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| [31] | | P 17 66 038.7 |

[56]

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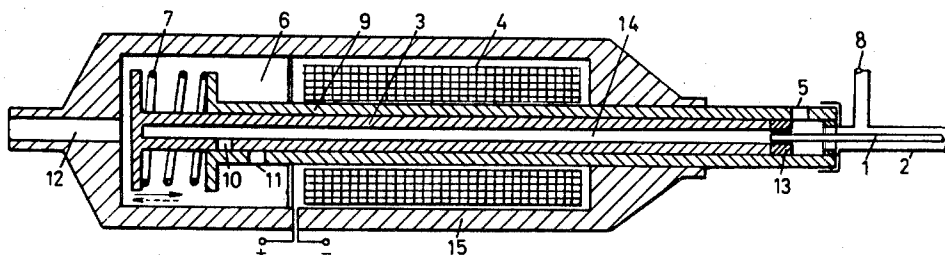
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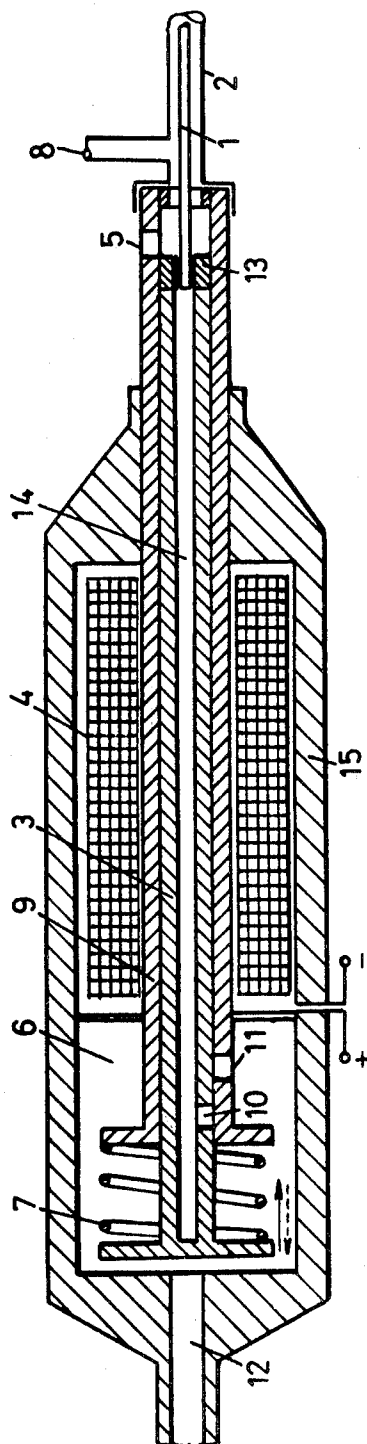
- [54] INSTRUMENT FOR PRODUCING BREATHING ACTION ON THE LUNGS**
2 Claims, 1 Drawing Fig.
- [52] U.S. Cl.**..... **128/145.6,**
137/625.65
- [51] Int. Cl.**..... **A62b 7/02**
- [50] Field of Search**..... 128/145.6,
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ABSTRACT: An externally controlled electromagnetic device for operating a valve mechanism to admit fresh air from an external source under pressure so as to control a supply of fresh air to an inspiration tube insertable into the trachea as far as the zone of the lung. An expiration tube is combined with the said tube to permit escape of used air and also reaches to the lung zone. The instrument, essentially by the control of frequency of valve movement, allows a rate and amount of fresh gas flow suitable for the animal species under observation.



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INSTRUMENT FOR PRODUCING BREATHING ACTION ON THE LUNGS

BACKGROUND OF THE INVENTION

1. Field of the Invention

Breathing machine having gas tubes insertable into the trachea as far as the lungs.

2. Description of the Prior Art

Small research animals which are used in pharmacological and animal experimentation in general have a high respiration rate. For rats and guinea pigs the rate is 100-150 respirations per minute, for mice 136-216, while for the cat it is only about 20-30, as a more or less useful comparison.

There are many difficulties with the hitherto used methods for artificial breathing at the high frequencies.

In conventional respiration pumps employing air takeoff tubes, and the expiration is regulated, there arises an undesirable air retention function of an air resistance which becomes still higher due to moisture of condensation from the exhalation air. Also, as a rule, inside the conventional breath ducts,—besides those which are constructed to operate according to the Pitot principle—the led in fresh air is mixed with a comparatively high amount constituent to the exit of exhalation air in such a way that the "dead space" of the lungs is enlarged. An increase in fresh air constituents is reached by a raising of air intake which leads to an amplified demand or strain on the breathing apparatus and a lengthening of exhalation time.

The invention reduces the shortcomings of the prior instruments.

SUMMARY OF THE INVENTION

the present invention, in the field of art mentioned above, an externally controlled electromagnetic device controls a valve arrangement for the externally supplied inspired or adspired air and the consequent expired air in such a way that the valve arrangement for the inspiration air is connected to a first tube and the valve arrangement for the expiration air is connected to a second tube and these tubes are fastened together as a double tube which is insertable into the trachea or windpipe as far as the region of the lungs.

There are a number of significant advantages in such an instrument. Besides a control means and respectively separated regulation or control of breath frequency and of tidal volume or breath-draw or range, it is of special importance that the double tube primarily end in the vicinity of the lungs. The gas exchange occurs then in direct proximity of the lungs. The inhalation and exhalation air are completely separated so that no stale air is led in.

In the conventional systems the stale expiration air from the trachea and bronchia is led again to the lungs. This dead space is substantially minimized with increased amount of insert depth of the double tube. Therefore the dead space of the trachea becomes reduced, if a higher inspiration reserve volume is provided. That is to say the lungs need not become as widely distended as otherwise, what with the fresh air arriving in the lungs, since the air of a dead space certainly must not be pushed back with it into the lungs.

Due to the absence of a long piping or tubing system and of the dead space of the trachea, the lead-to connection system of the adspired air provides no air storage or surge-tank function. In the case of the system of the prior art, the long connection tubes and the dead space of the trachea produce the condition that the pressure distribution of the breathing air in the zone of the lung as compared with the distribution at the apparatus is humidified and delayed, so that the possible breathing frequency has an upper limit and the tidal volume has a lower limit.

The double tubing is inserted orally, there is then no necessity for a tracheotomy or slit for an air tube. The device enables several test pressure impulses to be produced in the lung in order to ascertain its elastic behavior.

DRAWING

The drawing shows the invention in cross section.

DESCRIPTION OF PREFERRED EMBODIMENTS

The thin tube 1 for the fresh air intake is disposed inside of a somewhat similarly long tube 2 for the air discharge. The diameter of tube 2 is adapted to the tracheal width of the object under study. Both tubes 1 and 2 are substitutable or exchangeable. The outer tube 2 is connected to the forward end of a sleeve 9 rigidly connected on or mounted in a housing 15. The thin tube is connected to a movable magnet core 3 in the sleeve. The core is provided with a longitudinal bore 14 opening at its forward end where at this location it is connected gastight to the tube 1. This connection between the bore 14 and the tube is effected, for example, by a packing washer 13 movable with the magnet core 3 and slidable on the tube 1.

The magnet 3 is moved forwardly upon energizing the coil 4. Upon cessation of the current in the coil, the core moves backward under the influence of the spring 7 in the direction of the dashed arrow. This back and forth movement of the core 3 can be accomplished also by means of two coils or by reversal of a polarity of the supply voltage if the core is of magnetic polarized material.

During forward movement of the core, in the direction of the arrows, the bore 14, and therewith the tube 1, becomes connected to fresh air chamber 6, which, for example, is connected through opening 12 to an air storage flask or tank with pressure regulation. The connection between the chamber 6 and the bore 14 is obtained via a cross bore or port 11 in the sleeve 9 and which bore 11 during a normally more drawn up position of the core registers with port 10. Hereby the lung is fed or supplied.

The backflowing expiration air passes off by the opening 5 in the sleeve 9, which can be so adjusted or proportioned that upon the forward movement of the core 3 the opening 5 is closed. Preferably the control is such that in the first part of the movement of the core 3, the opening 5 becomes closed and the second part of movement the connection between the chamber 6 and the bore 14 is produced by registering of the cross ports 10 and 11. Closing of the port 5 is preferably by the sliding washer 13 which also assumes the sealing function between the core 3 and the tube 1. The induced breath results via the tube 1, then upon the forward movement of the core 3, the fresh air enters into the lungs under pressure. The expiration is accomplished by the rearward movement of the core 3; that is, the air supply from the chamber 6 is interrupted and the conduit system becomes open through the port 5.

The apparatus can be provided with a further connection part 8 on the exhalation tube 2 to which a sensitive pressure meter may be connected in order to measure and/or record instantaneous pressure in the lungs. This is of interest in the study of broncholytic properties of substances and pharmaceuticals in pharmacology. For example it permits a detection of a constriction of the bronchia, if the pressure distribution is measured at the part 8. By a comparison of the pressure distribution in tube 1 with that in tube 2 (at part 8) drawing of exact inferences or conclusions are permitted.

The branch 8 can be used also for drawing off phlegm or mucus. It is also possible to connect the branch 8 to a surge or equalizing tank so that inspiration air pressure peaks can be varied. Such a tank or flask produces a counter pressure and the pressure surges can be smoothed out or attenuated.

Instead of the shown control system with a core moving backward and forward, that is with a reciprocatory movement, a rotary or turnable system can be arranged in the housing 15. The rotary system is preferably composed of a rotary magnet, then upon turning in one direction, first the port 5 is closed. Next, by means of a slit in the sleeve and a slit provided in the core at an equal height on the core 3, registration produces the connection between the chamber 6 and bore 14. Upon the back-turning of the core in the opposite direction, the conduction is closed off so then the bore 14 at the chamber 6 closes,

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after which the bore from the chamber 6 again is cutoff; in the next step the port 5 is again opened.

An essential or intrinsic feature of the invention is the infinitely variable setting of respiration frequency and tidal volume, and these two are independent of each other so that all breathing patterns can be simulated. The respiration frequency is determined by the frequency of the current applied to the electromagnetic system 3, 4 i.e. the core and coil, while the breath quantity or tidal volume is determined by the variable pressure in chamber 6. The source of supply for the breathing air can be a compressed air tank with reducing valve connected to the nipple 12. The operating frequency and the pressure in chamber 6 can be electronically controlled and regulated.

It is of great advantage that by means of control of respiration frequency and/or the tidal volume the CO₂ content of the expiration gas can be held constant. In this situation, this CO₂ content at the outlet 5 can be measured and in dependence on this content the frequency and/or the tidal volume can be regulated, which means a regulation of the oxygen supply to the lungs.

The administered air can be alternated from time to time with definite doses of narcotic gases or broncho-active gas mixtures for pharmacological investigations. Also the supplied air can be moistened. This moistening is to be attempted since during the "pumping" no mixing between the dry inspiration air and the moist expiration air takes place.

The instrument is simple to build and serviceable by more or less ordinary personnel. It is small and handy, easily disas-

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sembled and easy to clean, and operates almost without noise.

The invention claimed is defined in the following:

1. An instrument for producing breathing action of the lungs comprising a cylindrical housing, a movable tubular magnetic core within said housing and having a forwardly open longitudinal bore therein, a sleeve around the core and fast with respect to and within the housing and having a forward end portion projecting from the housing, the sleeve being provided with a first port in said forward end portion coverable by the movable core to permit selective communication between the interior of the sleeve and the ambient and provided with a second port at the opposite end portion and open to the interior of the housing, the magnetic core having a cross port registerable with the second port for selectively permitting a passage of gas from the interior of the housing into the bore of the core, a coil within the housing for moving the core in one direction, means to energize said coil, means for moving the core oppositely from said one direction, inlet means open to the interior of said housing for the connection of a source of pressurized gas thereto, and concentric inhale and exhale tubes at the outer end of the sleeve and in communication with the bore and the interior of the sleeve respectively.

2. An instrument as claimed in claim 1, said core being reciprocatory within the sleeve, the fore of the core having the inhale tube therein and the core being slidable gastight on the inhale tube.

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