

Another aspect of this invention is directed to an electromagnetic means for developing a magnetic field whose maximum intensity is along a predetermined direction. The electromagnetic means comprises a magnetic core, preferably a soft iron elongated rod. A concentric coil is wound about the rod, and its radial build-up made large to provide substantial leakage flux, i.e., flux which does not pass through the core. The leakage flux converges or focuses the magnetic field developed by the electromagnetic means along the axis of the core, when the coil is energized by a rated current.

The novel features that are considered characteristic of the invention are set forth in the appended claims; the invention itself, however, both as to its organization and method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in conjunction with the accompanying drawings, in which:

FIGURE 1 is a front view of a patient showing in outline the alimentary canal and a decompression tube inserted therein;

FIGURE 2 is an enlarged view of the intubed stomach region of the patient in FIGURE 1 showing the stomach in section;

FIGURE 3 is a representation of a tip of an intubation tube showing magnetic means positioned therein;

FIGURE 4 is a representation of an electromagnetic means constructed in accordance with the principles of the present invention; and

FIGURE 5 is a control circuit diagram.

The novel method is best described by discussing the structural features of an apparatus used to practice the method and the operation thereof.

Referring to FIGURE 1 of the drawings where there is represented a front view of an intubed patient 10 showing the digestive tract in dash outline and an intubation tube 11 positioned therein, typically, the patient 10 is placed face up on an X-ray table 12. The intubation operation is observed by passing X-rays from the table through the body 10 to a fluorescent screen 13 placed over the patient 10. The intubation tube 11, hereinafter called the tube, is passed through the nose 14 of the patient into the esophagus 16, to the stomach 17. From the stomach 17 the tube 11 passes through the pylorus 18 into the intestinal tract 19. A tip 21, commonly called the distal tip, of the tube 11 is shown adjacent to an intestinal block. The region of the intestinal tract 19 immediately in back of the intestinal block is shown distended as a result of the pile-up of food, waste products and gases in the digestive tract.

Referring briefly to FIGURE 3 of the drawings there is represented therein the distal tip 21, in a partial sectional view. It will be noted that there is positioned within the tube a magnetic means 23, which may be a piece of ferromagnetic material or an electromagnet, but preferably comprises a permanent magnet. The tube 11 extends integrally from the distal tip 21 and includes numerous holes 24 distributed over its surface. When a suction force is applied to the external or proximal end of tube 11, the food, waste products and gases within the digestive tract are sucked into these holes and carried out of the tract. The tube 11 is generally made up of an extremely flexible rubber. It is about 1/4 of an inch in diameter and is made opaque to X-rays to facilitate viewing it. The magnet 23 is 1/8 of an inch in diameter and 1/2 of an inch long.

The most widely used intubation tube 11 is a long Levin tube called the gastro-duodenal tube. The Levin tube is shown and described in the chapter on decompression of the digestive tract found in Medical Physics,

Volume 2, edited by Otto Glasser, Year Book Publishers, 1950, starting on page 274. It will be understood that most of the other intubation tubes shown and described in the aforementioned chapter can also be used. An intubation tube may be as long as twenty-eight feet, and includes markings along its length which indicate the position of the distal tip 21 in the digestive tract. For example, a mark S indicates that the tip of the tube is just entering the stomach. A second marking, P, is located six inches beyond S and indicates that there is now sufficient tube in the stomach to allow the distal tip to pass through the pylorus. A third marking D is placed six inches beyond P and from thereon the tube is calibrated in feet.

The intubation apparatus also includes a means for generating a magnetic field which is adapted to couple the magnet 23 in the tip 21 for developing on the magnet a force, whereby the magnet, and the tube 11, in which it is positioned, is directed towards the pylorus 18. Normally, the force developed will tend to attract the magnet 23. However, it will be shown that a repulsive force may also be developed. FIGURE 2 of the drawings shows the tube 11 passing through the stomach 17 with the tip 21 in contact with the pylorus 18.

The electromagnetic means comprises preferably an electromagnet 26 which is designed and constructed for manual manipulation and control. It is often difficult to pinpoint the precise location of the pylorus 18, but in all cases, it is possible to ascertain its approximate location and to direct the tube 11 to its immediate vicinity. As seen in FIGURE 2, the magnet 26, with the aid of the X-rays and fluoroscopic screen, is positioned opposite the approximate position of pylorus 18 on the outside of the patient 10. As will be seen hereinafter, the maximum magnetic field intensity will be developed along the axis of the core 27 to forcibly attract the magnet 23.

It is well to point out, at this time, that the peristaltic and churning action of the stomach provide partly the motivating force for drawing the tube 11 into the intestinal tract and intestinal peristalsis provides the primary force for drawing the tube 11 through the intestines. The pylorus 18, when it is open, also exhibits a peristaltic action which draws the tube through the passageway from the stomach 17 to the intestine 19. Accordingly, the first function of the intestinal intubation apparatus is to make contact between the tube 11 and the pylorus 18, to stimulate the pylorus 18, causing it to open the passageway between the stomach 17 and the intestine 19. The intestinal intubation apparatus also provides a good part of the motive force for passage from stomach 17 to the duodenal end of the intestines 19.

Referring to FIGURES 3 and 4 of the drawings there are represented therein a preferred construction of the electromagnet 26. The electromagnet 26 comprises a magnetic core 27 formed from a rod of magnetic material, preferably soft iron. The rod is approximately six inches long and one and one-quarter inches in diameter. A concentric coil 29 covers approximately five inches of rod 27 and comprises a pair of end pieces 31 and 32, the latter including a handle 33 extending integrally therefrom. The electrical conductors making up the coil 29 are wound in the space between the end pieces 31 and 32. In order to maintain a reasonable size and weight, the coil 29 comprises, in this instance, a plurality of windings 34, each of which comprises a plurality of concentric turns made up of anodized aluminum strip 35. As is well known, the aluminum surface formed in an anodizing process can be made nonconductive and for the voltages normally used to energize the electromagnet 26, an anodized surface provides adequate insulation between the turns of the windings 34.

Current is supplied to the windings through a pair of leads 36 and 37. As seen in FIGURE 2 the handle 33 includes a push button 39 from which a pair of leads 40

5

and 41 are coupled. The leads 40 and 41, as will be seen hereinafter, are in the control circuit of the electromagnet 26.

The number of turns used in making up the coil 29 is a function of the space allocated for the coil, the current available to energize the coil and the material used in the magnetic core 28. A design which has been found suitable comprises five windings 34 having 140 turns per winding of 0.015 inch thick aluminum strip. The total resistance of the coil 29 was found to be 0.6 ohm and a current of 40 amperes was found to develop a magnetic field intensity of 150 gauss, at 4 inches from the core face. Clinical tests of this design of an intestinal intubation apparatus have shown it to be satisfactory. Under normal clinical conditions the above described electromagnet was used in intubing a patient in about ten to fifteen minutes total time. It is estimated that the initial separation between the magnet 23 in the intubation tube 11 and the face of the core 27, on the outside of the patient, will vary from six to eight inches.

It is clear from FIGURE 2 that it is desirable to construct a magnetic field having a maximum intensity parallel to the axis of the core 27. Accordingly, there is provided means for converging, or focusing the magnetic flux lines along a desired direction. The focusing means makes use of a leakage field surrounding, but not within the core 27, for directing the flux lines produced in the core along its axis. The leakage field is produced in the following manner. It is well known that the magnitude of flux produced in a magnetic field is proportional to the product of the number of turns in the energizing coil 29 and the current flowing in the coil. Accordingly, the number of ampere turns developed in the coil 29 is of sufficient magnitude to fully saturate the coil 27 and to create flux lines outside of the core 27. The flux lines which do not couple the core 27 make up a leakage field. It is also well known that the ability of a flux line developed in any particular turn of a coil to couple the magnetic core 27 is related to the distance between the turn in question and the core. Accordingly, the coil 29 has been constructed to have a substantial radial build-up, thus assuring that a substantial leakage field will be developed after the magnetic core 27 has been fully saturated.

The over-all magnetic field developed by the electromagnet 26 is depicted in FIGURE 4. It will be noted that there is a higher density of flux directed along the axis of the core 27 than at distances radially remote from the core 28. The flux lines are more widely separated laterally of the core 27.

Referring to FIGURE 5 of the drawings, there is depicted therein a current supply means comprising a D.C. power supply 43 which generates a unidirectional current. The output terminals of the D.C. power supply 43 are coupled through a current reversing switch 42 to the electromagnet 26 by means of conductors 36 and 37. The polarity of the electromagnet 26, as is conventional, is controlled by the direction of current in its coil 29. Its polarity further determines whether the magnet 23 will be attracted or repelled. Switch 42 is a conventional double pole double throw current reversing switch. Interposed between the power lines and the input terminals of the D.C. power supply 43 is the push button 39 which lies in the energizing path of an electromagnetic relay 44. The electromagnetic relay includes a pair of contacts 45 which lie in the current path of the energizing circuit of the D.C. power supply 43. The push button 39 is shown in a normally open position. When it is depressed, current from the power lines flows through the coil 46 of the relay 44 thus closing the contacts 45. When the contacts 45 are closed current is drawn from the power lines by the D.C. power supply 43 for energizing the electromagnet 26.

While the operation of the intubation apparatus is ob-

6

vious, a brief summary will be given. Initially the distal tip 21 of the intubation tube 11 is inserted in the nose of the patient 10 and directed by the physician into the stomach 17 of the patient. When the distal tip 21 is observed, through the fluoroscope screen 13, entering the stomach 17, the electromagnet 26 is positioned against the body of the patient opposite the pylorus 18 as shown in FIGURE 2. The push button 39 is depressed and the electromagnet 26 is energized producing a magnetic field which is generally directed along the axis of the core 27. The magnetic field interacts with the magnetic field of the magnet 23 positioned in the distal end of the intubation tube 11. There is developed on the magnet 23 an attractive force tending to pull the distal end of the intubation tube 11 toward the pylorus. This attractive force co-operates to bring the distal end 21 into contact with the pylorus. As described herebefore, the pylorus 18 is stimulated by the contact of the tube and opens the passageway between the stomach 17 and the intestine 19. With the passage open, the magnetic force aided by the peristalsis of the stomach, the pylorus, and the intestine when the tube 11 finally enters the intestine, moves the tube 11 through the intestine. A suction force is applied to the proximal end of the tube that lies outside of the patient and the food, waste products and gases found in the digestive tract are sucked into the tube and carried outside of the patient's body. The suction force may be applied while the patient is being intubed since it has been found that it will have no adverse effect on the intubation procedure.

On occasion, the tip 21 may become wedged in the stomach wall so that movement toward the pylorus is prevented. An assist in freeing the tip 21 can be obtained by reversing the current in the electromagnet, by means of switch 42, to repel the magnet 23 and consequently tip 21.

The various features and advantages of the invention are thought to be clear from the foregoing description. Various other features and advantages not specifically enumerated will undoubtedly occur to those versed in the art, as likewise will many variations and modifications of the preferred embodiment illustrated, all of which may be achieved without departing from the spirit and scope of the invention as defined by the following claims.

I claim:

1. An intestinal intubation method comprising:

(a) securing a magnetic member to the tip of an elongated flexible tube;

(b) passing the tip and the tube through the esophagus to the stomach of a patient; and

(c) applying a maneuverable magnetic field to the magnetic material and directing said tip to the pylorus valve in the stomach.

2. The method as described in claim 1 in which said magnetic member is a permanent magnet.

3. An intestinal intubation method comprising:

(a) inserting a magnetic member in the tip of an elongated flexible tube, said magnetic member being dimensioned to engage the walls of said tube to be secured thereby;

(b) passing the tip and the tube through the esophagus to the stomach of a patient; and

(c) applying a maneuverable magnetic field to the magnetic material and directing said tip to the pylorus valve in the stomach.

4. An intestinal intubation method comprising:

(a) securing a magnetic material to the tip of an elongated flexible tube;

(b) passing the tip and the tube through the nose and through the esophagus to the stomach of a patient; and

(c) applying a maneuverable magnetic field to the magnetic material and directing said tip to the pylorus valve in the stomach.

5. An intestinal intubation method comprising:
- (a) securing a magnetic member to the tip of an elongated, X-ray opaque, flexible tube;
 - (b) passing the tip and the tube through the esophagus to the stomach of a patient;
 - (c) illuminating the stomach region by means of X-rays for displaying the tube within the stomach; and
 - (d) applying maneuverable magnetic field to the magnetic material and directing said tip to the pylorus valve in the stomach.
6. An intestinal intubation method comprising:
- (a) securing a magnetic member to the tip of an elongated flexible tube;
 - (b) passing the tip and the tube through the esophagus to the stomach of a patient; and

5

10

15

- (c) applying an electrically reversible and maneuverable magnetic field to the magnetic material for attracting and repelling said tip for directing said tip to the pylorus valve in the stomach.

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