

Jan. 8, 1963

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UNITARY ARTIFICIAL LARYNX

3,072,745

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2 Sheets-Sheet 1

FIG. 1

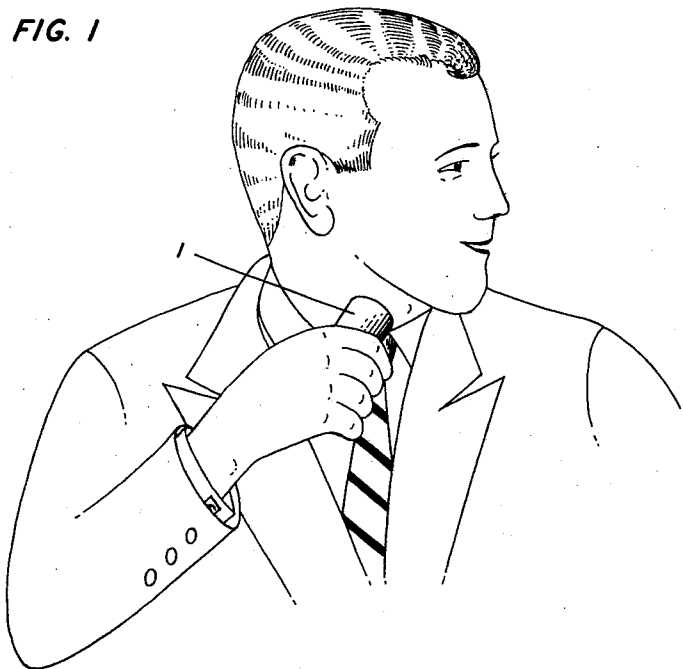
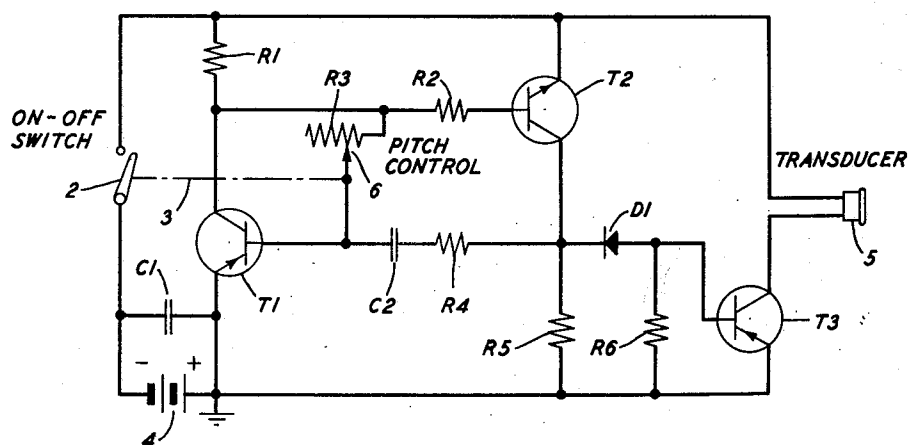


FIG. 2



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FIG. 3

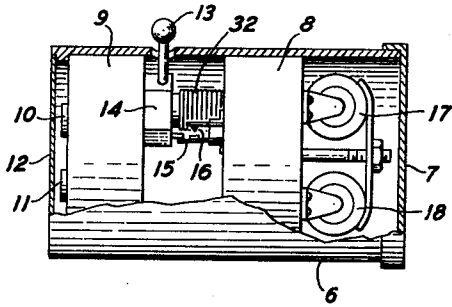


FIG. 4

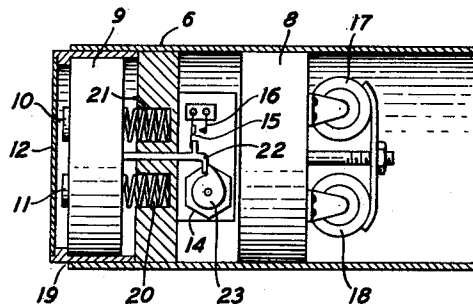


FIG. 5

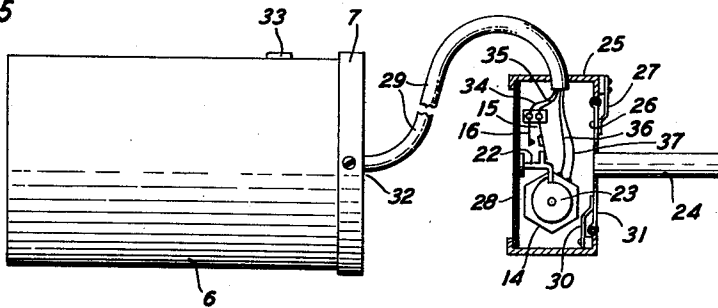


FIG. 6A

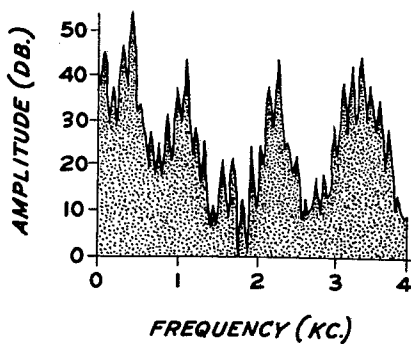
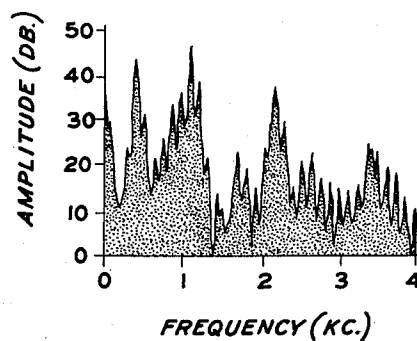


FIG. 6B



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11 Claims. (Cl. 179—1)

This invention deals with devices employed to restore the power of speech to persons deprived of the use of their vocal cords and, more specifically, to artificial larynges.

Persons who have been deprived of the use of their vocal cords, through paralysis or surgery for example, frequently employ mechanical or mechanical-electrical speech aids commonly known as artificial larynges. The basic operating principle of such device is to generate a tone having a fundamental frequency in the speech range and to introduce the tone into one of the resonant speech cavities of the user, such as the mouth or pharynx. To speak, the user modulates the artificially generated tone by varying the shape of the resonant speech cavities comprising the pharynx, mouth, and nose and by making the usual constrictions with the tongue, teeth, and lips.

One well known type of artificial larynx employs a tracheal tube with one end inserted in a surgically made aperture in the user's throat which terminates the user's trachea. The force of exhalation through the tube is applied to a reed which vibrates to produce the required tone. The sound from the vibrating reed is introduced into the mouth or nasal cavity by means of a second tube.

Another such device employs an electroacoustic transducer which is mounted in the mouth of a user by securing it to a denture. Power from batteries is translated into an oscillatory signal which is applied to the transducer by means of a wire entering the user's mouth. Still another type of artificial larynx employs an electro-mechanical vibrator adapted to be secured to or held against the outside of the user's throat so as to introduce a tone into the region of the pharynx.

Each of the devices described is deficient in one or more important aspects. For example, none of the prior art devices includes a satisfactory system for controlling pitch. In particular, one device employs an arrangement designed to control pitch by varying the point of resonance in a mechanically resonant vibrator. The principle, although sound, cannot be applied effectively within the necessary limits of size and complexity. The instrumentation is therefore a compromise, and the resulting changes in pitch lack the distinguishing characteristics of the human voice. Additionally, none of the described devices includes means for generating a basic tone with a spectrum that approximates natural speech and, accordingly, the sounds produced are defective in both quality and intelligibility. Further, the power systems in the prior art are restricted to relatively heavy-duty batteries which must be carried by the user or affixed to his person or clothing. Such arrangements are both awkward and obtrusive, and are therefore embarrassing to the user.

It is therefore one general object of this invention to provide an artificial larynx with improved speech quality and intelligibility.

It is a more specific object of this invention to provide an artificial larynx which duplicates both the energy distribution in the harmonics and the frequency changes which characterize natural speech.

A further object of this invention is to provide an artificial larynx that is both convenient and unobtrusive.

These objects are achieved in accordance with the invention by driving an electroacoustic transducer with the

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output of a pulse circuit which generates a low duty factor pulse train, for example as low as five percent, defining duty factor as the ratio between the duration of a pulse and the time interval between adjacent pulses. Analysis of a pulse train characterized by a relatively low fundamental frequency in the speech range and by a pulse duty factor of the order indicated shows approximately the same distribution of energy in the harmonics that is present in natural speech. Also, in accordance with the invention, the pulse generator includes an arrangement for varying the fundamental frequency of the pulse train in response to certain muscular actions of the user which closely parallel the natural, substantially involuntary muscular actions associated with changes in vocal pitch. The device thereby affords the user with pitch control which closely approximates the pitch control of the natural voice both in degree and in quality.

Further, in accordance with the invention, an electroacoustic transducer, which vibrates mechanically in response to the output of the pulse generator, is arranged to be held by the user against his throat in the region of the pharynx. The mechanical impedance of the transducer is closely matched to the average mechanical impedance offered by the cartilage and flesh of the human throat in the region of the pharynx, which ensures maximum efficiency and minimum drain on the power supply. Since the power requirements for the device are extremely low, miniature batteries are employed and all of the elements of the device, including the batteries, are conveniently and cooperatively arranged in a unitary assembly which the user may easily hold in the palm of his hand.

In a specific embodiment of the invention a transistor relaxation oscillator is employed as a pulse generator. The transducer is a simple and efficient bi-polar electromagnet together with a diaphragm which vibrates when the output of the oscillator is applied to the windings of the electromagnet. Pitch control is achieved by varying a resistance in the oscillator circuit by a rheostat, for example, thereby changing the frequency of the train of output pulses. The means employed to vary the pulse circuit resistance in order to control the pulse frequency is not restricted to a single arrangement but instead, in accordance with the invention, such control may be effected in various ways, each of which is advantageously related, as noted above, to the natural muscular actions which are associated with a vocal pitch change.

More specifically, it is known that raising the pitch of the human voice is accompanied by a substantially involuntary tightening of the throat muscles. Further, any substantial change in pitch is accompanied by a general tightening a number of muscles throughout the body, the muscles of the arm, for example, so that there is a direct and natural correlation between changing the pitch of one's voice and the exertion of muscular force. Conversely, in reducing the pitch of one's voice, there is a natural tendency to relax muscle tension and to exert less muscular force. These basic principles are uniquely turned to account in accordance with one aspect of the invention by employing pitch control apparatus that is responsive to external changes in pressure on the diaphragm of the transducer. Consequently, when the transducer diaphragm is in contact with the throat, small changes in pitch, such as those normally employed to create subtle changes of expression and meaning in the human voice, are obtained in a very natural manner, specifically, by a slight change in the tension of the muscles of the throat which is reflected as a pressure change on the diaphragm. More radical changes in pitch are effected by increasing or reducing the pressure with which the device is held against the user's throat, again, a physical action, specifically muscle tension in the arm, closely

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related to the natural action associated with a relatively large pitch change. As a result, the speech produced by a device employing this principle has a quality of naturalness which has not been approached by devices taught in the prior art.

In accordance with an alternative arrangement for varying pitch, the operation of the pitch control rheostat is made responsive to the force of the user's exhalation. This arrangement is based on the natural correlation between an increase in pitch and an increase in the force of exhalation. This particular form of the invention is suitable for persons who are able to use a tracheal tube inserted into a surgically made aperture in the throat. The force of exhalation is applied through the tracheal tube to a small control box with spring-loaded intake and output valves. Any increase in pressure in the box is suitably translated by means of a diaphragm and a mechanical link into a force for operating the rheostat in the direction of increasing pitch.

The pitch control arrangement employing the tracheal tube is necessarily less compact than the pitch arrangement which is responsive to external pressure on the vibrating diaphragm of the transducer. Nevertheless, an artificial larynx constructed in accordance with this form of the invention is still relatively unobtrusive and convenient. The controlling factor in the selection of one or the other of the pitch control arrangements described is primarily a matter of personal taste on the part of the user.

One feature of the invention, therefore, is the employment of a relatively low duty cycle pulse train to drive the vibrating tone-producing element in an artificial larynx.

Another feature of the invention is an arrangement for controlling the frequency of the fundamental tone produced by an artificial larynx by means of the pressure with which the user holds the device against his throat.

An additional feature of the invention is the combination of a pulse circuit, a power supply, and a transducer to form an artificial larynx comprising a unitary structure.

The invention, together with additional objects and features thereof, will be fully apprehended from a consideration of the following detailed description and accompanying drawings of selected illustrative embodiments, in which:

FIG. 1 is a sketch demonstrating the use of an artificial larynx embodying the features of the invention;

FIG. 2 is a schematic circuit diagram of the relaxation oscillator pulse source;

FIG. 3 is a partial cross-section, cutaway view of one embodiment of the invention;

FIG. 4 is a similar view of a second embodiment;

FIG. 5 is a similar view of a third embodiment; and

FIGS. 6A and 6B are spectrograms, the former showing natural speech and the latter showing speech produced by an artificial larynx embodying the principles of the invention.

The sketch of the artificial larynx user shown in FIG. 1 serves to illustrate the desirable aspects of convenience and personal comfort afforded by a device embodying the features of the invention. In particular, it will be noted that the entire assembly comprises a small cylinder 1 which may easily be held in the palm of one hand. The device has no external wires, tubes or other embarrassing appendages to mark the user as a person requiring an artificial speech aid. Additionally, the absence of tubes or wires in the user's mouth ensures full freedom of the tongue, teeth, and lips to modulate the fundamental tone in the same manner employed to produce natural speech.

For optimum coupling between the vibrating diaphragm and the throat of the user, the device should be held against the throat so that the sound is introduced into the lower part of the pharynx. Generally, the center of the preferred area of contact lies approximately

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two inches below the jaw bone and about one inch to one side of the front of the throat. For a particular user, the exact preferred area of contact may be located easily by determining the point that produces the most natural sounding speech.

A brief consideration of some of the fundamental characteristics of natural speech will contribute to a fuller understanding of the details of the specific embodiments of the invention. It is known that the initial sound source of natural voiced speech, the vocal cords, produces a complex tone with a fundamental frequency in the range of approximately 100 to 200 cycles for the average male voice or in the range of about 200 to 400 cycles for the average female voice. Additionally, the tone is rich in harmonic content. A further distinguishing characteristic of normal speech is that, on the average, the amplitude of each harmonic is approximately inversely proportional to the 1.5 power of the harmonic number. Although the sound spectrum for normal vocal cords varies somewhat with the intensity of the cord tone produced, and also varies to some extent from one individual to another, the 1.5 power law, as stated, is representative of an average condition.

To simulate the spectrum of natural speech, an artificial source producing the same sound spectrum inside the pharynx as described above must be employed. It is known, of course, that a pulse train of infinitely low pulse duty factor has a flat spectrum across the harmonics. Conversely, the spectrum of a pulse train with a relatively high pulse duty factor drops off rather abruptly in the higher harmonics. In accordance with a feature of the invention, a relatively low duty factor pulse source is employed, i.e., approximately five percent, to drive an electroacoustic transducer which is designed with a mechanical impedance that closely matches the mechanical impedance presented by the flesh and cartilage of the human throat in the region of the pharynx. The specific combination of the pulse source and the transducer as characterized above, produces a tone in the pharynx with a spectrum which includes substantially all of the same harmonics present in natural speech and further, the relative amplitude of each harmonic, as in natural speech, is approximately inversely proportional to the 1.5 power of its harmonic number.

Turning now to a specific embodiment of the features of the invention thus far described, FIG. 2 shows a relaxation oscillator comprising transistors T_1 and T_2 , with their associated circuit elements, resistors R_1 , R_2 , R_4 , and R_5 , variable resistor R_3 , and capacitors C_1 and C_2 . Additionally, the circuit includes a transducer 5 and an output transistor T_3 , with associated circuit elements, diode D_1 and resistor R_6 . Power for the circuit is supplied by the battery 4 and the circuit is energized through the switch 2.

Operation of the circuit is initiated by closing the switch 2 which is accomplished, as indicated by the broken line 3, by a slight movement of the rheostat control 6. When the switch 2 is closed, both transistors T_1 and T_2 are placed in a conducting condition since the positive potential of the battery 4 is applied to the emitter of the p-n-p transistor T_1 which serves to bias the base-emitter junction in the forward or conducting direction, while the negative terminal of the battery 4 is connected to the emitter of the n-p-n transistor T_2 to bias its base-emitter junction in the forward direction. With current flowing through transistor T_2 , a voltage drop is established across resistor R_5 . The negative potential at the ungrounded terminal of resistor R_5 acts through resistor R_4 and condenser C_2 to drive the base of transistor T_1 more negative, which holds transistor T_1 fully On. At this point, the collector of transistor T_1 is very nearly at ground potential and as the charge on the capacitor C_2 is dissipated, the base of transistor T_1 also approaches ground potential. The time required for the described change in base potential establishes the duration of the output pulses and is deter-

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mined primarily by the exponential discharge characteristics of the combination comprising capacitor C_2 and resistor R_4 . In the circuit shown, the magnitudes of capacitor C_2 and resistor R_4 may be suitably proportioned so as to produce a specific pulse width such as .05 millisecond, for example. As the voltage on both the base and the collector of transistor T_1 approaches ground potential, T_1 approaches cutoff. Then, as the current flowing into the collector of T_1 is reduced, the voltage across resistor R_1 is also reduced, thereby bringing the base of transistor T_2 toward a more negative potential by means of the connection through resistor R_2 . As the base of transistor T_2 becomes more negative, T_2 becomes less conducting and its collector current is reduced to the point of cutoff, which in turn reduces the voltage drop across resistor R_5 . At this point the charge on capacitor C_2 is such that as the potential of the ungrounded terminal of resistor R_5 becomes less negative a positive surge is transmitted through capacitor C_2 to the base of transistor T_1 , which drives T_1 to a state of full cutoff. Transistor T_1 is held in the Off condition until current flow through R_3 reduces the potential of the base down to the point at which the base-emitter junction of transistor T_1 is again biased in the forward direction and the cycle is repeated. In summary, transistors T_1 and T_2 and their associated circuit elements comprise a relaxation oscillator. Both transistors operate together shifting between conduction and non-conduction at the designed pulse repetition rate.

The purpose of transistor T_3 is to ensure that the full potential of the battery 4 is placed across the transducer 5 in the form of a pulse whenever transistors T_1 and T_2 are in their conducting states. When the collector of transistor T_2 becomes sufficiently negative, the diode D_1 is biased in its forward direction and the base of transistor T_3 goes sufficiently negative to place transistor T_3 in its conducting condition.

An appropriate base frequency and frequency range, 100 cycles to 200 cycles, for example, may readily be provided for by designing the rheostat R_3 with a suitably corresponding range of resistance. With the illustrative magnitudes of pulse width and frequency as stated, i.e., .05 millisecond and 100 cycles respectively, the resulting pulse duty factor is five percent.

The transducer 5, shown schematically in FIG. 2, may be any one of a variety of electroacoustic devices with the limitation that it must be of a type to enable a mechanical impedance match with the flesh and cartilage of the human throat in the area of the pharynx. A simple bi-polar electromagnet and diaphragm is one type of transducer which may be readily designed to meet this requirement.

As noted above, the pulse frequency at which the potential of the battery 4 is placed across the transducer 5 is determined by the setting of the variable resistor or rheostat R_3 . For a male voice, an initial setting to produce a frequency of approximately 100 cycles per second is desirable. The range of resistance offered by the rheostat R_3 should be sufficient to increase the pulse frequency to approximately 200 cycles which corresponds to an octave of pitch change. The average pitch range of the male voice does not usually exceed a single octave in normal speech. For a female voice a base frequency of approximately 200 cycles is desirable, and the resistance range of the rheostat R_3 should be sufficient to raise the base frequency by an additional 200 cycles which corresponds to an octave of pitch change above the 200 cycle tone.

Volume control is not provided for in the relaxation oscillator shown in FIG. 2 for the reason that many users of artificial larynges consider it an unnecessary feature. Should an arrangement for controlling volume be desired, however, it will be apparent to persons skilled in the art that the device may be readily modified to include such a feature, for example, by replacing resistor R_6 with a rheostat.

Turning now to a detailed consideration of the embodiment of the invention illustrated by FIG. 3, a cross sec-

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tion view of an artificial larynx employing the relaxation oscillator of FIG. 2 is shown. The entire device is housed in a cylindrical casing 6 with a base member 7. The pulse circuit of FIG. 2 is mounted in a protective casing 8. The transducer 9 is a bi-polar electromagnet with pole pieces 10 and 11 and a diaphragm 12. The rheostat 14 is controlled by the pitch knob 13. Moving the pitch knob 13 in a clockwise direction, or into the plane of the drawing, releases the lower switch contact 15 so that it closes with the upper contact 16. These contacts are the contacts of the On-Off switch 2 shown in FIG. 2. As the device is held in the hand of the user, the pitch control knob 13 may be controlled conveniently by thumb pressure. The rheostat 14 is spring loaded by the spring 32 so that when the pitch knob 13 is released, the pitch control rheostat 14 is automatically returned to its initial position. The lower part of the assembly includes a pair of batteries 17 and 18. Since the power requirements of the device are very low, these batteries may be of the miniature mercury-cell type.

FIG. 4 shows a second specific embodiment of the invention which employs the feature of a rheostat 14 which is responsive to external pressure on the diaphragm of the transducer. As in the embodiment shown in FIG. 3, the device in FIG. 4 includes a cylindrical casing 6, batteries 17 and 18, and a transducer 9 with pole pieces 10 and 11 and a diaphragm 12. A pulse circuit is enclosed within the protective casing 8. The pitch control arrangement comprises the cylindrical housing 19 which telescopes into the exterior housing 6 against the spring pressure of the springs 20 and 21 when axial force is applied to the diaphragm 12 or to the rim of the cylindrical casing 19. Axial movement of the casing 19 is translated by the mechanical link 22 into rotary movement of the cam 23 which in turn controls the rheostat 14. The design of the springs 20 and 21 and the degree of friction between the casing 19 and the casing 6 are such that a very slight pressure on the diaphragm 12 or on the edge of the casing 19 is sufficient to change the position of the rheostat which in turn controls the pitch of the oscillator. Additionally, the transducer is so designed that the ratio between the mass of the pole pieces and the mass of the diaphragm is sufficient to ensure movement of the diaphragm alone in response to a magnetic force in the air gap. Movement of the mechanical link 22 also serves to release the switch contact 15 so that it closes with switch contact 16, thereby closing the power circuit of the oscillator.

FIG. 5 shows still another embodiment of the invention which employs the feature of controlling the pitch through the force of the user's exhalation. The devices shown in FIGS. 3 and 4 may be employed irrespective of whether the user has a surgically made tracheal aperture. The device shown in FIG. 5, however, does require that the user have such an aperture. The apparatus of the device in FIG. 5 includes the tracheal tube 24 and a control box 25 with an outlet valve 26 loaded by a spring 27, an intake valve 31 loaded by a spring 30, and a diaphragm 28. With the tracheal tube 24 in position in the tracheal aperture of the user, inhalation by the user opens intake valve 31 against the pressure of the spring 30. With exhalation, the intake valve 31 closes and pressure in the control box 25 builds up against the pressure of the spring 27 on the outlet valve 26. Relatively slight increases in pressure in the control box 25 are insufficient to open the outlet valve 26 and instead work against the sensitive diaphragm member 28. Movements of the diaphragm are translated into a force which controls the rheostat 14 through the mechanical link 22 and the cam 23. As in the embodiment shown in FIG. 4, the first movement of the pitch control linkage 22 closes the starting switch contacts 15 and 16.

The conducting lead pairs 34, 35 and 36, 37 couple the contacts of the starting switch and the rheostat, respectively, into the pulse circuit. Outside of the control box

25 the leads 34, 35, 36, and 37 are conveniently formed into a single cable 29 which enters the casing member 6 through a suitable aperture 32 in the base member 7. In order that the device may be placed in the On condition by the force of the user's exhalation only when a speech tone is desired, an additional On-Off switch is provided which is in series with the switch represented by the switch contacts 15 and 16 and which is operable by the switch button 33 shown protruding from the casing 6.

The physical size of the control box 25 may be quite small, one inch across, for example, and its thickness need not exceed one-half inch. Accordingly, both the tracheal tube 24 and the control box 25 may readily be concealed by the clothing of the user. The outward physical appearance of the device of FIG. 5 thus differs from the embodiment shown in FIG. 4 only by the presence of the small cable 29 and the switch button 33.

As noted in the introduction, there is a natural correlation between the force of exhalation and the pitch of the human voice. As a result, with very little experience, a user of the device shown in FIG. 5 is able to change pitch with substantially the same degree of accuracy as a normal speaker.

In each of the embodiments shown, control of the pulse frequency of the oscillator, or pitch control, is achieved by the use of a rheostat. This device, however, is intended as merely illustrative of one of a number of possible means for controlling the pitch in accordance with the invention. Alternatively, a circuit employing a piezoresistive device may be used so that the force for controlling pitch may be translated directly into a corresponding change in resistance in the pulse generating circuit. Suitable arrangements of this type are well known in the art as shown, for example, by F. P. Burns in Patent No. 2,866,014, issued December 23, 1958.

Although the driving source employed to illustrate the principles of the invention is a relaxation oscillator, it will be apparent to persons skilled in the art that a variety of pulse circuits, a multivibrator for example, may be employed with equal effectiveness within the scope of the invention.

Useful analyses of sounds may be made by so-called visible speech techniques. These techniques include the use of apparatus which presents a visual display or spectrogram of speech showing the distribution of energy or amplitude at the frequencies within the speech range. Spectrograms are particularly useful for the purpose of analyzing the quality or characteristics of speech and for comparing one speech sound with another. FIG. 6A is a spectrogram of the vowel sound "oo" (as in "book") as spoken by a normal talker. The individual spikes in the spectra are the fundamental and the harmonics of the sound, and the regions in which the cavity resonances of the vocal tract result in groups of harmonics being enhanced in amplitude are called "formants." The shape of the formants and the particular positions of each along the frequency scale comprise the distinguishing characteristics of the various voiced sounds. To produce natural sounding speech artificially, the apparatus employed must be capable of matching the formant patterns of normal speech sounds.

FIG. 6B is a spectrogram of the vowel sound "oo" as spoken by a talker using an artificial larynx embodying the features of the invention. It will be noted that the formant patterns are substantially identical to those shown in the spectrogram of FIG. 6A. Audible comparison of the two sounds demonstrates an equally close correspondence.

It is to be understood that the above-described arrangements are illustrative of the principles of this invention. Numerous other arrangements may be designed by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. An artificial larynx for the aid of a user with a

tracheal opening in the throat comprising, in combination, means for generating a train of pulses with a relatively low duty cycle at a frequency substantially equal to the average fundamental frequency of the human voice, means responsive to said pulse train for externally vibrating a portion of said user's throat, thereby to introduce a tone into the pharynx of said user, means responsive to the force of the user's exhalation for varying the pitch of said tone, and means connecting the tracheal opening of said user to said pitch varying means thereby to apply the force of the user's exhalation to said last named means.

2. Apparatus in accordance with claim 1 wherein said pulse generating means comprising a transistor relaxation oscillator circuit.

3. Apparatus in accordance with claim 2 wherein said pitch varying means comprises means for varying the impedance in a portion of said oscillator circuit and means responsive to changes in air pressure for controlling said impedance varying means.

4. An artificial larynx comprising, in combination, a pulse circuit for producing a train of pulses in the frequency range of approximately 100 to 200 pulses per second, with a pulse duty factor of approximately five percent, an electroacoustic transducer responsive to said pulses for introducing a tone into the pharynx of the user, the mechanical impedance of said transducer being substantially equal to the average mechanical impedance of the human throat in the region of the pharynx, means for supplying power to said pulse circuit, a unitary casing member for housing said larynx, said transducer being slidably mounted in and protruding slightly from said casing, spring means opposing axial movement of said transducer in said casing, and means responsive to axial movement of said transducer in said casing for varying the frequency of said pulse train, whereby the pitch of said tone may be varied by varying the pressure with which the device is held against the throat of the user.

5. An artificial larynx for a user with a surgically made tracheal opening comprising, in combination, a pulse circuit for producing a train of pulses with a relatively low pulse duty factor at a fundamental frequency of approximately 100 to 200 pulses per second, an electroacoustic transducer responsive to said pulse train for introducing into the pharynx of the user a tone comprising said fundamental frequency and a plurality of harmonic frequencies with the relative distribution of energy in each of said harmonic frequencies being substantially proportional, inversely, to the 1.5 power of the number of said harmonic frequency, the mechanical impedance of said transducer being substantially equal to the average mechanical impedance of the human throat in the region of the pharynx, means for supplying power to said pulse producing means, means responsive to relatively slight changes in air pressure for varying the frequency of said pulse train, means encasing said pulse circuit, said transducer, said power means, and said frequency varying means in a unitary assembly, and means for applying the pressure of exhalation from said tracheal opening to said frequency varying means, thereby enabling said user to control the pitch of said tone by the force of his exhalation.

6. An artificial larynx comprising, in combination, means for generating pulses with a relatively low duty cycle at a frequency substantially equal to the average fundamental frequency of the human voice, means supplying power for the operation of said pulse generating means, means responsive to said pulse generating means for externally vibrating a portion of the user's throat, thereby introducing into the pharynx of said user a tone characterized by the average fundamental frequency of the human voice and characterized further by harmonics corresponding to the harmonics of natural speech in both amplitude and distribution, and pressure responsive means for varying the pitch of said tone.

7. Apparatus in accordance with claim 6 including

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means encasing said artificial larynx in a unitary structure.

8. Apparatus in accordance with claim 6 including means encasing all of the elements of said larynx except said pressure responsive means in a unitary structure.

9. Apparatus in accordance with claim 6 wherein said pulse generating means includes a relaxation oscillator circuit comprising at least one transistor.

10. Apparatus in accordance with claim 9 including means responsive to externally applied pressure on said vibrating means for actuating said pitch varying means, whereby the pitch of said tone may be controlled by the pressure between said vibrating means and said portion of said user's throat.

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11. Apparatus in accordance with claim 10 wherein said pitch varying means comprises a rheostat in said oscillator circuit and wherein said actuating means comprises a mechanical linkage between said vibrating means and said rheostat.

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