

**Nov. 27, 1962**

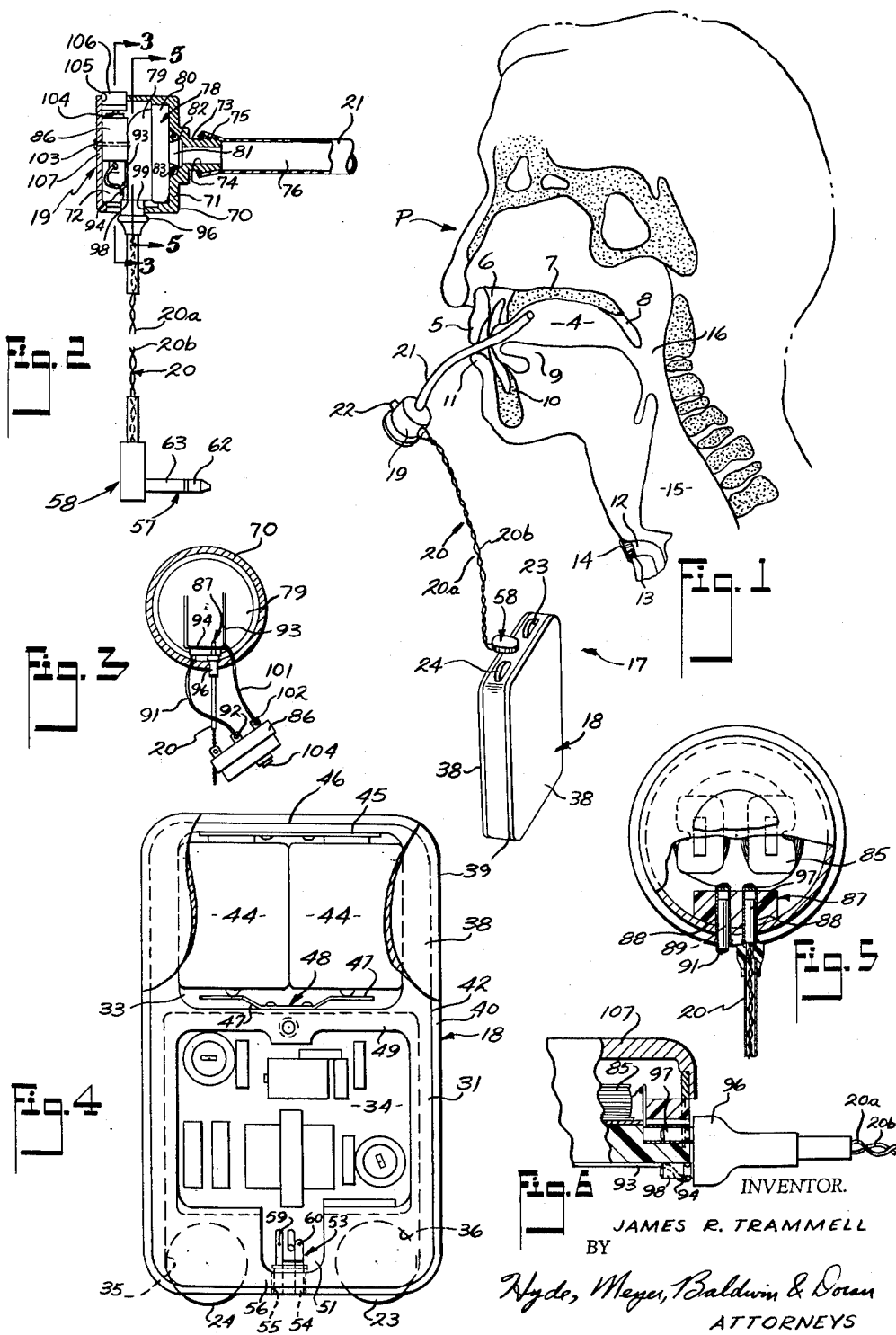
J. R. TRAMMELL

**3,066,186**

ELECTRONIC VOICE BOX

Filed April 2, 1958

3 Sheets-Sheet 1



**Nov. 27, 1962**

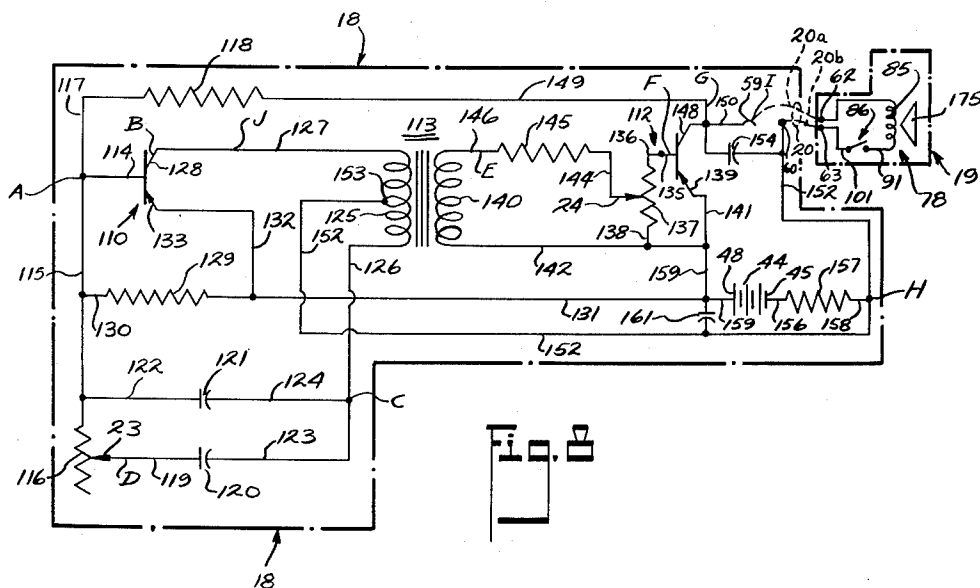
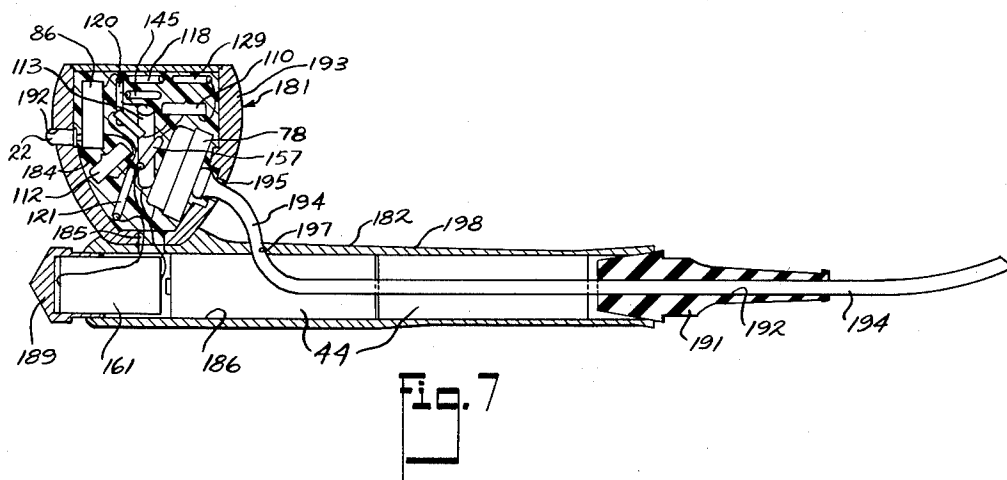
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3 Sheets-Sheet 2



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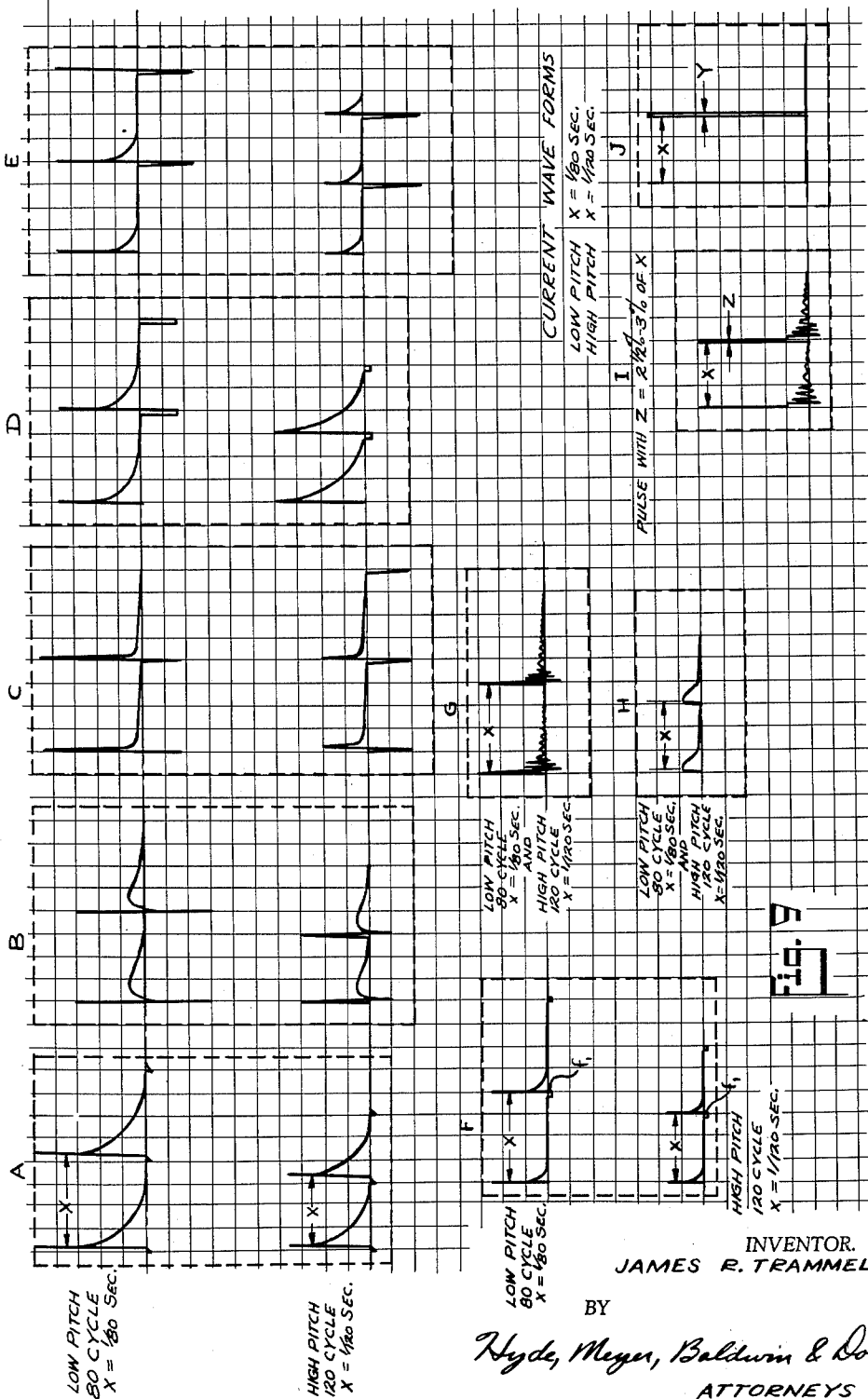
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3 Sheets-Sheet 3

## VOLTAGE WAVE FORMS



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3,066,186

## ELECTRONIC VOICE BOX

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10 Claims. (Cl. 179-1)

This invention relates to artificial larynxes and more particularly to an electronic larynx capable of developing a complex acoustical wave which in turn functions to provide a tone substantially resembling the tone which is normally produced by the natural larynx in the throat of a human being.

In some cases of throat infection, for instance where a malignant laryngeal tumor is discovered, more frequently occurring in the male sex, it becomes necessary to perform a laryngectomy which consists primarily in removing the larynx or "voice box," as oftentimes referred to, and terminating the trachea or windpipe in an outside orifice at the base of the front portion of the neck. In operations of this kind, the patient invariably loses the power of normal articulation or speech because by the removal of the larynx, it is impossible for the person to produce a tone in the throat which may then be modulated in the mouth or nasal cavities into articulate speech.

So great is the patient's fear of forever losing his power of speech when he considers the consequences of having his larynx removed that the attending physician takes great pains to assure him that he may learn to speak again by a method known as "esophageal speech." This method basically consists of literally belching air through the esophagus and pharynx wherein the latter if constricted in a particular manner vibrate the air much like it is normally vibrated with vocal folds of a normal voice box to produce an audible tone. Said tone then enters into the mouth wherein the patient attempts to develop articulate speech in the normal manner. However, this method of speech development is very difficult to master, since it must be substantially independent of the respiratory function. For instance, the patient must learn to hold the air in his lungs so as to retain the pressure on the esophagus so that he will be able to belch out the air within the latter by distinct expiratory movements. Also if exhalation through the trachea does occur during this period it is oftentimes so noisy that any esophageal sound created is drowned out. Other similarly difficult obstacles, some physical, others psychological, not disclosed herein, are well known to the instructor of esophageal speech.

It has been found that of the total number of laryngectomized persons approximately one-third are capable of overcoming the attendant physical and psychological barriers to master esophageal speech to a point where they can develop somewhat of a normal speaking voice; another one-third are able to be barely understood, and still another one-third are not able to develop any intelligible speech at all by this method. It is not uncommon for some persons to study and practice for a year or more before they are able to utter intelligible sounds, and also this method of speech habilitation cannot commence until a time period of approximately one month has elapsed after removal of the larynx.

Consequently for laryngectomized persons in the past, artificial tone producing instruments known as artificial larynxes have been developed, the prosthesis of which to the human body attempted to function as the natural

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larynx. Said instruments may be categorized into two general classifications, namely, a mechanical type and an electro-mechanical type of artificial larynx. In the mechanical type a vibratory element such as a reed is set into vibration by the exhalation of air through the trachea connection at the front portion of the neck, which air is transmitted to the reed by a suitable tube or the like connected to the latter to effect a tone being produced which is then projected into the mouth of the user and modulated to produce articulate speech. The most obvious disadvantage to the use of artificial larynxes of this type is that the device must be attached to the user, namely, directly to the trachea orifice in the neck which means that said larynx device is oftentimes uncomfortable, conspicuous in use and also readily denotes to others the affliction of the user. Another distinct disadvantage of the mechanical type of artificial larynx relates to the fact that the vibrating reed is actuated by the user exhaling air directly through the trachea connection to the vibrating reed container which means that he must first supply a stream of air sufficient to mechanically vibrate said reed before the tone produced thereby is able to be used to develop articulate speech.

Other disadvantages of this type of artificial larynx are well known to both the physician and laryngectomized person which accounts for its not being in widespread use.

In the electro-mechanical artificial larynxes heretofore developed, an electrical source of energy is used to excite a magnetic speaker or the like, which source is then interrupted by a mechanical vibrating switch or the like to create an acoustical wave, which when projected into the mouth cavity of the user attempts to develop a tone somewhat characteristic of the tone normally produced in a human larynx.

A distinct disadvantage of this type of artificial larynx is that the mechanical vibrating means for the same are located externally of the person of the user, and consequently develop a substantial amount of noise.

Another pronounced disadvantage is that this type of artificial larynx is normally applied to the outside or skin of the neck of the user since it depends upon actually vibrating the internal body tissues associated therewith for its operation, and oftentimes when a person's larynx or voice box is removed scar tissue forms which does not respond adequately to said vibrating means to create intelligible speech. Still another disadvantage of this type of larynx is that the pitch of the acoustical wave created thereby is substantially of one fixed frequency, and hence may not be readily adaptable to various persons each of which may have a different pitch characteristic in their normal voice.

Another disadvantage in the use of this type of artificial larynx is that the tone generating device utilized therewith is normally placed against the outside of the neck below the lower jaw and by pressing lightly the same tone developed therein is transmitted through the adjacent body tissues to the esophagus and mouth cavity. It is required that the pressure applied thereto be substantially constant in order for said device to function properly, for in effect, by pressing against the body tissues, the latter present a mechanical load to the vibratory elements of the device, and if said load is varied, the aforesaid elements will not be able to vibrate in the intended manner, certainly not so as to produce an audible tone resembling the tone produced in the natural larynx; oftentimes said elements cease to operate entirely.

Other disadvantages to the use of this type of artificial larynx, not disclosed herein, are well known to the physician and speech therapists which readily account for its not being acceptable by the laryngectomized person.

Therefore, a primary object of the present invention is the provision of an electronic artificial larynx or voice box which is capable of developing an audible tone having a complex acoustical wave form closely resembling the acoustical wave form characteristic of the audible tone normally produced by the natural larynx of a human wherein the prosthesis of said artificially developed audible tone into the speech mechanisms of the body is then effective to produce articulate speech substantially similar to the natural speaking voice of the user.

Another object of the present invention is the provision of an electronic larynx or voice box as referred to in the last paragraph and further characterized by being a completely self-powered unit which does not require insertion into the trachea orifice or other similar body orifices of the laryngectomized person, and may be utilized by said person immediately after a laryngectomy is performed.

Still another object of the present invention is the provision of an electronic larynx as above referred to and which does not interfere with the normal articulation of the speech forming mechanisms of the body such as the tongue and lips.

Another object of the present invention is the provision of a novel and improved electronic larynx or voice box as referred to above, and which is operative to generate an electrical signal having separate and distinct pulses of energy recurring at a preselected rate corresponding to the fundamental frequency of an average male human voice, and wherein said energy pulses are of a predetermined configuration and contains a plurality of harmonic frequencies of said fundamental frequency, which in turn, are capable of generating a complex acoustical wave form closely resembling the wave form normally produced by the natural larynx of a human.

Another object of the present invention is the provision of an electronic larynx or voice box capable of producing an audible tone having a complex acoustical wave form closely resembling the acoustical wave form characteristic of the audible tone normally developed by the natural larynx, and wherein the pitch and/or volume of the artificially developed audible tone may be selectively adjustable such that the same is readily adaptable to various persons, each of which had particular pitch and volume characteristics in their normal speaking voice.

Yet another object of the present invention is the provision of an electric larynx or voice box as referred to in the above paragraphs and which, in addition, does not have any mechanical vibrating elements which may develop audible noise to interfere with and diminish the quality of the complex acoustical wave form developed therein.

Another object of the present invention is the provision of an electronic larynx or voice box which is very compact, light-weight and readily inconspicuously carried by the user.

Still another object of the present invention is the provision of a self powered electronic larynx or voice box which is readily adaptable to placement within various recreational devices or the like normally used by a human such as a device simulating a smoking pipe whereby the use thereof is substantially imperceptible and more readily applicable to the natural habits or characteristics of a human being.

Another object of the present invention is the provision of a self-powered compact electronic artificial larynx or voice box having elements which require very minute quantities of electrical energy whereby an electrical source such as a very small battery is capable of providing sufficient energy to operate the same over an extended period of time.

Additional objects and advantages of the present invention will be realized by those skilled in the art upon reference to the following disclosure of several preferred embodiments and as illustrated in the accompanying drawings forming a part of this specification and wherein:

FIG. 1 is a view of the head of a human male subsequent to a laryngectomy being performed on said person and showing the internal facial structure of the speech forming apparatus remaining with said person and the manner in which the same is operative with one embodiment of artificial larynx of the present invention;

FIG. 2 is an elevational view, shown partly in section of the tone generator device in the artificial larynx of FIG. 1;

FIG. 3 is a sectional view taken substantially on line 3—3 of FIG. 2;

FIG. 4 is a plan view enlarged of signal generator of the artificial larynx of FIG. 1 with the top cover partially broken away to show the internal construction and placement of the electronic elements thereof;

FIG. 5 is an elevational view enlarged of the tone generator device with a part of the external casing broken away to reveal otherwise hidden details of construction for the connecting socket for the same;

FIG. 6 is an enlarged fragmentary view, shown partly in section, of the socket construction shown in FIG. 5;

FIG. 7 is a longitudinal sectional view of another embodiment of artificial larynx of the present invention with the same adapted for use with a smoking pipe;

FIG. 8 is an electrical schematic wiring diagram of the electronic circuitry embodied in the artificial larynx of the present invention; and,

FIG. 9 is a graphic illustration of voltage and current wave forms taken at various points in the electronic circuitry of the artificial larynx of the present invention to clearly show the characteristics of its operation.

Briefly, the electronic larynx of the present invention comprises two distinct components, the first being a signal generator which electronically generates electrical signals or pulses of energy representative of the plurality of frequencies contained within the complex acoustical wave of the audible tone normally developed by the natural larynx, and the second, a tone generator which is connected in electrical circuit to the signal generator and responsive to the same to transform said electrical signals into an audible tone closely resembling the tone developed in the human larynx and including means to transmit said audible tone into the speech forming mechanism in the mouth of the laryngectomized person. As will be hereinafter apparent, the instant form of larynx is a completely self-contained battery powered electronic device which may be adjustably controlled to change the pitch and/or volume of the generated audible tone so that it may be adaptable to the speech characteristic of various types of individuals; and in addition, is substantially compact and of such size as not to interfere with the normal articulation of the user's speech forming mechanism. In addition, the novel circuitry contained within the electronic larynx of the present invention requires very minute quantities of electrical energy utilizing thereby small energy sources such as miniature batteries and hence is capable of operating over extended periods of time. Although not intended as a structural limitation in any sense of the word, the size of one embodiment of electronic larynx of the present invention as is shown in FIGS. 1-4 may be compared to that of a small hearing aid device in present use, and as is mentioned previously, may also be readily adaptable to various other kinds of devices such as a smoking pipe or the like as is shown in FIG. 5 so that it may be used in a readily inconspicuous and in a more natural manner and hence with substantially little chance of detection.

Referring now to the drawings wherein like elements are designated by the same reference character, one embodiment of electronic larynx of the present invention is

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shown in FIGS. 1-4 inclusive, and particularly in FIG. 1 in the manner in which a laryngectomized person would put it to actual use. Referring momentarily to FIG. 1, there is illustrated the head of a male human in profile as indicated by the reference P representing a laryngectomized person whose natural larynx or voice box has been removed, and with the trachea or windpipe as indicated at 12, brought out to and terminated in an orifice as indicated at 13 in the front side of the neck. A suitable filtering device as indicated at 14 may be inserted into said neck orifice to thereby prevent the inhalation of any extraneous foreign material into the lungs of the individual. In this manner, the laryngectomized person is able to perform the usual respiratory functions, that is, the inhalation and exhalation of air for the lungs through the trachea without the same first entering into the mouth cavity 4.

The laryngectomized person, in attempting to develop esophageal speech must force air upward through the esophagus and pharynx, as indicated at 15 and 16, respectively, and by one of several methods of muscular control of the same well known to the speech therapist, an audible tone is generated which is then directed into the mouth cavity 4 wherein through normal articulation of the above mentioned speech forming mechanism, said tone is transposed into intelligible speech.

However, as is previously mentioned only a minority of laryngectomies are able to master this method and then only after a prolonged period of constant practice.

Therefore, to restore the power of speech to those persons who are unable to speak by this latter method, and also to assist the above defined minority group while they are mastering said method, the instant form of electronic larynx or voice box is operative to generate an audible tone which is projected directly into the mouth cavity of the person from the exterior thereof, and as will be hereinafter apparent, the operation of said electronic larynx is completely independent of the user's respiratory system and/or his ability to utilize the operational principles of esophageal speech.

More specifically, one form of electronic larynx of the present invention is indicated in its entirety in the reference character 17 in FIG. 1, and includes a signal generator 18 which is adapted to generate electrical signals or pulses of energy each of which is representative of the plurality of frequencies contained within the complex acoustical wave of the audible tone normally developed by the natural larynx, and a tone generator 19 normally held in the hand of the user, being connected in electrical circuit to said signal generator by means of a suitable conductive cable 20 or the like and responsive to said signals to transform the same into an audible tone closely resembling said normally developed tone. Said tone generator also includes means to transmit the audible tone into the above defined mouth cavity 4, which, in the instant embodiment, is accomplished by means of a suitable length of hollow non-toxic plastic tubing 21 which has its one end attached to said tone generator in tone receiving position and its opposite end adapted to extend between the lips of the user and into the mouth cavity 4, said generator being held so as to position said latter end of the tubing closely adjacent the hard palate 7.

The operation of the electronic larynx or voice box is also adapted to be controlled so that it may be shut-off when not in use in order to conserve its power source. For this purpose suitable control means presently to be defined in more detail, are provided with an operator as identified at 22, extending exteriorly of the tone generator housing and positioned to be selectively manually actuated when it is desired to connect the electronic circuit of said larynx to an audible tone generating condition.

The instant form of electronic larynx also includes control means 23 and 24 carried in the signal generator and which are selectively actuatable to preselect the pitch

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and/or volume of the generated audible tone, the operation of which will also be later explained in detail, and to thereby enable said larynx to be adjustable to closely match the normal voice characteristics of a particular user such that the generated audible tone will result in permitting phonation closely resembling that developed by the natural larynx or voice box.

Referring now particularly to FIG. 4, the structural configuration of the instant form of signal generator 18 includes a housing 31 preferably constructed of a moldable non-metallic and/or non-conductive material such as a plastic or the like, being substantially rectangular in overall configuration and of an appreciable depth, and having a plurality of recesses provided therein, as is indicated at 33-36 inclusive, adapted to accommodate the several electronic components of said generator. A flat cover 38, preferably of a thin metallic construction is placed over each side wall of the housing 31, substantially completely enclosing the same to thereby afford maximum protection to said components. Said cover may also be integrally provided with a narrow annular rim 39 which is adapted to seat upon a shoulder 40 formed on the periphery of the housing 31 on either side thereof, said rim snapping over the adjacent shoulder surface 42 being effective to secure said cover in its normally protective position.

The housing recess 33 is adapted to accommodate the power supply for the signal generator, which consists of a pair of batteries as indicated at 44 disposed in side by side relation within said recess and having the negative electrode of each in engagement with a conductive contact plate 45 rigidly mounted to the inner surface of the housing end wall 46 defining one side of said recess. In like manner, the positive electrode of each battery 44 is engaged by opposed, oppositely extending resilient wings 47 of a conductive spring contact plate 48, the latter being rigidly mounted to the adjoining wall of the housing partition 49 defining the opposite side of the aforesaid recess 33 and effective to retain said batteries under suitable spring pressure between and in electrical circuit with said contact plates. With this construction, said batteries are connected in parallel as referred to in the art and thus conditioned to supply electrical energy to the remaining electronic components of the signal generator connected in circuit thereto in a manner to be presently described. In the disclosed form of signal generator it is preferred to use a dry cell type of battery having a voltage rating of approximately 15 volts D.C.; however, it is also contemplated that other types may be readily adaptable for this purpose.

The housing recesses 34-36 accommodate the remaining electronic components of the signal generator which will be hereinafter specifically defined and described in more detail and as is seen in FIG. 4, the same are mounted therein such that upon removal of the cover 38 the same may be readily accessible for purposes of maintenance, replacement or the like.

The housing recess 34 is also provided with an offset portion 51 extending centrally between the recesses 35 and 36 into which is disposed a female socket 53, the latter having a hollow base 54 extending through an aperture 55 formed in the end wall 56 of the housing 31 and which receives the metallic connecting post 57 of a male plug 58, FIGS. 1 and 2. The female socket 53 is also provided with resilient conductive sleeve type-connectors 59 and 60 which connect with the aforementioned electronic components in a novel circuit arrangement, later to be described, and receive the electrical pulses or signals generated therein. The aforesaid sleeve connectors 59 and 60 are adapted to engage with separate parts of the connecting post 57 of said male plug, as indicated at 62 and 63, respectively, and the latter, in turn are each separately connected to one of the conductors 20a and 20b comprising the instant form of cable 20 connecting said signal generator in electrical circuit with the

above-mentioned tone generator 19 whereby said signals are transferred to the latter.

The overall size of the completely assembled signal generator, as just described, is approximately 2½ inches in width, 4½ inches in length and 1 inch in thickness and weighs substantially 6 ounces; hence, it is readily apparent that the same is very compact in construction and may easily be carried within or attached to the clothing of the user without being appreciably noticeable and/or to interfere with the latter in the performance of his daily work or the like.

Referring now to FIGS. 2 and 3, the structural configuration of the tone generator 19 in the instant embodiment of electronic larynx is shown in detail, and particularly in FIG. 3 in the novel manner in which the same is connected in electrical circuit with the conductors 20a and 20b of the cable 20. More specifically, the tone generator 19 includes a cylindrical housing 70 preferably formed of a metallic material such as aluminum or the like, having a transverse end wall 71 closing off one end thereof defining a cavity 72, said wall also being integrally formed with an elongated neck or stem 73 extending longitudinally axially of the housing and centrally provided with an aperture 74. A portion of the outside surface of the stem 73, as is shown in FIG. 2, is inclined longitudinally thereof outwardly toward the end wall 71 defining thereby an annular shoulder 75 facing the latter and disposed intermediate the ends of said stem. One end of the above-mentioned hollow plastic tubing 21 is extended around said inclined wall surface and over said shoulder being secured thereby to said generator housing in such manner that the interior of said tubing, as identified by the reference 76, communicates with the stem aperture 74. The opposite open end of the tubing, as mentioned previously, is adapted to be extended between the lips of the user as is shown in FIG. 1, and preferably positioned adjacent the hard palate 7 defining the upper side of the mouth cavity 4. And, as will be apparent, a column of air within said tubing and communicating with stem aperture 74, is thence effective to act as a carrier and transmit the audible tone produced by said generator into said mouth cavity.

The audible tone producing means in the instant form of the generator is herein shown to include a magnetic transducer 78 of conventional electrical configuration having a cup-shaped housing 79 preferably constructed of a non-metallic, non-conductive material such as plastic, and mounting the electro-magnetic components of the same therein. Said transducer also has a pan-shaped cover 80, constructed of a suitable metallic material which is placed over the open end of said housing in press fit relation effective to seal the same, and integrally provided with a cylindrical hollow boss 81 extending axially thereof and communicating with the interior of said housing and said electromagnetic components. The transducer is rigidly mounted in the cavity 72 of the generator housing 70 with the hollow boss 81 extending centrally within an enlarged counterbore 82 formed on the inner end of the stem 73 and communicating with the aperture 74. A suitable insulative element, such as a soft rubber O-ring as is indicated at 83, may be placed over the boss 81 and adapted to engage the annular wall of said counterbore and thereby position said boss centrally within the latter and directly opposite the inner end of the stem aperture 74. Hence, with this construction, it is contemplated that any audible tones generated within said tone generator will emanate therefrom through said boss to the aforesaid stem aperture and then to the interior of the plastic tubing 21 and thence transmitted by the latter to the user's mouth cavity. Said insulative element is also effective to prevent the audible tones from passing into the generator housing cavity 72 where they might tend to set up interference tones or the like which could possibly dampen or entirely diminish the normally directed audible tone output through the aforesaid tubing 21.

As previously mentioned, the tone generator 19 is connected in electrical circuit to the signal generator 18 by means of the cable 20 and in such manner as to selectively control the operation of the electronic larynx. To accomplish this, the conventional electro-magnetic circuitry of the transducer 78, which is indicated schematically in FIG. 8 by the inductance coil 85, is connected in series with said signal generator through an electrical switch 86, preferably the type known in the art as a "single pole, single-throw, normally open microswitch." For this purpose, the transducer housing 79 is provided with a female type socket 87 having a pair of terminal sleeves 88 to which is connected the ends of the inductance coil 85. A conductive stub 89 is inserted into said socket into engagement with one of the terminal sleeves 88, and is, in turn, connectable through wire 91, FIG. 3, to one terminal 92 of the aforesaid normally open switch 86. A substantially U-shaped conductive bus bar 93 formed preferably of metallic wire of suitable resilient characteristics is connected or otherwise fastened to the back face of the plastic transducer housing 79 such that its base portion 94 is positioned adjacent the terminal posts 88 of the above-mentioned socket 87. In addition, said base portion is slightly spaced from said housing face as is shown in FIGS. 2 and 6.

The cable 20, on the end opposite to that connected to the signal generator is provided with a male plug 96 having a pair of connecting posts 97 and 98 to which are connected the cable conductors 20a and 20b, respectively. The male plug 96 is extended through a suitable aperture 99 formed in the annular wall of the tone generator housing 70 such that either one of its posts 97 or 98 is inserted into the remaining terminal sleeve 88 of the female socket 87 and the other of said posts is projected between the back face of the transducer housing and the resilient base portion 94 of said bus bar. A suitable wire 101, which has its one end connected to the other terminal 102 of the switch 86 and its opposite end connected to said bus bar, places said switch in series relation with the electro-magnetic circuitry of the transducer and thence through the cable 20 to the signal generator 18. Therefore, by selective actuation of the aforesaid switch 86 the instant form of electronic larynx may be energizable to an audible tone generating condition. It is contemplated that the user of said larynx be able to manually operate said switch and to accomplish this, and with the same thus connected in the manner just described, it is then placed within the tone generator housing 70 against said transducer, as seen in FIG. 2, being rigidly secured to the latter by means of suitable fasteners as indicated at 103, such that its actuator button 104 faces toward and is in alignment with an aperture 105 formed in the annular wall of said generator housing adjacent its open end. A cylindrical operator 106 is slidably disposed in said aperture and operatively connected with the aforesaid actuator button 104 being actuatable to depress the same and actuate the switch to its closed position, which, as above mentioned, is effective to energize the electronic larynx to its audible tone generating condition. A suitable cap 107 placed over the open end of the generator housing 70 and secured in place by means of the aforesaid fastener 103 is effective to prevent any extraneous matter from entering the housing cavity 72 and also affords additional rigidity to the completed structure.

The size of the tone generator housing in its completely assembled form is approximately one inch in diameter and three-quarter inches in depth and hence may be easily carried in the hand of the user and substantially concealed therein so as not to be readily detected. Said size is also indicative of its light weight thereby enabling the same to be easily moved by the user to its normal operative position.

Having thus described the details of construction of the instant form of electronic larynx, a further description of the electronic components of the signal generator and

the novel manner in which the same are connected in electrical circuit and operable with the aforementioned tone generator to generate an audible tone will now be explained.

With reference particularly directed now to FIG. 8 of the drawings, wherein is shown a schematic wiring diagram of the electronic circuitry utilized in the several embodiments of electronic larynx disclosed herein, the signal generator includes a power transistor 110 of the type known in the art as a PNP transistor connected in electrical circuit to operate as an oscillator, and a second transistor 112, also of the type PNP, being electromagnetically coupled to said oscillator circuit by means of a transformer 113 and responsive to amplify and further characterize the signals generated in said oscillator and hence provide output signals or pulses which, as is mentioned previously, are each representative of the plurality of frequencies contained within the complex acoustical wave of the audible tone normally developed by the natural larynx of a human being.

More specifically, the transistor 110 includes a base electrode 114 connected by wire 115 to one end of a variable resistance or potentiometer as indicated at 116, and by conductor 117 to one end of a dropping resistor 118. The variable tap for the potentiometer 116, hereinabove referred to as the pitch control means 23, is connected by wire 119 to one plate of a condenser 120. A condenser 121 is connectable by wire 122 to said one end of the potentiometer 116 in parallel with the aforementioned wire 115, whereas the opposite side of each of the condensers 120 and 121 is connected in parallel with the other by means of conductors 123 and 124 respectively, and thence to one end of the primary winding 125 of the coupling transformer 113 by means of conductor 126. The opposite end of said primary winding is connected by wire 127 to the collector electrode 128 of said transistor. A resistor 129 has its one end connected by wire 130 to the aforementioned wire 115 and its other end by wires 131 and 132 to the emitter electrode 133 of the transistor 110.

The above described electronic components of the oscillator circuit, particularly those in the base-emitter and base-collector circuits of the transistor 110, are selected so that the signal generator will oscillate preferably within the frequency range of 80-120 cycles per second, which has become known in the art as the frequency range centering about the fundamental frequency of the audible tone generated by a normal larynx of the average human male, namely, 100 cycles per second.

The signal generator herein shown also includes the transistor 112 operating as an amplifier and having a base electrode 135 connected by wire 136 to one end of a variable resistor or potentiometer 137, the opposite end of the latter connecting by a wire 138 in parallel by means of wires 141 and 142 with the emitter electrode 139 of the transistor 112 and one end of the secondary 140 of the transformer 113. The variable tap for the potentiometer 137, hereinabove referred to as the volume control means 24, is connected by wire 144 to one end of resistor 145, the opposite end of the latter connecting through wire 146 to the opposite end of the transformer secondary winding 140. The collector electrode 148 of said transistor, in like fashion, is connected by wire 149 to the opposite end of the aforementioned resistor 118 and thence by wire 150 to the sleeve connector 59 of the female socket 53. The remaining sleeve connector 60 is connected by wire 152 to the center tap 153 of the aforesaid transformer primary winding 125, and a capacitor 154 is likewise connected across said socket connectors.

The aforementioned battery source of electrical energy which is utilized to supply the electrical power to operate the present form of electronic larynx is shown in FIG. 6 by the conventional battery symbol as indicated at 44, and has its negative terminal identified by the reference

45 (designating the aforesaid plate in FIG. 4), and connected by wire 156 to one end of load resistor 157, the opposite end of the latter connecting through wire 158 to the wire 152, and hence in parallel with the socket connector 60 and the center tap 153 of the coupling transformer primary 125. The positive terminal of the battery source 44 as similarly indicated at 48, is connected by wire 159 to the junction of wires 141 and 142 in the base-emitter circuit of amplifier transistor 112 and in like manner to wire 131 in the base-emitter circuit of transistor 110.

To complete the electronic circuitry for the instant form of signal generator, a capacitor 161, preferably of larger size than the capacitors 120 and 121 heretofore referred to, the purpose for which will be presently explained, is connected across the aforesaid wires 131 and 152 and hence in series circuit with the battery source 44 and load resistor 157, and in parallel with the base-emitter circuits of the transistors 110 and 112.

Also, the conductor 20a of the cable 20 which is connected to the part 62 on the male plug post 57 connects one end of the transducer coil 85 of the tone generator 19 through the female socket sleeve 59 and hence in circuit with the collector electrode 148 of the transistor 112 and the base electrode 114 of the transistor 110. In like manner, the conductor 20b of the cable 20, which is connected to the part 63 of the male plug post 57, connects the normally-open switch 86 and the opposite end of the transducer coil 85 through the female socket sleeve 60 and wire 152 in circuit with the battery source 44. With this novel circuitry, it is now seen that the emitter electrodes 133 and 139 of the transistors 110 and 112, respectively, are in circuit with the positive terminal 48 of the battery source 44, and are hence biased in the forward or low resistance direction while the collector electrodes 128 and 148 of said transistors are in circuit with the negative terminal 45 of the battery source 44 and hence biased in the reverse or high resistance direction. With the signal generator and tone generator thus connected, it is contemplated that upon actuation of the aforesaid switch 86, the signal generator will be excited in a novel manner presently to be described to generate distinct separate pulses of energy which in turn are effective to energize the electromagnetic elements of the tone generator sufficiently to physically vibrate the audio tone producing mechanism of the latter, schematically indicated by the diaphragm at 175 in FIG. 4, and thereby produce an audible tone closely resembling the tone developed by the natural larynx of a human being.

In the embodiment shown in FIG. 7, the electronic components of the artificial electronic larynx of the present invention, as above described, are shown mounted in a smoking pipe, whereby a laryngectomized person may insert the latter in his mouth in a normal manner and operate said larynx to provide an audio tone, which may then be projected to his speech forming apparatus to form intelligible sounds. Since the greater majority of laryngectomized persons are of the male sex, as is above mentioned, it is therefore clearly understood how this latter construction is readily adaptable to one of the more characteristic of habits attributed to the male sex, i.e., the smoking of a pipe; hence, the most efficient use of said form of artificial larynx may be easily accomplished without requiring the user to first develop conspicuous or otherwise obvious mannerisms that may be readily detected and/or keynote his handicap.

More specifically, the instant form of artificial larynx, as herein embodied, comprises a smoking pipe having a conventional bowl 181 which is rigidly mounted on one end of an elongated stem 182, said bowl having an internal cavity as identified at 184 communicating by means of a passageway 185 provided in its base to a chamber 186 formed centrally in the aforesaid stem. The end of said stem adjacent the bowl 181 mounts a cap, or the like,

189, which acts to seal said end of the stem chamber 186, whereas, a hollow mouthpiece 191 is pressed into the opposite end of said stem to seal off the same and has a chamber 192 formed centrally therein which interconnects the aforesaid chamber 186 to the exterior of said stem. The bowl and stem parts of the smoking pipe may be formed of any suitable material, preferably a nonconductive material, such as to prevent the unintentional grounding and/or short circuiting of any of the aforesaid electronic components of said device thereto. In like manner, the mouthpiece 191 may be also formed of any suitable material such as hard rubber so that it may be firmly held by and between the teeth of the user in the normal manner. Several of the electronic components for the instant form of artificial larynx are identical in electrical value to those utilized in the previous form, hence are identified by the same reference characters. However, the mechanical configuration of said components are changed to adapt the same to their particular location within the bowl and/or stem of the pipe construction. For example, the microswitch 86 mounted in the bowl cavity 184 in the present embodiment is substantially smaller than its corresponding microswitch component utilized in the previous form shown in FIGS. 1 to 6; hence, it is to be understood that the electrical configuration of said component in either embodiment is that as is shown in the schematic diagram of FIG. 8.

The electronic components for the instant form of larynx with the exception of the capacitor 161 and the batteries 44, are first placed within the bowl cavity 184, being positioned therein in the manner shown in FIG. 7, and then a suitable plasticized filler material or the like, such as a resin, is poured into said bowl cavity to substantially completely fill the same. Care is taken however that the operator 22 of the microswitch 86, which, in its present form is shown to be slidably disposed in an aperture 192 provided in the bowl wall 193, is able to be operated in the manner understood to actuate the said artificial larynx. In like manner, the transducer 78 is also disposed in the aforesaid bowl cavity such that it may be connected to one end of a suitable length of hollow plastic tubing as indicated at 194, the latter being equivalent in structure and operation to the aforementioned tubing 21 in the previous embodiment. As seen in FIG. 7, said one end of the tubing extends through a suitable aperture 195 formed in the bowl wall 193, preferably closely adjacent the stem 182. The remaining portion of said tubing projects into and through an aperture 197 formed in the wall 198 of the aforesaid pipe stem 182, and thence completely through the stem chamber 186 and the chamber 192 in the mouthpiece 191 and externally of the latter a suitable distance so that the opposite end thereof when said artificial larynx is utilized may be placed in its intended position adjacent the roof of the mouth cavity of the user.

As is also seen in FIG. 7, the aforementioned capacitor 161 is preferably located in the stem chamber 186 adjacent the cap 189. In like manner, the batteries 44 used in the instant form of larynx are of such size and shape as to be inserted within said stem chamber, being disposed therein such as to permit the aforesaid hollow tubing 194 to be freely extended therethrough. The stem cap 189 is likewise preferably removable so that replacement of the aforesaid electronic components in said stem may be readily undertaken.

The electronic circuitry for the instant form of artificial larynx is substantially similar to that of the previous embodiment, the various conductors interconnecting the components utilized therein being interspaced throughout the bowl cavity and interconnecting to the aforesaid components in the stem chamber by means of the passageway 185 communicating with the latter and said bowl cavity. However, as is seen in FIG. 7, the electronic components, namely, the potentiometers 116 and 137 and hence the respective operators 23 and 24 for the same, which function

to control the pitch and volume, respectively, of the audio signal output of said larynx, are not used in the present form of pipe embodiment. This is done merely to simplify the construction and to keep the same to a minimum size. However, it is also understood that said components may, if desired, be provided internally and/or externally of the pipe device and the absence of the same in the present showing is not intended to indicate that they are not adaptable to said construction.

With the aforesaid potentiometers 116 and 137 removed from the electronic circuitry in the present form of artificial larynx, the remaining components are hence connected in circuit in identically the same manner as is shown in FIG. 8, with the exception that the wire 119, which in the previous form connected one side of the capacitor 120 to the operator 23 for the potentiometer 116, is now connected directly to wire 115, and, the wire 114 now connects one end of the resistance 145 directly to the base electrode 135 of the transistor 112. In this manner, the present form of artificial larynx is capable of electronically generating an audio signal in a manner to be presently described.

Having thus described the details of construction and intended functional purpose of several preferred forms of the electronic artificial larynx disclosed herein, the manner in which the electronic circuitry for the same is operable to produce the intended purpose and result will now be set forth.

In the operational disclosure now to follow the first described embodiment of electronic larynx will be utilized to illustrate the intended function, and it will first be assumed that the several electronic components of the same are connected in circuit in the manner previously described so as to function within the frequency band of an average male human voice, i.e., between 80-120 cycles per second. The following set of electrical values selected for said components, as are referred to by their reference numerals, is illustrative of merely one group capable of performing in the manner intended.

- 110 transistor, 2N188A
- 112 transistor, 2N241A
- 113 transformer, Thordarson-Meissner TR-5
- 116 potentiometer, 0-2500 ohms
- 118 resistor, 27,000 ohms
- 129 resistor, 1500 ohms
- 145 resistor, 680 ohms
- 137 potentiometer, 0-2500 ohms
- 157 resistor, 100 ohms
- 120 capacitor, 2 mfd., 20 volts
- 121 capacitor, 2 mfd., 20 volts
- 154 capacitor, 2 mfd., 20 volts
- 161 capacitor, 50 mfd., 12.5 volts
- 44 battery, 15 volts

It will also be assumed for the present operational disclosure that the potentiometer 137, hereinafter referred to as the "volume control," is adjusted to provide a maximum audio signal, whereas, the potentiometer 116, hereinafter referred to as the "pitch control" is adjusted such as to condition the circuitry of the electronic larynx to function at approximately a frequency of 80 cycles per second; the low end of the above defined frequency band.

Further, to more clearly understand the novel manner in which the electronic circuitry is operable, and to simplify the operational disclosure thereof, reference is directed to FIG. 9 of the drawings wherein is shown a series of typical voltage and current wave forms observed at preselected points in the electronic circuitry for the device as are indicated by the reference letters (A-J) in FIG. 9 and also in FIG. 8. Referring momentarily to FIG. 9, it is seen that the voltage and current wave forms have been noted at the low end of the frequency band wherein the time ( $x$ ) between pulses in the current output signal is approximately  $\frac{1}{80}$  of a second, and also at the high end of said band wherein the time

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(x) between pulses in this instance being  $\frac{1}{120}$  second.

With the above circuit parameters established and with the switch 86 in its open condition it will be realized as is shown in FIG. 8, that the collector electrode 148 and base electrode 114 of the transistors 112 and 110 respectively, are disconnected from the battery source 44; hence said transistors are in a nonoperative or quiescent state. With the circuitry thus conditioned, the capacitor 161, is substantially fully charged to the potential of the battery source 44 which, in the instant structure as is mentioned previously, preferably 15 volts.

With the tone generator 19 held in its operative position so that the plastic tubing 21 extends into the mouth cavity 4, in the manner shown in FIG. 1, the operator 22 may then be depressed to actuate the switch 86. As a result the negative terminal 45 of the battery source 44 is connected through wire 152, cable conductor 20b, switch 86, transducer coil 85, cable conductor 20a and wire 150 to the collector electrode 148 of the amplifier transistor 112, and thence through wire 149, resistor 118 and wire 117 to the base electrode 114 of the oscillator transistor 110. In like manner, the positive terminal 48 of the battery source 44 is connected through wires 159 and 141 to the emitter electrode 139 of the transistor 112, thence through conductor 142, potentiometer 137 to the base electrode 135 of said transistor. Likewise, said positive terminal is connected by conductors 131 and 132 to the emitter electrode 133 of the transistor 110 and also through the resistor 129 (referred to in the art in this instance as a stabilizer resistor) to the base electrode 114 of said latter transistor. As a result, the oscillator transistor 110 begins to conduct, the output signal therefrom being taken from its collector electrode 128 and applied through conductor 127 to the primary 125 of the coupling transformer 113. And, as is seen in FIG. 8, a portion of said output signal is taken by conductor 126 and applied across one side of parallel connected capacitors 120 and 121, and thence across the potentiometer 116, said components providing the feedback network for said oscillator circuit as understood in the art, and then through conductor 115 back to the base electrode 114. Consequently with said latter network functioning the transistor 110 will therefore oscillate substantially as a blocking oscillator, whereas, with the "pitch control" adjusted in the manner previously noted, the output signal therefrom comprises separate and distinct square wave pulses of current, the general configuration of which is seen at J in FIG. 9, said current pulses recurring at a frequency of approximately 80 cycles per second.

The electronic circuit components for the oscillator are preferably of such order that the instant the switch 86 is closed, the current surge output of the oscillating transistor 110 is characterized such that it substantially instantaneously reaches a maximum value, is thence sustained at said value for a predetermined interval of time to define a definite pulse width such as is indicated by the reference letter Y in the current wave form J of FIG. 9, and then rapidly instantaneously diminishes to zero, said transistor then remaining in a non-conducting state for the remainder of said pulse time interval. With the transistor 110 operating in this manner the pulse width Y of the nature just described provides a current flow at its peak of approximately 250 ma. However, the current drain on the battery source 44 is very little per cycle operation of said transistor; hence it is possible therefore to utilize a relatively small battery and still obtain optimum operating conditions over a sufficient period of time. For example, a highly efficient operation for the present form of larynx over a period of approximately two months has been accomplished by using a pair of batteries commercially available and recognized in the art under the title "Eveready #411-15 volt battery." Additionally, since the current drain on the battery source 44 per pulse output of the oscillator transistor 110 is sub-

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stantially negligible, the operation of the latter does not tend to pull any of the charge out of the capacitor 161; hence the latter remains substantially fully charged.

The pulse signal output of the oscillator transistor 110 is then taken from its collector electrode 128 and transmitted by conductor 127 to the primary winding 125 of coupling transformer 113 whereby it induces a signal in its secondary winding 140 substantially of the configuration shown by the voltage curve E in FIG. 9. The signal output of said secondary winding is then applied to the base electrode 135 of the amplifier transistor 112 wherein the latter is intended to be operable to amplify said signal and cause the activation of the transducer 78. To accomplish this, the bias established for the base electrode 135 of said transistor, as is determined by the resistance 145 and potentiometer 137, is effective to clip off a greater part of the negative going portion of the incoming signal from the transformer secondary in such manner as to provide a base electrode voltage having a configuration as characterized by the curve F in FIG. 9. With reference directed to FIG. 9, it is seen that said base voltage curve F has a negative square wave part as indicated at F<sub>1</sub>; hence with the same applied to the base electrode 135 of the amplifier transistor 112, the latter conducts so as to provide an output signal on its collector electrode 148, which signal is primarily composed of separate and distinct pulses of current, substantially of square wave configuration, as is illustrated by the current wave form I. With reference directed to said current wave form, it is realized that the current output pulse of the transistor 112 also reaches its maximum peak value substantially instantaneously upon said transistor first conducting; is thence maintained at said peak output a predetermined period, as is identified by the reference character Z to define a preselected pulse width; and then falls to a substantially low amplitude also in a substantially instantaneous manner wherein the lower portion of its trailing edge next diminishes gradually in an oscillatory fashion to approximately zero amplitude before the next pulse of said current signal is produced. It is contemplated that the width of said current pulse shall be approximately  $2\frac{1}{2}$  to 3% of the time period between adjacent pulses in said output signal, and at the present operational frequency of 80 cycles per second, said pulse width Y is therefore of the order of 250 microseconds.

An important feature of the instant form of electronic circuitry relates to the intended function of the capacitor 161, which will now be described. When the amplifier transistor 112 is conductive to provide the aforesaid separate square wave pulses of energy, the surge of current in its emitter-collector circuit is such as would ordinarily put an excessive demand on the battery source 44. However, in order to prevent this from occurring and hence prolong the life of said battery source, the capacitor 161, having previously been substantially completely charged as described hereinabove, is operative to relinquish its charge to said emitter-collector circuit the instant said transistor begins to conduct. And, with the present square wave pulse characteristics for the signal output wherein a substantial "slug" of current is required almost instantaneously, said capacitor charge is sufficient to supply a maximum part if not all of the demand current during said pulse formation. As seen in FIG. 9, the discharge characteristic of said capacitor preferably follows the curve as is identified by the reference character H, wherein it is seen that said capacitor discharges once per each cycle of operation of the amplifier transistor 112, and then, in such manner that it relinquishes substantially all of its accumulated charge in the beginning portion of said cycle. For purposes of circuit definition it may be said that the "time constant" of the RC series circuit comprising the aforesaid capacitor 161 and the resistance 157, is substantially less than the time interval between pulses of the output current signal from said

amplifier transistor. For example, with the values for said components as disclosed above, namely, 50 mfd. for capacitor 161 and 100 ohms for resistance 157, the "time constant" is substantially  $\frac{1}{200}$  second. The battery source 44, as seen in FIG. 8, is also in charging circuit with said capacitor and thereby operative to re-charge the latter after its charge is dissipated such that it may be conditioned for the next pulse generation in the afore-said transistor 112. Hence, with the capacitor 161 functioning in this manner, the demand put upon said battery source 44 is maintained at a substantially low value, which is therefore effective to prolong the life of the same.

The current output signal thus provided by the amplifier transistor 112 is then taken from its collector electrode 148 and applied through wire 150 and cable conductor 20a to the winding 85 of the magnetic transducer 78. As a result, said transducer is electro magnetically energized by the separate and distinct pulses of current of said signal such as to mechanically vibrate its diaphragm 175 and provide an audible tone which is then transmitted by the air column contained within the flexible tubing 21, and thereafter into the mouth cavity 4. Said tone is thence projected toward the speech forming apparatus of said person as above described, whereby through normal articulation of the same, clearly intelligible speech is created. And, with the electronic circuitry conditioned in its present form at the low end of the aforementioned frequency band said current pulses of square wave configuration in said signal recur at a rate of approximately 80 cycles per second, and hence it is realized that the fundamental frequency of the acoustical wave form of said audible tone is also the same as said pulse recurring rate. It is also realized that with the square wave configuration of the current pulses in said output signal, the same also includes a plurality of harmonics or multiples of the fundamental frequency of 80 cycles per second. Hence, the acoustical wave form for the audible tone generated as a result of energizing the electro-magnetic transducer 78 with said output signal is of substantial complex configuration and very rich in harmonic content. Likewise, the resultant artificially developed speed is also substantially rich in harmonic tones and closely resembles the speech sounds produced by the natural larynx of a male human.

It is now realized that by adjusting the "pitch control" (potentiometer 116), the fundamental frequency of operation for the electronic larynx may be selected such that it may operate at any frequency within the above described band width for the average male human and thereby provide an audible tone for any particular individual that also resembles the natural pitch of his one-time normal voice.

It is also realized that by adjusting the "volume control" (potentiometer 137) the loudness of the artificially developed speech sounds may be varied such that the same are closely related to the volume of a particular individual's normal voice.

Further characteristic of the present form of electronic circuitry is that the electro-magnetic transducer 78 tends to sustain its mechanical vibrations once energized by the current pulse of the signal output, and hence the magnitude of the acoustical wave form generated thereby tends to be maintained at a substantially constant level between pulse generations and excitations. In this manner the pitch and/or volume of the audible tone generated thereby does not noticeably vary.

In addition, it is also apparent that by preselecting the various components of the electronic circuitry and the mannerism in which the same is operative, the configuration of the square wave current pulses in the signal output may be varied, and thereby change the characteristics of the complex acoustical wave form of the audible tone to any predetermined shape. For instance, the shape of said current pulse may be altered to one of stepped con-

figuration which ascends to a maximum magnitude toward the trailing edges of the pulse, or said current pulse may be formed with holes or valleys at preselected parts thereof as referred to in the art. In this manner, the harmonic content of said audible tone may be preselected in effect to compensate for a particular individual having a predominate high or low pitch voice which may be rich in harmonic tones at a predetermined sound level.

The operation of the "pipe" embodiment of electronic larynx as shown in FIG. 7, will be substantially the same as that just described, however, as is previously mentioned, the pitch and volume controls (potentiometers 116 and 137) are removed from the latter form of device. Hence, the pipe embodiment of artificial larynx is capable of operating at only one frequency, which may be preselected so as to be in accordance with the voice characteristics of the intended user, and in like manner at only one level of volume output. With the circuitry of the instant form of "pipe embodiment" connected in the manner previously described, the frequency of operation for the same is approximately 120 cycles per second.

It is also realized that the values selected herein for the components in the present form of electronic larynx which condition the latter to function for use with the male sex, may also be changed so that said larynx may be utilized with a person of the female sex, i.e., the operating frequency band of said device may be preselected so as to be characteristic of the average frequency range of the normal female voice.

Having thus described several preferred forms, it is clearly understood that the electronic larynx or voice box of the present invention is susceptible to various changes, modifications and arrangements of parts without departing from the inventive concepts as are defined in the claims.

What is claimed is:

1. An artificial electronic larynx comprising a first transistor having a base, emitter and collector electrodes, impedance means, a source of electrical energy connected in circuit with said impedance means and said electrodes functioning therewith to define an oscillator, said oscillator being operable to generate a pulsating electrical signal, each of the pulses of said signal recurring at a predetermined recurrence rate within a frequency range of approximately 80 to 120 cycles per second, said impedance means including an adjustable feed-back network being operable to cause said oscillator to continuously generate said pulsating electrical signal and to selectively vary the rate of recurrence of said pulsating electrical signal, each of the pulses of said signal having an on-duty portion that is substantially less than the time interval between adjacent pulses and having a plurality of signal frequencies therein recurring at predetermined multiples of said recurrence rate and which are characteristic of the complex acoustical wave form of the audible tone normally generated by the natural larynx of a human, a second transistor, means connecting said first and second transistors in electrical circuit being effective to transfer said pulsating signal to the latter, said second transistor being operable to amplify said pulsating signal, and electro-magnetic transducer means being connected in signal receiving relation with said second transistor and operable to transform said pulsating signal into an audible tone closely resembling said normally generated audible tone.

2. An artificial electronic larynx comprising a first transistor having a base, emitter and collector electrodes, first impedance means, a source of electrical energy connected in circuit with said first impedance means and said electrodes functioning therewith to define an oscillator, said oscillator being operable to generate a pulsating electrical signal, each of the pulses of said signal recurring at a predetermined recurrence rate within a frequency range of approximately 80 to 120 cycles per second, said impedance means including a feed-back network being

operable to cause said oscillator to continuously generate said pulsating electrical signal, each of the pulses of said signal having an on-duty portion that is substantially less than the time interval between adjacent pulses and having a plurality of signal frequencies therein recurring at predetermined multiples of said recurrence rate and which are characteristic of the complex acoustical wave form of the audible tone normally generated by the natural larynx of a human, a second transistor, means connecting said first and second transistors in electrical circuit being effective to transfer said pulsating signal to the latter, said second transistor being operable to amplify said pulsating signal, second impedance means connected in electrical circuit with said second transistor and adjustable to selectively vary the amplification of the amplified pulsating signal, and electromagnetic transducer means being connected in signal receiving relation with said second transistor and operable to transform said pulsating signal into an audible tone closely resembling said normally generated audible tone.

3. An artificial electronic larynx comprising transistor means, impedance means in circuit with said transistor means, a source of electrical energy connected in electrical circuit with said impedance means and transistor means being effective therewith to generate a pulsating electrical signal recurring at a preselected recurrence rate within a frequency range of approximately 80 to 120 cycles per second, each of the pulses of said signal having an on-duty portion that is substantially less than the time interval between adjacent pulses and having a plurality of signal frequencies therein recurring at predetermined multiples of said recurrence rate and which are characteristic of the complex acoustical wave form of the audible tone normally generated by the natural human larynx, means in circuit with said transistor means for supplying a pulsating surge current to the latter comprising capacitor means operable to periodically discharge surges of current to said transistor means in phase with said electrical pulsating signal, and electro-magnetic transducer means in electrical circuit with said transistor means being operable to transform said electrical pulsating signal into an audible tone closely resembling said normally generated audible tone.

4. An artificial electronic larynx comprising a first transistor having a base, emitter and collector electrodes, a source of electrical energy, impedance means connected in electrical circuit with said first transistor electrodes and said energy source being operable therewith to define an oscillator, said oscillator being operable to generate a pulsating electrical signal recurring at a preselected recurrence rate within a frequency range of approximately 80 to 120 cycles per second, each of the pulses of said signal having an on-duty portion that is substantially less than the time interval between adjacent pulses and having a plurality of signal frequencies therein recurring at predetermined multiples of said recurrence rate and which are characteristic of the complex acoustical wave form of the audible tone normally generated by the natural human larynx, a second transistor having a base, emitter and collector electrodes, coupling means connecting at least one of the electrodes of said first and second transistors in electrical circuit and effective to transfer said electrical signal to the latter, second impedance means connected in electrical circuit with said electrodes of said second transistor and said source and effective therewith to amplify said pulsating signal, capacitor means in said second impedance means for supplying a surge current to said second transistor in phase with said electrical signal, and electro-magnetic transducer means in signal receiving relation with said second transistor and operative to transform said pulses of electrical energy into an audible tone closely resembling said normally generated audible tone.

5. In an artificial electronic larynx as is defined in claim 4 and wherein said capacitor means is connected

in a charging circuit relation with said source of electrical energy and effective to receive a predetermined electrical charge therefrom.

6. An artificial electronic larynx as is defined in claim 5 and wherein said charging circuit is a series circuit having a time constant less than the time interval between pulses of said pulsating electrical signal.

7. An artificial electronic larynx comprising a first transistor having a base, emitter and collector electrodes, a source of electrical energy, impedance means connected in electrical circuit with said transistor electrodes and said energy source being operable therewith to define an oscillator, said impedance means including a feed-back network connected in circuit with the collector and base electrodes of said transistor being operable to cause said oscillator to continuously generate a pulsating electrical signal recurring at a preselected recurrence rate within a frequency range of approximately 80 to 120 cycles per second, each of the pulses of said signal having an on-duty portion that is substantially less than the time interval between adjacent pulses and having a plurality of signal frequencies therein recurring at predetermined multiples of said recurrence rate and which are characteristic of the complex acoustical wave form of the audible tone normally generated by the natural human larynx, a second transistor having a base, emitter and collector electrodes, transformer means coupling said first and second transistors in signal transfer relation effective to pass said pulsating signal to the latter, second impedance means connected in electrical circuit with said electrodes of said second transistor and said source and effective therewith to amplify said pulsating signal, capacitor means in said second impedance means connected in energy discharge circuit with the emitter electrode of said second transistor and operative to supply pulsating surge current to the latter in phase with said electrical signal, and electro-magnetic transducer means in signal receiving relation with said second transistor and operative to transform said pulses of electrical energy into an audible tone closely resembling said normally generated audible tone.

8. In an artificial larynx as is defined in claim 7 and wherein the duration of each separate pulse of electrical energy is within the range of 2-3% of the time interval between individual pulses of said electrical signal.

9. An artificial electronic larynx consisting of a housing shaped in the form of a smoking pipe and having a bowl and a stem portion integrally formed with said bowl, oscillator means in said bowl for providing a pulsating electrical signal recurring at a preselected recurrence rate within a frequency range of approximately 80 to 120 cycles per second, each of the pulses of said signal having an on-duty portion that is substantially less than the time interval between adjacent pulses and having a plurality of signal frequencies therein recurring at predetermined multiples of said recurrence rate and which are characteristic of the complex acoustical wave form of the audible tone normally generated by the natural larynx of a human, electro-magnetic transducer means in said bowl responsive to said pulsating electrical signal for transforming the same into an audible tone closely resembling said normally generated audible tone, and means disposed in said stem portion and connecting with said transducer means for transmitting said audible tone from the latter through said stem portion to the exterior of said housing wherein said audible tone may be projected into the mouth cavity of a laryngectomized person to form articulate speech.

10. In an artificial electronic larynx as is defined in claim 4 and wherein means connecting with said transducer means is operable to transmit said audible tone into the interior of the mouth of a laryngectomized person to form articulate speech.

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