

[54] **AIR SUPPLYING DEVICE FOR AN ENDOSCOPE**

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[58] Field of Search 128/276, 6; 318/484, 318/487, 443; 417/12, 44

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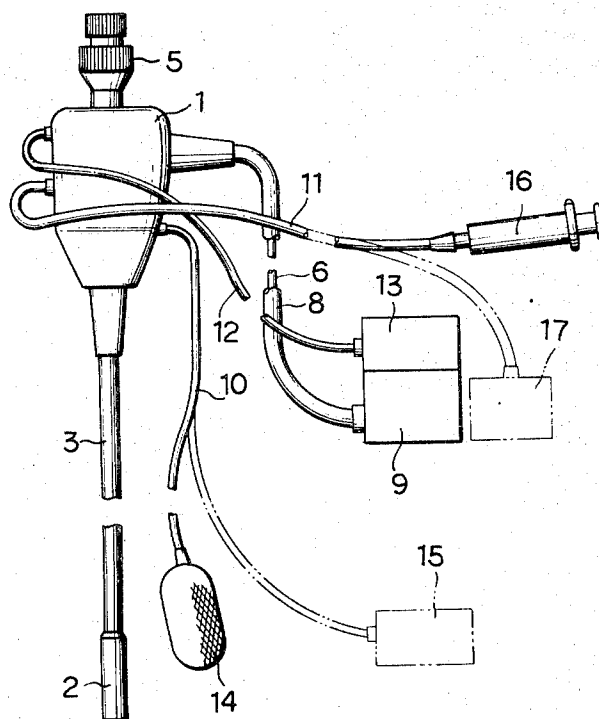
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[57] **ABSTRACT**

An air supplying device for use with an endoscope for supplying desired quantity of air into a hollow portion of a living body into which the forward end portion of the endoscope is inserted for the inspection thereof so that the hollow portion is inflated appropriately for the proper inspection and/or photographing of the hollow portion. The air supplying device comprises a foot switch, a timer and an air pump actuated by closing the foot switch through the timer for supplying air to the endoscope to which the air pump is connected. The timer is actuated each time the foot switch is closed for actuating the air pump so that the timer deenergizes the air pump after a predetermined time period set in the timer so that a predetermined quantity of air is supplied to the endoscope each time the foot switch is closed while the air pump is stopped at any desired moment during the actuation of the timer by opening the foot switch so that excess quantity of air is prevented from being supplied to the endoscope.

3 Claims, 6 Drawing Figures



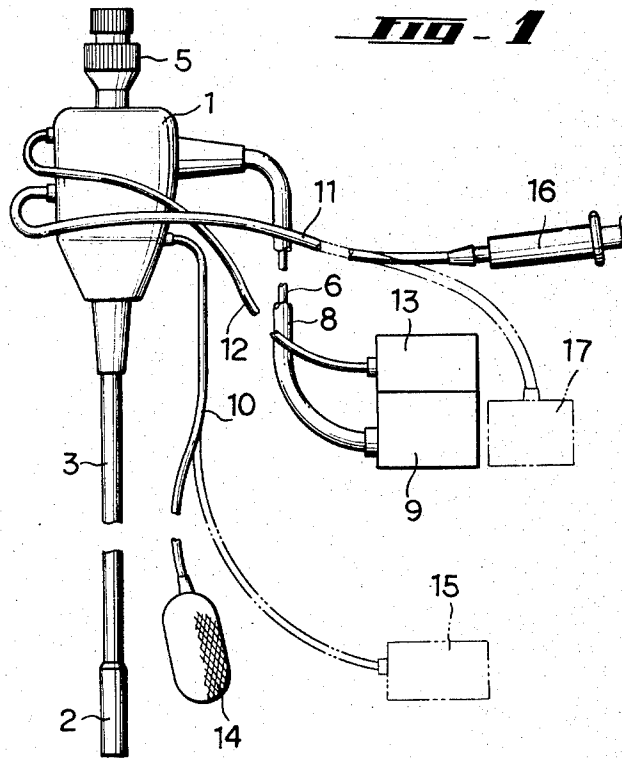
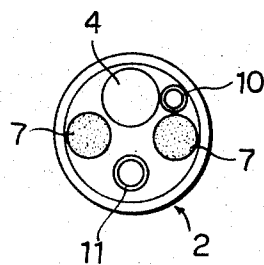


FIG. 2



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FIG - 5

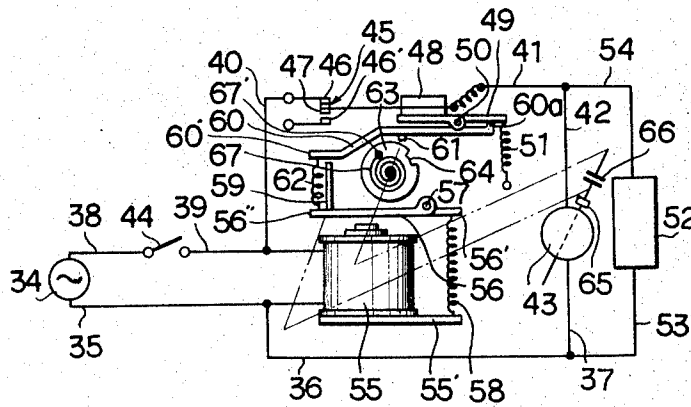
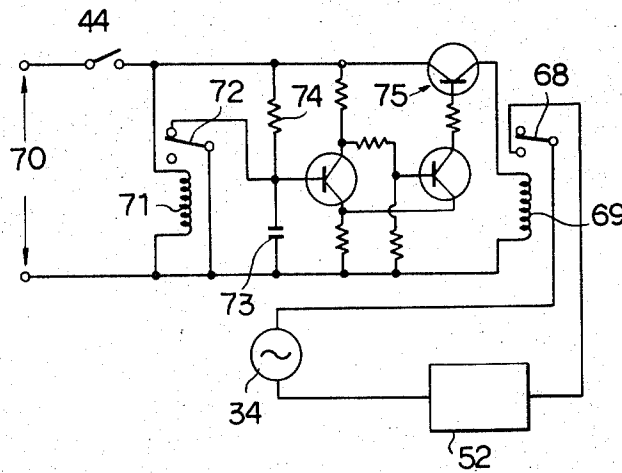


FIG - 6



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AIR SUPPLYING DEVICE FOR AN ENDOSCOPE

This is a division of application Ser. No. 760,151, filed Sept. 17, 1968 and abandoned in favor of continuation application Ser. No. 126,941, filed Mar. 22, 1971.

BACKGROUND OF THE INVENTION

The present invention relates to a novel and useful air supplying device adapted to be used with an endoscope for supplying any desired quantity of air into the hollow portion of a living body which is being observed by the endoscope.

When an endoscope is in operation, it is necessary to inflate the hollow portion of a living body which is being inspected by introducing air into the hollow portion so that the forward end portion of the endoscope inserted into the hollow portion is spaced a suitable distance from the inner wall of the hollow portion thereby permitting the observation and/or the photographing thereof by means of the endoscope to be properly carried out.

Heretofore, the admission of air into the hollow portion is usually effected by a manually operable rubber-bulb blower provided with a non-return valve which is connected to a tube extending from the control housing through the elongated tube to the forward end portion of the endoscope. The air is discharged from the open end of the tube into the hollow portion of the living body by a predetermined quantity each time the rubber-bulb blower is actuated by the operator. The quantity of the air admitted into the hollow portion is determined by the number of times of the manual operation of the rubber-bulb blower. However, since the operation of the rubber-bulb blower is relatively hard when the operation is carried out together with the operation of the endoscope for the observation and/or the photographing of the object, the operator tends to get tired soon, particularly when the group diagnosis is to be carried out. And, at the same time, when forceps incorporated in the endoscope are operated while the hollow portion is observed by means of the endoscope, it is impossible for the operator to manually operate the rubber-bulb blower thereby requiring the rubber-bulb blower to be operated by another assistant operator. The admission of air into the hollow portion can also be effected by means of mechanically driven air pump. In this case, however, since no means has been developed to measure the quantity of air introduced into the hollow portion, there is a danger that too much amount of air might be introduced into the hollow portion thereby harming the internal organ of the living body. When the integrating flow meter is provided for measuring the quantity of air admitted into the hollow portion, it is very troublesome to read out the graduation of the flow meter thereby rendering the operation of the endoscope very difficult.

The present invention aims at providing a novel and useful air supplying device for use with an endoscope which avoids the above described disadvantages of the prior art air supplying device.

SUMMARY OF THE INVENTION

One object of the present invention is to provide a novel and useful endoscope which avoids the above described disadvantages of the prior art endoscope.

Another object of the present invention is to provide a novel and useful air supplying device for use with an endoscope which avoids the above described disadvantages of the prior art air supplying device and which permits the air to be admitted into the hollow portion by any desired quantity by the operation effected by the operator thereby dispensing with the employment of an assistant operator.

This is achieved by the present invention by providing a timed air supplying mechanism adapted to be coupled with the endoscope and comprising a foot switch, a timer and an air pump which is driven by a drive motor by closing the foot switch so as to feed air into the hollow portion of the living body, the timer being comprised of a timing lever, a spring biased timing cam disc cooperable with the timing lever and an electromagnet for bringing the timing lever into cooperative position with the timing cam disc by closing the foot switch thereby permitting the air to be admitted at a constant rate into the hollow portion of the living body for a given time period determined by the timer each time the foot switch is closed until the timer is stopped after the operation thereof while the pump can be stopped any desired moment by opening the foot switch so that the timing lever is disengaged from the timing cam disc thereby permitting the desired amount of air to be admitted into the hollow portion of the living body by closing the foot switch any desired number of times and by opening the foot switch any desired moment when sufficient amount of air has been introduced into the hollow portion of the living body.

In accordance with the other feature of the present invention, the timer may be substituted by a transistor timer comprised of relays, a transistor circuit and a C-R timing circuit thereby dispensing with mechanical timer elements which are complicated in construction.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of a prior art endoscope illustrating the various tubes connected individually to the various exterior devices;

FIG. 2 is an end view of the forward end portion of the endoscope shown in FIG. 1;

FIG. 3 is a schematic view partly in cross-section illustrating the construction of an endoscope constructed in accordance with the present invention with the forward end portion omitted;

FIG. 4 is a cross-sectional view taken along line 4-4 in FIG. 3;

FIG. 5 is a schematic view showing an embodiment of the timed air supplying mechanism and the electric circuit constructed in accordance with the present invention; and

FIG. 6 is a view similar to FIG. 5 but showing the electric circuit of the timer in which relay, transistors and C-R timing circuit are provided instead of mechanical timing elements.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Prior to the description of the present invention, a prior art endoscope will be briefly described in connection with FIGS. 1 and 2 for the better understanding of the feature of the present invention.

In FIG. 1, the prior art endoscope comprises a control housing 1 and a forward end portion 2 adapted to be inserted into a hollow portion of a living body and connected by elongated tube 3, preferably flexible, to the control housing 1. An objective lens system 4 (FIG. 2) is provided in the forward end portion 2 for focusing the image of the object in the forward end portion. An elongated image transmitting optical system (not shown) such as a fiber optical system extends through the elongated tube 3 with the forward end thereof located at a position in the forward end portion 2 where the image of the object is focused by means of the objective lens system 4. The rearward end of the image transmitting optical system terminates in the control housing 1. Ocular means 5 is provided in the control housing 1 at a position adjacent to the rearward end of the image transmitting optical system in opposing relationship thereto so that the image formed in the forward end of the image transmitting optical system and transmitted therethrough to the rearward end of the image transmitting optical system can be viewed through the ocular means 5.

In order to illuminate the object to be inspected by the endoscope, a light conducting fiber optical system 6 (FIG. 1) may be provided which extends through the elongated tube 3 with the forward end thereof divided into two portions and terminating at the forward end of the forward end portion 2 to form a pair of light emanating windows 7, 7 respectively. The rearward end of the light conducting fiber optical system 7 extends outwardly of the control housing 1 through a sheath 8 connected to the control housing 1. The outer end of the light conducting fiber optical system 6 is detachably connected to a light source 9 so that the light from the light source 9 is transmitted through the light conducting fiber optical system 6 to the forward end thereof so as to emanate the light through the illuminating windows 7, 7 thereby illuminating the object.

The light conducting fiber optical system 6 can be replaced by lamp means provided in the forward end portion 2. In this case, the lamp means is energized by an exterior electric power source through lead wires extending through the elongated tube 3 and connecting the lamp means to the exterior electric power source.

The above construction of the endoscope is well known in the art.

In addition, the endoscope may be provided with various tubes such as air supplying tube 10, water supplying tube 11, tube 12 for protecting electric wires connected to a photoelectric element in the endoscope and leading to the automatic exposure control device 13 exterior of the control housing 1 each extending outwardly from the control housing 1. The air supplying tube 10 and the water supplying tube 11 extend from the control housing through the elongated tube 3 to the forward end portion 2, respectively. The rearward end of the tube 10 may be connected to a rubber-bulb blower 14 or an air pump 15 so that the air is fed to the forward end portion 2 so as to inflate the hollow portion into which the forward end portion 2 is inserted. In the similar manner, the rearward end of the tube 11 may be connected to an injector 16 or a water pump 17 so that the water is fed to the forward end portion 2 so as to effect the washing of the inner wall of the hollow portion to be inspected by the endoscope. The

photoelectric element may be located adjacent to the rearward end of the image transmitting optical system or in the forward end portion 2. In the latter case, the lead wires extend through the elongated tube 3.

When the endoscope of the prior art is used, each of the devices for effecting the above described various operations must be individually connected to the tubes of the endoscope belonging to the respective devices. This is very troublesome and time consuming. Moreover, since the endoscope must be moved and rotated during the operation of the endoscope in order to aim at the desired point in the inner wall of the hollow portion to be inspected, the various tubes tend to be entangled each other thereby disturbing the operation.

The endoscope comprises a control housing 1, a forward end portion (not shown) which is similar to the forward end portion 2 in FIGS. 1 and 2 and which is connected to the control housing 1 through an elongated tube 3 analogous in construction to that shown in FIG. 1. An objective lens system is located in the forward end portion, ocular means 5 is located in the control housing 1, and an image transmitting optical system 18 extends through the elongated tube 3 in like manner as in the case shown in FIG. 1.

Light conducting fiber optical system 6 extends from the forward end portion through the elongated tube 3 into the control housing 1 and further extends outwardly therefrom through cylindrical projection 1' integral with the control housing 1 and flexible sheath 19 connected at its one end to the end of the projection 1'. The free outer end 6a of the light conducting fiber optical system 6 extends beyond the connecting member 20 having threaded connecting ring 21 rotatably mounted thereon which is attached to the free end of the sheath 19 as shown in FIG. 3.

A beam splitting prism 22 having half mirror 22a diagonally arranged therein is located adjacent to the rear end of the image transmitting fiber optical system 18 in alignment therewith so that a portion of the light incident to the prism 22 from the image transmitting fiber optical system 18 is directed to the ocular means 5 through the half mirror 22a so that the image transmitted to the rearward end of the image transmitting fiber optical system from the forward end thereof is viewed through the ocular means 5 while the remainder of the light incident to the prism 22 is reflected toward the side of the prism 22 on which a photoelectric element 23 is secured. Lead wires 12' covered by a tube 12 extend from the photoelectric element 22 through the projection 1' and the sheath 19 to the free end of the sheath 19 and are connected to pins 12'a projecting from the connecting member 20 as shown in FIG. 3.

Water and air supplying tube 24 extends from the forward end of the forward end portion through the elongated tube 3 and the inner end of the tube 24 is connected to the circumferential surface of a cylindrical member 25 provided in the control housing 1 and having an open end 25a opening in the surface of the control housing 1 and a bottom 25b and a mating shoulder 25c formed by an enlarged hollow portion in the member 25 near the bottom 25b. One end of water supplying tube 26 is connected to the water and air supplying tube 24 at a position near the inner end of the tube 24 and the tube 26 extends through the projection

1' and the sheath 19 to the connecting member 20 and terminates at fitting 26a provided on the circumferential surface of the connecting member 20.

One end of air supplying tube 27 is connected to the bottom 25b of the cylindrical member 25 and the tube 27 extends through projection 1' and the sheath 19 to the free end of the sheath 19 and the outer end of the tube 27 is connected to a cylindrical projection 27a projecting from the connecting member 20 as shown in FIG. 3.

A suction tube 28 for sucking undesired material such as phlegm out of the hollow portion into which the forward end portion of the endoscope is inserted extends from the forward end of the forward end portion through the elongated tube 3 into the control housing 1 and further extends therefrom through the projection 1' and the sheath 19 to a fitting 28a provided on the circumferential surface of the connecting member 20 as shown in FIG. 3.

The cylindrical member 25 is connected to the water and air supplying tube 24 and the air supplying tube 27 is provided therein with a slidable hollow actuator member 29 slidably fitting with the inner wall of the enlarged hollow portion of the cylindrical member 25 and having a through hole 29a and a flange 29b. A shoulder 29c is provided on the outer circumferential surface of the actuator member 29.

A spring 30 is provided around the actuator member 29 between the flange 29b thereof and the opening 25a of the cylindrical member 25 so that the actuator member 29 is normally urged outwardly until the shoulder 29c abuts against the shoulder 25c.

Cylindrical member 31 having an open end 31a and a bottom 31b is provided in the control housing 1 in juxtaposed relationship to the cylindrical member 25. A portion of the suction tube 28 extends in the hollow portion of the cylindrical member 31 and an opening 28b is provided in the tube 28, which opens in the hollow portion of the cylindrical member 31 as shown in FIG. 3.

In operation, the connecting member 20 is connected to a mating connecting member 32 shown by chain-dot line by means of connecting ring 21. The mating connecting member 32 is provided with fittings each leading to the light source 9, the automatic exposure control device 13 and the air pump 15, respectively, so that, when the connecting members 20 and 32 are connected to each other, the light conducting fiber optical system 6, the air supplying tube 27 and the lead wires 12' leading to the photo-electric element 23 are coupled with the light source 9, the automatic exposure control device 13 and the air pump, respectively. Also, the water pump 17 and a suction pump 33 are connected to the fitting 26a of water supplying tube 26 and the fitting 28a of the suction tube 28, respectively.

By energizing the light source 9, the object to be inspected can be illuminated so that it is observed in like manner as the conventional endoscope. When the photographing of the object is to be effected, the photoelectric element 23 connected to the automatic exposure control device 13 serves to achieve proper exposure in like manner as the conventional exposure control system.

When the air is to be admitted into the hollow portion into which the forward end portion of the en-

doscope is inserted for the inspection, the air pump 15 is first actuated by means not shown so that the air is fed through the air supplying tube 27 to the cylindrical member 25. By closing the opening 29e of the actuator member 29 by the operator's finger without depressing the same, the air is prevented from flowing freely out of the opening 29e through the hole 29a of the cylindrical member 29 so that the air is forced to flow through the water and air supplying tube 24 to the forward end of the forward end portion of the endoscope to thereby permit the air to be admitted into the hollow portion as long as the opening 29e of the cylindrical member 29 is closed by the operator's finger without depressing same.

When the water is to be admitted into the hollow portion to be inspected, the actuator member 29 is first pushed inwardly by means of the operator's finger against the action of the spring 30 until the opening 24a of the water and air supplying tube 24 is closed by the actuator member 29, and then the water pump 17 is actuated by means not shown. Then, the water is fed through the water supplying tube 26 and the water and air supplying tube 24 to the forward end portion to thereby permit the water to be admitted into the hollow portion as long as the water pump 17 is actuated while the actuator member 29 is kept depressed so as to close the opening 25a.

When the undesired material such as phlegm is to be removed from the hollow portion to be inspected, the suction pump 33 is first actuated. By closing the opening 31a of the cylindrical member 31, the air is prevented from flowing into the tube 28 through the opening 28b to thereby permit the undesired material in the hollow portion to be sucked through the suction tube 28 as long as the opening 31a is closed.

It is evident, in case a lamp is provided in the forward end portion of the endoscope in place of the light conducting fiber optical system 6, lead wires connected to the lamp are led through the elongated tube 3 and the sheath 19 to the connecting member 20 and the lead wires are connected to an electric power source instead of the light source 9 when the connecting member 20 is connected to the mating connecting member 32.

Further, any of the above described elements can be dispensed with or any further elements for carrying out further desired functions can be added to the endoscope of the present invention depending upon the requirements when the endoscope is used.

Further, the fittings 26a and 28a are shown as being located in the circumferential surface of the connecting member 20, but they may be located in the end surface thereof, and any of the elements can be located either in the end surface of the connecting member 20 or in the circumferential surface thereof depending upon the desired design of the endoscope.

It is also evident that the photoelectric element 23 may be located in the forward end portion of the endoscope instead of being located adjacent to the rearward end of the image transmitting optical system 18. In this case, the lead wires 12 are extended through the elongated tube 3 and the sheath 19 and connected to the automatic exposure control device 13.

As described above, the various operations of the endoscope of the present invention are very simple and the operations are very reliable and no delay in the operations occurs.

Since the various tubes used for effecting the various operations of the endoscope, as described above, are housed together within the single sheath 19, not only the connection of the various tubes to the respective corresponding devices is effected very simply and easily, but also no entanglement of the various tubes during the operation of the endoscope occurs. This is extremely advantageous in handling the endoscope.

Further, since the various tubes are housed together within the single sheath 19, danger that the tubes might be collapsed by the bending of the sheath is extremely reduced in comparison with the case in which the tubes are individually connected to their corresponding devices.

FIG. 5 shows the air supplying device of the present invention to be used with the endoscope for regulating the quantity of the air admitted into the hollow portion of the living body into which the forward end portion of the endoscope is inserted.

Electric power source 34 is connected through lead wires 35, 36, 37, 38, 39, 40, 41 and 42 to a driving motor 43. A foot switch 44 is provided between leadwires 38 and 39, while a time switch 45 is provided between lead wires 40 and 41. The time switch 45 comprises a stationary contact 46 provided at the end of the lead wire 40 and a movable contact 47 secured to mounting pieces 48 which are in turn secured to a swingable lever 49 pivoted about pin 50. Stopper 46' limits the range of movement of the movable contact 47. The lever 49 is urged to rotate clockwise by means of a spring 51 secured with its one end to the end of the lever 49 and with its other end to a stationary portion of the device, so that the contacts 46, 47 are normally held in closed state. An air pump 52 adapted to feed the air to the endoscope is also connected to the electric power source 34 through lead wires 53 and 54 in parallel relation to the motor 43.

Further, an electromagnet 55 is connected to the electric power source 34 through leadwires 35 and 39 in parallel relation to the motor 43 and the air pump 52.

The timing mechanism actuating the timing switch 45 will be described below. A magnetically attractable lever 56 pivoted about shaft 57 is provided adjacent to the electromagnet 55 so that the lever 56 is rotated counterclockwise by the magnetic force of the electromagnet 55 when it is energized by closing the foot switch 44. The lever 56 is normally urged to rotate clockwise by means of a spring 58 secured at its one end to the end 56' of the lever 56 and with its other end to a stationary point such as the extension of the base 55' of the electromagnet 55. An abutment pin 59 is fixedly secured to the lever 56 at a position adjacent to the end 56'' of the lever 56 as shown.

A timing lever 60 also pivoted about the shaft 50 is provided beneath the lever 49 adjacent thereto but a small amount of the swinging movement of the lever 49 relative to the lever 60 is allowed. A pin 61 is fixedly secured to the lower side of the lever 60 at about the midpoint of the length thereof, the function of the pin 61 will be described later. The end of the lever 60 opposite to the side where the pin 61 is fixed is provided with an abutment projection 60a which abuts against the lever 49 when the lever 60 is rotated counterclockwise as described later so that the lever 49 is swung counterclockwise to thereby opening the time switch 45 comprised of contacts 46, 47.

One end of spring 62 is fixed to the end 56'' of the lever 56 at a position adjacent to the pin 59 while the other end of the spring 62 is fixed to the end 60' of the lever 60 opposing to the end 56'' of the lever 56 so that the ends 56'' and 60' of the levers 56 and 60 are urged toward each other by the action of the spring 62 until the outer end of the pin 59 abuts against the lever 60. The spring 51 is made weaker than the spring 62 for the reason described hereinbelow.

A timing cam disc 64 provided with a recess 64 in the periphery thereof is located beneath the lever 60 in such a manner that the recess 64 receives the pin 61 when the cam disc 63 is rotated by an appropriate angle so that the lever 60 is swung counterclockwise by the engagement of the pin 61 within the recess 64. The shaft of the timing cam disc 63 is connected to the shaft of a reduction gear schematically shown by 65 which is driven by the motor 43 so that the cam disc 63 is driven counterclockwise by the motor 43. A clutch 66 also schematically shown, is interposed between the shaft of the cam disc 63 and the shaft of the reduction gear 65. The clutch 66 is controlled by the lever 56 such that the clutch 66 is engaged to rotate the cam disc 63 when the lever 56 is attracted by the energization of the electromagnet 55 and disengaged when the electromagnet 55 is deenergized to release the lever 56.

A spiral spring 67 is provided around the shaft of the cam disc 63 with its outer end 67' secured to a stationary point in the device while the inner end is secured to the shaft of the cam disc 63 so that the cam disc is returned to its predetermined initial angular position by the action of the spiral spring 67 when the clutch 66 is disengaged. The angular position of the recess 64 with respect to the position of the pin 61 is appropriately set depending upon the time period in which the desired quantity of the air is fed to the endoscope by means of the air pump 52.

In operation of the air supplying device shown in FIG. 5, the air pump 52 is connected to the air supplying tube of the endoscope. In case the endoscope as shown in FIG. 3 is used, the opening 29e of the actuator member 29 may be preliminarily closed, or the actuator member 29 may be replaced by an actuator member having no throughhole.

By closing the foot switch 44 by the operators foot, the driving motor 43 and the air pump 52 are actuated through the timing switch 45 comprising the contacts 46, 47. At the same time, the electromagnet 55 is energized to attract the lever 56 against the action of the spring 58 to rotate it anticlockwise about the shaft 57 thereby permitting the clutch 66 to be engaged. Thus, the air pump 52 begins to supply air to the endoscope to which the air pump 52 is connected, while the rotation of the motor 43 causes the timing cam disc 63 to be rotated anticlockwise against the action of the spring 67 from its predetermined initial position with respect to the position of the pin 61 fixed to the timing lever 60 through the reduction gear 65 and the clutch 66 engaged by the energization of the electromagnet 55. The anticlockwise rotation of the lever 56 caused by the energization of the electromagnet 55 also causes the timing lever 60 to be rotated about the pin 50 anticlockwise by the action of the spring 62 connecting the ends 56'' and 60' of the respective levers 56 and 60 until the pin 61 of the timing lever is urged to contact with the peripheral surface of the cam disc 63 with ap-

appropriate pressure exerted by the spring 62 but an appropriate distance is still held between the outer end of the pin 59 and the lever 60. When the recess 64 of the cam disc 63 comes to the position where the pin 61 can engage with the recess 64 of the cam disc 63 as it rotates, the pin 61 engages with the recess 64 so that the lever 60 is further rotated anticlockwise by the action of the spring 62 while the lever 56 is attracted by the electromagnet 55. This causes the lever 49 to be rotated anticlockwise against the action of the spring 51 by the abutment of the projection 60a of the lever 60 against the lever 49 because, as previously described, the force of the spring 51 is weaker than that of the spring 62.

The anticlockwise rotation of the lever 49 causes the anticlockwise movement of the mounting pieces 48 secured to the lever 49 to thereby open the switch 45 by disengaging the movable contact 47 from the stationary contact 46, so that the circuit including the electric power source 34, the motor 43 and the air pump 52 is opened to stop the motor 43 and the air pump 52. The time period during which the air pump 52 continues to feed the air to the endoscope is determined by the actuation of the foot switch 44 and the engagement of the pin 61 of the timing lever 60 with the recess 64 of the timing cam disc 63. As previously described, the relative angular position of the recess 64 of the timing cam disc 63 with respect to the position of the pin 61 of the timing lever 60 is preliminarily set at any desired angle.

After the switch 45 is opened to stop the air pump 52 and the motor 43, the foot switch 44 is opened by the operator. Thus, the electromagnet 55 is deenergized to release the lever 56 so that the lever 56 is rotated clockwise by the action of the spring 58 to thereby rotate the timing lever 60 clockwise by virtue of the abutment of the pin 59 against the lever 60 to disengage the pin 61 from the recess 64 of the cam disc 63. At the same time, the clutch 66 is disengaged by the release of the lever 56 so as to free the shaft of the cam disc 63 from the shaft of the reduction gear 65. When the pin 61 is disengaged from the recess 64 of the cam disc 63, the cam disc 63 is rotated clockwise to its initial position set by a stopper means not shown by the action of the spiral spring 67, so as to be ready for the next operation of the air supplying device.

Thus, the desired quantity of air is fed to the endoscope by the air supplying device of the present invention by repeatedly operating the foot switch 44 by the required number of times.

In case excess quantity of air is fed by one complete operation of the air supplying device of the present invention, the air supplying device can be stopped any time during the operation thereof so as to stop the feeding of air to the endoscope by merely opening the foot switch 44 at the moment desired. When the foot switch 44 is opened during the operation of the air supplying device, all the motor 43, the air pump 52 and the electromagnet 55 are simultaneously deenergized and the lever 56 is released to disengage the pin 61 of the timing lever 60 from the recess 64 of the timing cam disc 63 so that the cam disc 63 is returned to the initial position by the action of the spring 67 because the clutch 66 is disengaged by the release of the lever 56 while the switch 45 is held in closed position by the action of the

spring 51. Thus the air supplying device is ready for the next operation.

As described above, the air supplying device shown in FIG. 5 is very simple in construction and can feed any desired quantity of air to the endoscope without the danger of feeding excess air by merely closing the foot switch by the operator's foot without disturbing the operation of the endoscope proper and, at the same time, no assistant operator is required for feeding air to the endoscope.

FIG. 6 shows an alternative embodiment of the air supplying device employing a transistor timer system in place of the mechanical timing system as shown in FIG. 5.

Referring to FIG. 6, the electric power source 34 is connected to the air pump 52 through a switch 68 actuated by means of a relay 69. In order to actuate the relay 69, an electric circuit comprising DC power source 70, a foot switch 44, a relay 71, a switch 72 actuated by the relay 71, a condenser 73 and a resistance 74 and a transistor circuit including transistors 75 and the relay 69 as shown in FIG. 6.

The operation of the air supplying device shown in FIG. 6 is similar to that shown in FIG. 5.

By closing the foot switch 44, the circuit is closed whereby DC current supplied by the DC power source 70 flows therein so that the relay 71 is energized to actuate the switch 72 thereby permitting the condenser 73 to be charged. The transistor circuit 75 is held in conductive state until the condenser 71 is fully charged so that the switch 68 is held in closed state by the action of the relay 69 so that the air pump 52 continues the feeding of air to the endoscope. When the condenser 71 is fully charged the transistor circuit 75 is made non-conductive thereby deenergizing the relay 69 to open the switch 68 so that the air pump 52 is stopped. The foot switch 44 is opened after the completion of the operation so as to be ready for the next operation. The time period during which the air pump 52 is actuated is controlled by adjusting the resistance 74.

When it is desired to stop the feeding of air during the operation of the air supplying device of FIG. 6, it is merely necessary to open the foot switch 44 at any moment desired, the condenser 73 being short-circuited by the deenergization of the relay 71 while the relay 69 is deenergized thereby opening the switch 68 so as to stop the air pump 52. Thus, the device is made ready for the next operation.

What is claimed is:

1. An endoscope having air supplying means to inflate appropriately a hollow portion of a living body, said endoscope comprising in combination, a control housing, and a forward end portion adapted to be inserted into a hollow portion of a living body, said forward end portion being connected by an elongated tube to the control housing, a timed air supplying mechanism, air supplying means disposed from said forward end portion through said elongated tube and control housing and in communication with said air supplying mechanism, a foot switch, a timer and an air pump actuated by closing said foot switch through said timer for feeding air to the air supplying means to which said air pump is connected, said timer being actuated each time said foot switch is closed for actuating said air pump so that said timer operates for a given

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time period set in said timer to stop said air pump at the end of its operation so as to feed a predetermined quantity of air to the said forward end portion thereby permitting the total quantity of air to the endoscope to be determined by the number of times said foot switch is closed while said air pump is stopped any time during the operation of said timer by opening said foot switch thereby preventing the excess air from being fed to the endoscope.

2. The endoscope of claim 1 wherein said timer comprises an electromagnet energized by closing said foot switch, timing lever means actuated by the energization of said electromagnet, normally closed switch means for actuating said air pump when said foot switch is closed, and timing cam means driven by closing said foot switch and cooperable with said timing lever means so as to actuate said timing lever means after a predetermined time period set to said timing cam means so that said normally closed switch means is opened by the actuation of said timing lever means caused by the cooperation with said timing cam means

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to thereby stop said air pump, said timing cam means being returned to its initial position by resilient means connected thereto by opening said foot switch while said lever means are returned to their initial positions by resilient means connected thereto upon deenergization of said electromagnet by opening said foot switch so that said normally closed switch means is returned to its closed position.

3. The endoscope of claim 1, wherein said timer comprises an electric circuit including a first relay means, a condenser and a resistance, a transistor circuit, a second relay means and a DC power source in which said foot switch is connected, said first relay means being actuated by closing said foot switch so as to actuate switch means thereby permitting said condenser to be charged, said transistor circuit being rendered nonconductive when said condenser is fully charged thereby deenergizing said second relay means so that a switch for actuating said air pump is opened by the deenergization of said second relay means.

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