

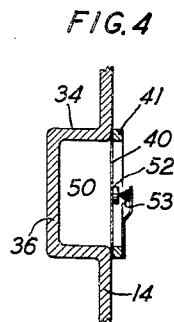
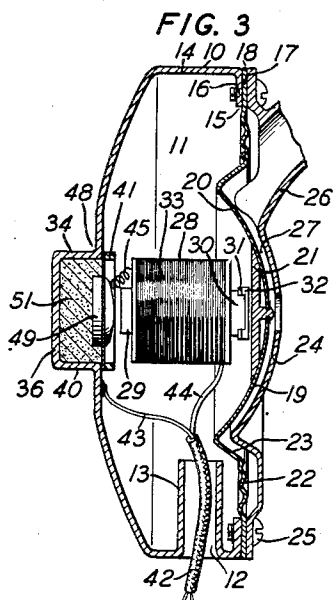
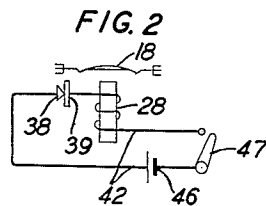
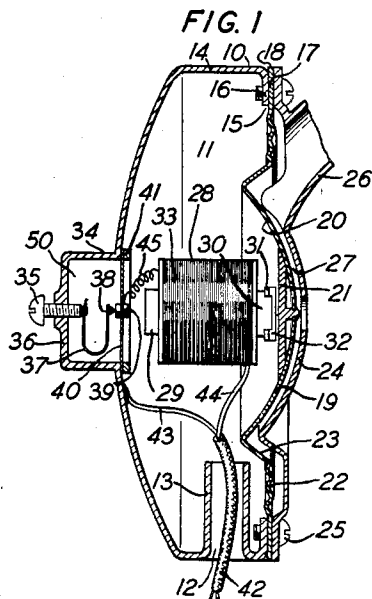
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R. R. RIESZ

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ELECTRICAL ARTIFICIAL LARYNX

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INVENTOR
R. R. RIESZ
BY
Walter C. Kiesel
ATTORNEY

UNITED STATES PATENT OFFICE

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ELECTRICAL ARTIFICIAL LARYNX

Robert R. Riesz, Mount Vernon, N. Y., assignor
to Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

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This invention relates to artificial larynges and, more particularly, to artificial larynges of the electrical type.

An object of this invention is to simplify the structure and to improve the operating characteristics of the artificial larynx of the electrical type.

A feature of this invention comprises coupling the larynx tone generating member or diaphragm and circuit current controlling or regulating means through a fluid.

Another feature comprises regulating the circuit current flow with a microphone, preferably of the granular resistance material type.

Still another feature comprises so coupling the diaphragm and current flow regulating means of the larynx that the impedance offered to current flow is at a maximum when the inductance of the electrical driving means is at a maximum.

A further feature comprises employing an auxiliary diaphragm coupled through a fluid to the main diaphragm or tone generating member, the auxiliary diaphragm being responsive to the movement of the main diaphragm to vary the circuit resistance.

Other and further features will be evident from the general and detailed description that follows hereinafter.

A preferred embodiment of the invention comprises a case or housing having an open end closed by a larynx tone generating member or diaphragm preferably of the piston type, that is, one having a centrally stiffened or rigid portion supported by an associated flexible, annular surround or support. Electromagnetic driving means are mounted within the case and on the rear side of the diaphragm. In one wall of the case, and preferably opposite to the diaphragm closed end, is mounted a circuit resistance controlling or regulating means connected in circuit with the driving means. The regulating means comprises a microphone, preferably of the granular resistance material type, or a make-and-break contact. In either case, it comprises a diaphragm coupled with the tone member through the fluid in the case, which fluid, preferably, is air. The diaphragms are so related, preferably, that the regulating diaphragm is responsive to movement of the tone member or diaphragm to raise the circuit resistance to a maximum when the inductance of the driving means is at a maximum.

A more complete understanding of this invention will be obtained from the detailed description which follows, taken in conjunction with the accompanying drawing, wherein:

Fig. 1 is a cross-sectional view of an electrical artificial larynx embodying the invention;

Fig. 2 shows the electrical circuit of the larynx of Fig. 1;

Fig. 3 is a cross-sectional view of an electrical artificial larynx embodying a modified form of this invention; and

Fig. 4 is a cross-sectional view of another modification of an electrical larynx circuit resistance control or regulating means in accordance with the invention.

The electrical artificial larynx of Fig. 1 comprises a case or housing 10, for instance, of metal, defining a fluid or air chamber 11 connected with the atmosphere outside the case through a tubular passage 12 defined by a reentrant tubular portion 13 of the case wall 14. The provision of such a tubular portion in an artificial larynx is disclosed and claimed in my U. S. Patent No. 2,041,487 issued May 19, 1936. The case has an open end 15 provided with an internally projecting flange 16 constituting a support for the marginal or outer peripheral portion 17 of the larynx tone generating member or diaphragm 18. The diaphragm, preferably of a light-weight, high strength metal, such as aluminum or an aluminum alloy, such as duralumin, comprises a central dome-shaped stiffened portion 19 to the under surface 20 of which an armature 21 is secured; a flexible corrugated annular portion 22; a frusto-conical portion 23 joining the portions 19 and 22; and the peripheral portion 17. The diaphragm closes the open end of the case, and is held in place by a front plate 24 that conforms to the diaphragm shape, and fastening members or screws 25. The plate 24 has a tubular extension 26 leading from the shallow air chamber 27 between the plate and diaphragm and providing a path to a user's mouth for the larynx tone generated when the larynx is in operation. An electromagnetic structure 28 is supported in the chamber 11. It comprises an electro-magnetic core 29 having pole pieces 30 (only one of which is shown); a non-magnetic pole piece spacer plate 31; a compressible pad or member 32; and an energizing winding 33. The case wall 14 is provided with a hollow extension 34. An adjustable member or screw 35 extends through the wall 36 of the extension. The member 35 supports a contact or spring member 37 normally in contact at its extremity 38 with a contact member 39 supported at the central portion of an auxiliary diaphragm or member 40 preferably of an insulating material, such as mica. The member 40 is suitably secured at its periphery to the case wall 14

by a fastening ring or clamping member 41. A schematic of the electrical circuit of the larynx of Fig. 1 is shown by Fig. 2. The cord 42 contains a pair of conductors 43, 44, one of which is connected to one end of the energizing coil and the other of which is secured in electrical contact to the case. The other end of the energizing winding is connected to the contact member 39 by the conductor 45. The energizing current for the larynx is supplied by the battery 46. The switch 47 is for connecting the battery in the larynx circuit when it is desired to generate a larynx tone, and for disconnecting the battery when the larynx tone is no longer wanted. When the switch 47 is closed, thus completing the electrical circuit of the larynx, sustained oscillations will be produced by the larynx.

The artificial larynx of Fig. 3 differs from that of Fig. 1 in that a granular carbon button or microphone 48 replaces the make-and-break contact arrangement. The agitator electrode 49 is supported on the diaphragm 40, the small chamber 50 defined by the case extension 34 being filled with granular carbon 51.

It has been determined that if an electro-mechanical oscillator or tone generator is to produce sustained oscillations, the driving force acting on the vibrating mechanical member should be as nearly as possible in phase with its velocity. If the driving mechanism is electromagnetic and the energizing or driving current is interrupted by a make-and-break contact, as in Fig. 1, this contact should be at open circuit during that portion of the cycle when the inductance of the energizing or driving coil is a maximum. If the current is controlled by a microphone, for instance, of the granular carbon button type, the button should go high in resistance during that portion of the cycle when the inductance of the driving coil is a maximum. Ordinarily, this means that the electrical contact or carbon button and the driving means should be situated on the opposite sides of the vibratory mechanical member. When both of these parts, however, are situated on the same side of the vibrating member, the contact must be caused to open or the resistance of the carbon button to increase, when the vibrating member moves down toward the pole pieces of the electromagnetic structure. While this could be done by a system of mechanical levers or links or by an inverted contact of appropriate design, a phase reversing arrangement that is acoustically coupled to the vibrating member or diaphragm is preferred and has been embodied in the larynxes of Figs. 1 and 3.

For a given diaphragm 18, air chamber 11 and atmosphere-connecting tube 13, the diaphragm 40 and the small air chamber 50 of Fig. 1 should be proportioned so that the diaphragms 18 and 40 vibrate 180° out of phase. A motion of the diaphragm 18 to the right results, therefore, in a motion of diaphragm 40 to the left, and vice versa. Under these conditions, it has been determined that the electrical larynx will generate a sustained larynx tone when the switch 47 is closed. This is true, also, of the larynx of Fig. 3.

A more complete understanding of the invention will be obtained from the following discussion of the factors affecting the proportioning of the elements of the larynx so that the desired phase relation shall exist between the members 18 and 40 when vibrating.

Referring to Fig. 1, the current that energizes the electromagnet is to be interrupted by the separation of the members 38, 39. The dia-

phragms 18 and 40 are coupled by the air chamber 11. Since a motion of diaphragm 40 to the right is required to separate members 38, 39 and current in the driving coil tends to move the diaphragm 18 to the left, the diaphragms must vibrate 180 degrees out of phase for the system to oscillate. Calling the velocity of diaphragm 18, i_1 and that of diaphragm 40, i_2 , i_1 and i_2 must be out of phase for the system to oscillate. I have:

$$i_2 = i_1 \frac{Z_3}{Z_3 + Z_2}$$

where Z_2 is the effective impedance of diaphragm 40; and Z_3 is the mutual acoustic impedance between the two diaphragms. Z_2 , of course, will be slightly modified by the small air chamber 50. For the system to oscillate, the fraction

$$\frac{Z_3}{Z_3 + Z_2}$$

must be negative.

Neglecting the effects of dissipation in the larynx of Fig. 1 and assuming the impedance of diaphragm 40 to be that of a simple series resonant circuit,

$$i_2 = i_1 \frac{X_3}{X_3 + X_2}$$

If f_0 is the frequency of oscillation, and f_3 , the anti-resonant frequency of the mutual impedance, is higher than f_0 , then f_2 , the resonant frequency of diaphragm 40, must be higher than f_0 , in order for the desired phase relationship to hold. At f_0 , also, the inequality

$$|X_2| > |X_3|$$

must be satisfied. This is true, also, of the device of Fig. 3. The value of i_2 can be adjusted to a value within the operating range of the make-and-break contact or the carbon button by adjusting the absolute magnitude of the ratio

$$\frac{X_3}{X_3 + X_2}$$

If the tube 13 is closed and the chamber 11 does not connect with the atmosphere, for

$$\frac{X_3}{X_3 + X_2}$$

to be negative f_2 must be below f_0 . If the make-and-break arrangement of Fig. 4 is used, i_2 and i_1 will have to be in phase for the system to oscillate. This means that the ratio

$$\frac{X_3}{X_3 + X_2}$$

in such a case, must be positive.

If desired, the make-and-break contact arrangement of Fig. 1 may be replaced by that shown in Fig. 4, the contacts 52, 53 being located on the chamber side of the diaphragm 40. With such an arrangement, however, the larynx tone generating member or diaphragm and the diaphragm 40 must vibrate in phase if the system is to maintain sustained oscillations, and the diaphragm 40 must be proportioned so that its vibrations are in phase with those of the diaphragm 18.

The operation of the device of Fig. 1 will now be more fully described with reference to Figs. 1 and 2. When the switch 47 is closed, current will flow from the battery 46, through one conductor 43, to and through the contact members 38, 39, energizing winding or coil 33 of the electromagnet 28, and through the other conductor 44 back to battery. The electromagnet thereby be-

comes energized and the armature 21 and, consequently, the diaphragm 18 are caused to move toward the pole-pieces 30. Since the diaphragms 18, 40 are coupled together by the fluid of the chamber 11 and the chambers 11, 50 and the diaphragms 18, 40 are proportioned to that end, inward movement of the diaphragm 18 produces inward movement of the diaphragm 40. As the inductance of the energizing winding increases to a maximum because of the approach of the armature, the diaphragm 40 is moving inwardly to separate the contact members 38, 39 to interrupt the flow of current by increasing the impedance of the contact to that of an air-gap separating them. This causes a deenergization of the electromagnet and a return of the diaphragms to their original positions, whereupon the cycle is repeated until the switch 47 is opened. The repeated displacements of the diaphragm generate a tone that is led through the tube 26 to the user's mouth cavity, where, by positioning of the lips, teeth and tongue and shaping of the mouth cavity as in natural speech, articulate sounds or speech may be produced. In Fig. 3, the granular carbon variable resistance replaces the contact members 38, 39. The operation is the same except that as the inductance of the electromagnet increases, the movement of the diaphragm 40 increases the effective resistance or impedance of the granular carbon so that it is a maximum when the inductance is a maximum, whereby a minimum of current flows in the electrical circuit of the larynx and the diaphragms return to their original position, but only to have the cycle repeated until the current circuit control switch is opened.

While this invention has been disclosed with reference to several specific embodiments thereof, it is to be understood that it is not restricted thereto, but is to be considered as limited in scope by the appended claims only.

What is claimed is:

1. An artificial larynx comprising a diaphragm, electrical means for actuating said diaphragm, and means for controlling the current flow in said electrical means, said means being acoustically coupled to said diaphragm.

2. An artificial larynx comprising a larynx tone generating member, electrical means for actuating said member, and means for controlling the current flow in said electrical means, said means being acoustically coupled to said member and being movable to increase to a maximum the impedance to current flow when the inductance of the electrical means is at a maximum.

3. An artificial larynx comprising a diaphragm, electrical means including a coil for actuating said diaphragm, and means for controlling current flow in said electrical means, said means being acoustically coupled to said diaphragm so that it offers highest impedance to current flow when the inductance of said coil is a maximum.

4. An artificial larynx comprising a case, a diaphragm in one part of said case, a second diaphragm in another part of said case and air-coupled to the first diaphragm, electrical means for actuating said first diaphragm, current controlling means in circuit with said electrical means and actuated by said second diaphragm, said second diaphragm being movable upon the movement of the first diaphragm to cause the current controlling means to offer its greatest impedance when the inductance of the electrical means is at a maximum.

5. An artificial larynx comprising a larynx tone

generating member, electrical means including a coil for actuating said member, and current controlling means of granular variable resistance material in circuit with said coil for controlling the current flow in said coil when said member is actuated, said controlling means including a member coupled to said first-mentioned member and movable therewith to vary the resistance of the granular material.

6. An artificial larynx comprising a larynx tone generating member, electrical means including a coil for actuating said member, and current controlling means of granular variable resistance material in circuit with said coil, said resistance adapted to be varied by a vibratory member movable upon actuation of the tone member and engaging with the resistance material to cause its resistance to become high upon actuation of the tone member.

7. An artificial larynx comprising a case containing a fluid chamber and having an open end, a diaphragm closing said open end, electrical means including a coil for actuating said diaphragm, and means in circuit with said electrical means for controlling the current flow in said coil, said controlling means including a diaphragm coupled with said first-mentioned diaphragm through the fluid in the fluid chamber and vibratable upon actuation of said first mentioned diaphragm which acts through said fluid to cause the second-mentioned diaphragm to vibrate.

8. An artificial larynx comprising a case containing an air chamber and having an open end, a main diaphragm closing said open end, electrical means for actuating the diaphragm, an auxiliary diaphragm coupled to said diaphragm through the air in said chamber, impedance means in circuit with said electrical means and controlled by said auxiliary diaphragm so that its impedance varies between its extreme values when the diaphragm is actuated, said auxiliary diaphragm being caused to vibrate by vibration of the main diaphragm and to vibrate 180 degrees out of phase with said diaphragm.

9. An artificial larynx comprising a pair of acoustically coupled movable members one of which is adapted to produce the larynx tone, electrical means for actuating the larynx tone member, and means in circuit with said electrical means and comprising a make-and-break contact controlled by the other of said members for controlling the current flow in said electrical means upon movement of said other member for the production of a sustained larynx tone.

10. An artificial larynx comprising a larynx tone generating member, electrical means for actuating said member, said means including variable resistance means, and a member acoustically coupled to said tone generating member for varying the resistance of said resistance means to vary current flow through said electrical means when said tone member is being actuated.

11. An artificial larynx comprising a larynx tone generating diaphragm, electrical means for actuating said diaphragm, a second and smaller diaphragm acoustically coupled to said tone generating diaphragm, and means in circuit with said electrical means for breaking the current circuit upon the actuation of said tone diaphragm, said second diaphragm being movable upon actuation of the generating diaphragm and controlling said current circuit-breaking means.

ROBERT R. RIESZ.