

May 19, 1936.

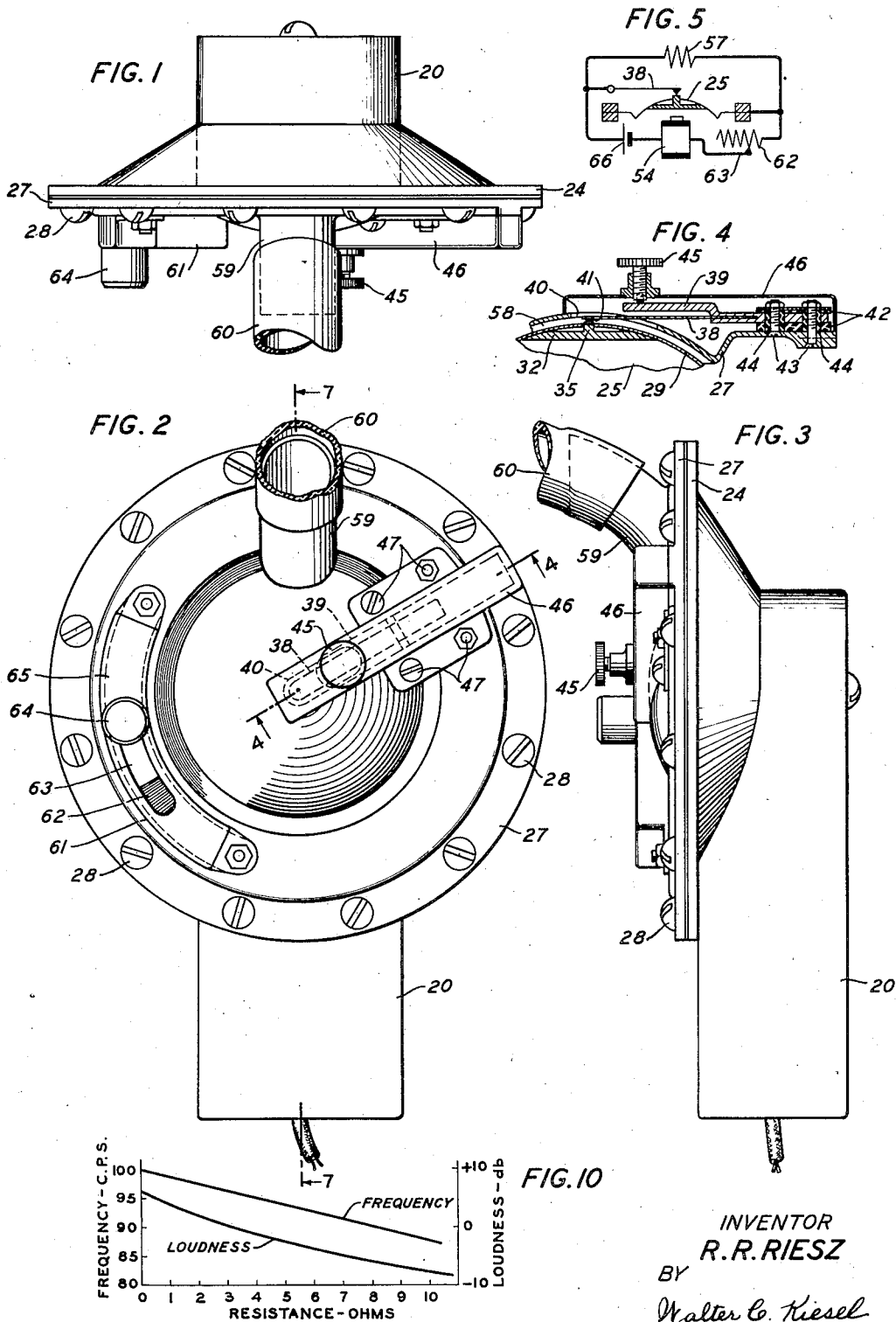
R. R. RIESZ

2,041,487

ARTIFICIAL LARYNX

Filed Jan. 10, 1934

2 Sheets-Sheet 1



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

May 19, 1936.

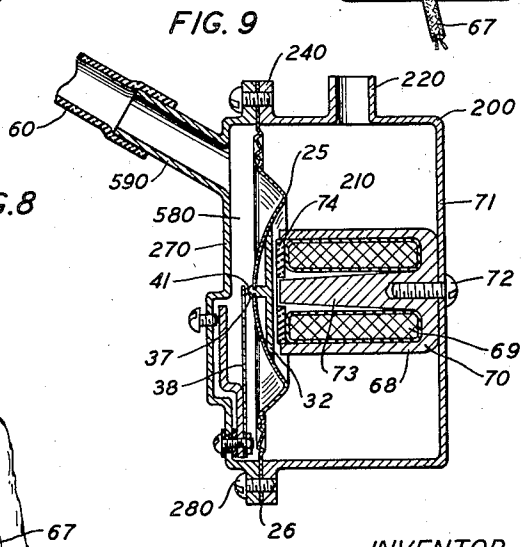
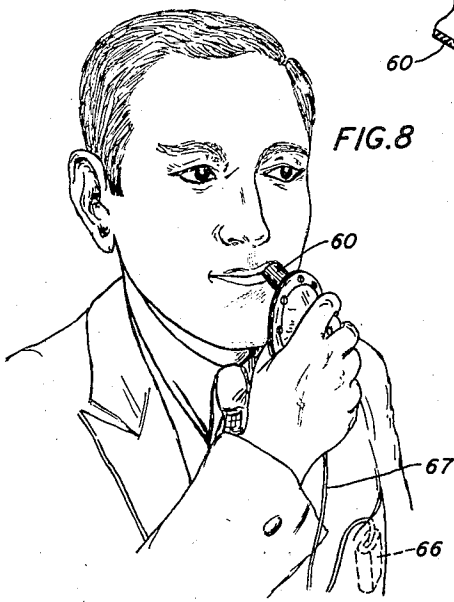
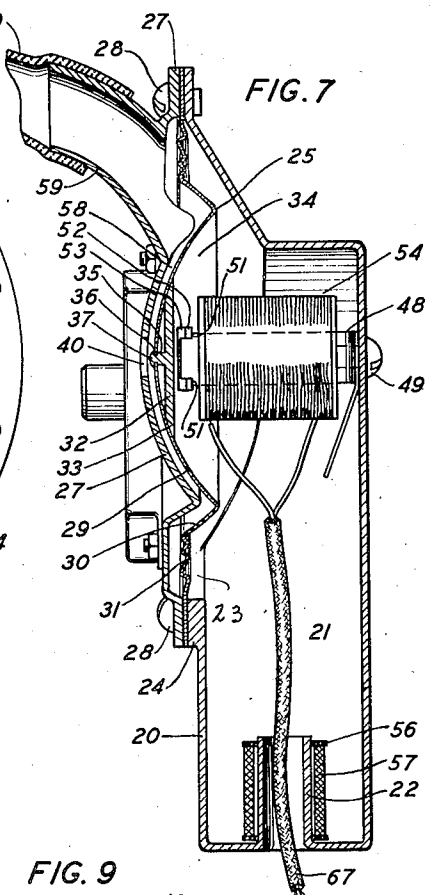
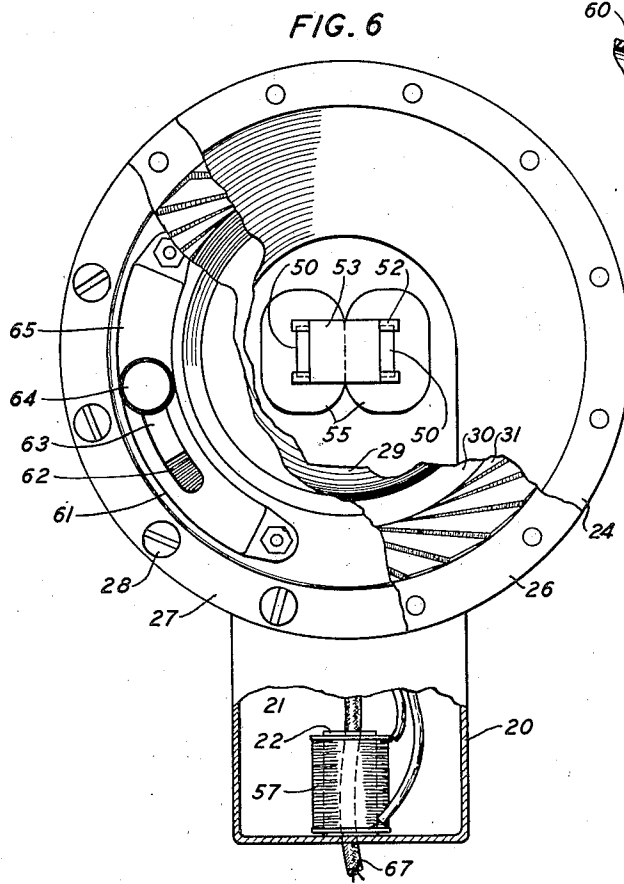
R. R. RIESZ

2,041,487

ARTIFICIAL LARYNX

Filed Jan. 10, 1934

2 Sheets-Sheet 2



INVENTOR
R. R. RIESZ

BY

Walter C. Kiesel
ATTORNEY

UNITED STATES PATENT OFFICE

2,041,487

ARTIFICIAL LARYNX

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

Application January 10, 1934, Serial No. 706,008

8 Claims. (Cl. 3—1)

This invention relates to an artificial larynx.

An object of this invention is to enable a person to produce artificial articulate sounds that, more nearly than heretofore has been possible, simulate articulate sounds produced in the natural manner.

One feature of this invention comprises providing an air chamber on each side of a larynx tone generating member, connecting one chamber with the atmosphere through a restricted passage, and connecting the other chamber with the user's vocal cavities.

A further feature comprises embodying, in an artificial larynx, means for controlling the harmonic content of the larynx tone to be introduced into the mouth of a user of the device.

Another feature of this invention comprises a larynx tone generating member having an outer peripheral portion, a central stiffened portion, and an intermediate flexible portion.

Still another feature of the invention comprises means for limiting the movement of a larynx tone generating member with reference to electrical actuating means therefor.

A further feature comprises associating a resonator with a larynx tone generating member, the resonator being tuned to a desired frequency with reference to the fundamental frequency of the larynx tone generating member.

Another feature comprises a larynx tone generating member of sufficiently large effective area to generate a tone whose low frequency harmonics are sufficiently loud to give naturalness to the artificial voice.

A preferred embodiment of this invention comprises a casing divided into two air chambers of different sizes by a larynx tone generating member or diaphragm having a centrally stiffened portion, an outer, peripheral, clamped portion, and an intermediate flexible portion. The smaller of the chambers has an outlet leading to the mouth of a user of the device. The other chamber contains electromagnetic means for operating upon an armature member secured to the stiffened portion of the diaphragm. The electromagnetic means supports a resilient member which cushions the diaphragm when the latter is vibrating so as to limit its movement with reference to the electromagnetic means. A tubular member extending either into or out of the second and larger air chamber couples the latter to the atmosphere. This tubular member is proportioned as to length and sectional area so that, with the free volume of the large air chamber,

there is provided on one side of the diaphragm a resonator tuned to a desired frequency.

A more complete understanding of this invention will be obtained from the detailed description which follows, read with reference to the appended drawings wherein:

Fig. 1 is a plan view of a device embodying this invention;

Fig. 2 is a front elevational view of the device of Fig. 1;

Fig. 3 is a side elevational view of the device of Fig. 1;

Fig. 4 is a sectional view of a fragment of the same device along the line 4—4 of Fig. 2;

Fig. 5 shows the electrical circuit and connections for the device of Fig. 1;

Fig. 6 is a front elevational view, partly broken away and partly in section, of the device of Fig. 1;

Fig. 7 is a sectional view of the same device along the line 7—7 of Fig. 2;

Fig. 8 illustrates the manner of use of the device of Fig. 1;

Fig. 9 is a sectional elevational view of another device embodying this invention; and

Fig. 10 shows how the pitch of the larynx tone of the device of Fig. 1 and its loudness vary with variations in the resistance of a variable resistance element in the electrical circuit of the device.

The artificial larynx of Figs. 1 to 8 comprises a case or housing 20, for instance, of brass, defining an air chamber 21, having a re-entrant portion or tubular passage defining member 22, and having a laterally disposed aperture 23 bounded by an annular flange or rim portion 24. This chamber and tube constitute a resonator that is tuned to resonate at a frequency preferably between the first and second harmonics of the larynx tone generating member or diaphragm 25. When the member 25 is vibrating, only the low frequency components will be radiated to any extent by the tubular opening provided by the member 22, but since these components are not greatly modified in the mouth in the production of articulate sounds, intelligibility of the speech from the mouth is not reduced. In fact, these low frequency components coming from the back opening to the diaphragm improve the naturalness of the artificial voice. If the chamber 21 were closed off from the atmosphere, a stiffness would be added to the diaphragm which, if the chamber were not made very large, would be comparable to that of the diaphragm itself. Providing the tubular passage between the chamber 21 and the atmosphere, permits this chamber to be made quite small, thereby reducing the size of the in-

strument, and by proper proportioning of the chamber 21 and the tube 22, a positive reactance may be added to the diaphragm instead of the large negative reactance which the closed chamber would provide.

The diaphragm 25 is disposed in the aperture 23, its peripheral portion 26 being secured against the rim 24 by the cap or front member 27 and suitable fastening means, such as screws 28. The diaphragm, which is of sufficiently large effective area to generate a tone whose low frequency harmonics are sufficiently loud to give naturalness to the tone, comprises a central, stiffened, dome-shaped portion 29, an obliquely disposed annulus 30 joined to the periphery of the central portion, and a preferably tangentially corrugated, intermediate flexible portion 31, and is preferably of a lightweight, high strength material, for instance, aluminum or an aluminum alloy, such as duralumin. A disc, plate or armature 32 of magnetic material, preferably circular in shape and of 45% permalloy, is secured along its peripheral or edge portion 33 to the diaphragm on the concave surface 34 of the portion 29, for instance, by cement. A rod or projection 35 extends from one surface of the armature through an aperture in the center of the diaphragm where it may be riveted over, as at 36. A contact point 37, for instance, of platinum, is affixed, as by soldering, to this rod. A reed, spring, or other flexible metallic strip 38 is secured at one end to a relatively massive support or bar member 39. At its other end, it extends through an aperture 40 in the cap member 27 and carries a contact point 41, for instance, of platinum, that contacts with the contact point on the diaphragm. The bar member 39 is secured at one end between strips 42 of insulation, and is secured to but insulated from the cap member by any suitable means, for instance, the screws 43 and insulating bushings 44. At its other and free end, the member 39 is engaged by an adjustable member 45 for varying the equilibrium position of the reed. The member 45 is supported on a housing member 46 enclosing the contact reed structure, and is fastened to the cap member by any suitable means, for instance, the screws 47.

A U-shaped core or pole piece 48 of magnetic material, preferably 45% permalloy, is secured within the chamber 21 and to the case 20, by suitable fastening means, for instance, screw 49, and has its pole faces 50 disposed in spaced relation to the armature 32. Shoulders 51 are cut in each pole face, and an H-shaped metal plate 52 of non-magnetic material is cemented thereto. A strip, pad, or stiffness element 53, rectangular in shape and of a compressible, resilient material, such as rubber, is fastened, for instance, with cement, to the outer surface of the plate 52. The outermost surface of the resilient pad projects above the plane of the pole faces. When the diaphragm vibrates, the armature comes in contact with the resilient pad and compresses it but not to such an extent as to result in freezing of the armature to the pole pieces.

Measurements have shown that for an artificial larynx to simulate the quality of a normal larynx, there must be introduced into the mouth a complex acoustic wave, the amplitudes of whose flux velocity components vary inversely with the square of the frequency. Because of the sharpness of tuning of the larynx tone generating member, the frequency components of the electrical larynx decrease much more rapidly than this. The necessary har-

monics are introduced by the action of the member 53. If it be assumed that when the armature is not in contact with the rubber pad, the vibration of the diaphragm is a simple sine wave, then qualitatively, when the armature comes in contact with the compressible member, the stiffness of the vibrating system is increased and during the portion of the cycle that the armature is in contact with the compressible member, the frequency of the sine wave is higher than when the armature is out of contact. The frequency spectrum of such a wave consists of components that decrease in an oscillating fashion with increase in frequency. The rate of falling off is more rapid and the amplitude of oscillations is smaller as the interval during which the armature and the rubber pads are in contact is longer. The interval of contact is adjusted until a wave of the desired frequency spectrum is obtained.

The energizing winding 54 comprises a coil 55 around each upright portion of the U-shaped core. Within the chamber 21 and supported on a bobbin or spool 56 is a non-inductively wound coil 57 constituting a resistance which, as shown by Fig. 5, is shunted across the contacts 37 and 41 to reduce sparking thereat. The member 27 is of contour similar to that of the diaphragm and forms with the outer or front surface thereof a shallow air chamber 58 of small volume relative to that of chamber 21. This chamber should be as small as possible so as not to shunt out the high frequencies of the complex wave generated by the member 25 and thus prevent them from reaching the larynx tone outlet. The member 27 is provided with a larynx tone outlet or tube 59 to which is connected a tube or conduit 60 for insertion in the mouth of a user of the device, as shown clearly in Fig. 8. The member 27 carries a variable resistor 61 comprising a wound wire resistance element 62, a finger controlled spring contact 63, of the type that returns to its original position when the finger is removed from the button 64, and an elongated frame or housing 65.

Fig. 5 is a diagram of the electrical circuit of the artificial larynx. The battery 66 may be carried, as illustrated by Fig. 8, in the user's jacket breast pocket, being connected in the circuit by conductors comprised by the cord 67. Varying the amount of the resistance 62 in series with the energizing winding of the larynx results in a variation both in loudness and in pitch of the larynx tone, as indicated clearly by the curves of Fig. 10. The zero on the loudness axis is a conversational intensity reference level.

It is apparent that the artificial larynx described above embodies means for controlling the harmonic content of the larynx tone generated and for electrically controlling the loudness and pitch of the larynx tone. The device is efficient, compact, easily operated, and high in quality, approaching in naturalness the tone produced by the natural larynx.

Fig. 9 shows another embodiment of this invention although not in the same detail as the device of Figs. 1 to 8. The casing 200 is substantially cylindrical in shape and defines an air chamber 210 coupled to the atmosphere by the outwardly projecting tubular or passage defining member 220. The function of this air chamber and the tubular passage is the same as that of the chamber 21 and the passage defining tube 22, above described. The open end of the casing is provided with a flange or rim portion 240, against which the peripheral portion 26 of the larynx tone

generating member 25 is secured by the front or cap member 270, and suitable fastening means, such as screws 280. The cap member defines a shallow air chamber 580 with the member 25 and has a larynx tone outlet or tube 590 to which a tube 60 for insertion in the mouth of the user of the larynx is attached. The larynx tone member is actuated by the electromagnet 68 comprising the energizing winding 69, and the pot-shaped magnetic structure 70, for instance, of 45% permalloy, secured to the base 71 of the casing 200 by the screw 72, and having a central pole 73. An annulus 74 of resilient, compressible material, such as rubber, performs the same function as the member 53, above described, and is supported by the electromagnet intermediate it and the armature 32 of the larynx tone generating member 25.

Although this invention has been described with reference to specific embodiments thereof, it is to be understood that variations therefrom may be made without departing from the scope of this invention, which is to be considered as limited by the appended claims only.

What is claimed is:

1. An artificial larynx comprising a larynx tone generating member fastened around its periphery, means on one side of said member forming an air chamber therewith and having a sound wave outlet, a resonator on the other side of said member, said resonator comprising a chamber defining member having a tubular portion for connecting the chamber directly with the atmosphere and means within said resonator for actuating the tone generating member.

2. An artificial larynx comprising a casing, a larynx tone generating member dividing said casing into two chambers, said member being fastened about its entire periphery, means for connecting one of said chambers with a user's mouth, and tubular means connecting the interior of the other chamber with the atmosphere.

3. An artificial larynx comprising a larynx tone generating member, a casing having an aperture entirely closed by said member and defining a resonator on one side of said member, electromagnetic means within said casing for vibrating said member, means defining with the other side of said member an air chamber for connection with the mouth cavities of a user of the larynx, and electrical means for varying the loudness and

the pitch of the larynx tone generated, said electrical means being supported on the front surface of said second-mentioned means.

4. An artificial larynx comprising a casing having an opening therein and a tubular portion connecting the casing interior with the atmosphere when the larynx is in use, a tone generating member closing the casing opening and secured against movement at its periphery, a cover member defining a shallow chamber with the tone member 10 and having an outlet to a user's mouth for the tone generated, and electrical means in said casing for actuating the tone member.

5. An artificial larynx comprising a casing having an opening therein and a reentrant tubular 15 portion connecting the casing interior with the atmosphere when the larynx is in use, a tone generating member closing the casing opening and secured against movement at its periphery, a cover member defining a shallow chamber with 20 the tone member and having an outlet to a user's mouth for the tone generated, and electrical means in said casing for actuating the tone member.

6. An artificial larynx comprising a tone generating member, a resonator on one side of said member and having an opening closed by said member, said member being secured around its periphery to said resonator, means on the other side of said member forming a chamber having 30 an outlet for the larynx tone generated, and means in said resonator for actuating said tone member.

7. An artificial larynx comprising a tone generating member having a central portion movable as a piston, a resonator on one side of said member and having an opening closed by said member, said member being secured around its periphery to said resonator, means on the other side of said member forming a chamber having an outlet for the larynx tone generated, and means 40 in said resonator for actuating said tone member.

8. An artificial larynx comprising a casing divided into acoustically separate hollow portions by a larynx tone generating diaphragm that extends completely across said casing and is secured around and against movement at its periphery to said casing, one of said portions constituting a resonator tuned to be resonant in the lower 50 portion of the audio frequency range.

ROBERT R. RIESZ.