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Habal

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[54] **NASAL AIR FLOW DETECTION METHOD FOR SPEECH EVALUATION**

[76] Inventor: **Mutaz B. Habal,** 3848 Knollton Rd., Indianapolis, Ind. 46208

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[51] **Int. Cl.²** **A61B 10/00**

[58] **Field of Search** ..... 128/2 H, 2 R, 2 C, 2.08, 128/DIG. 29; 73/204; 179/1 SC

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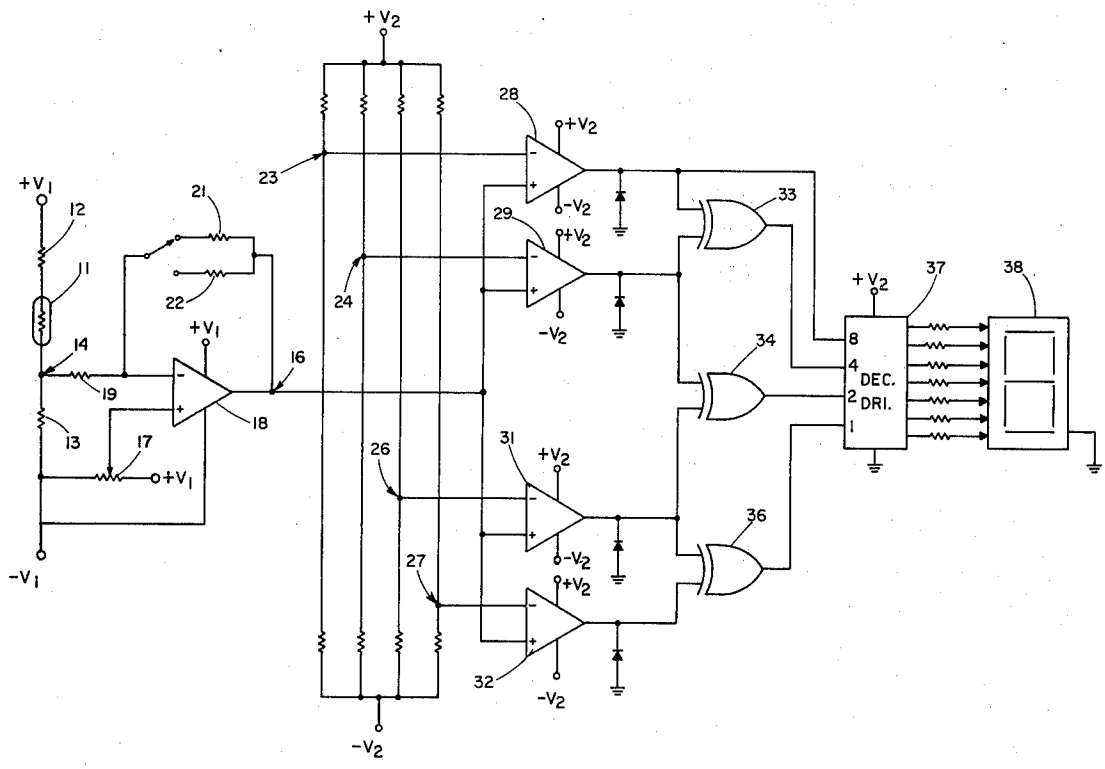
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Primary Examiner—Richard A. Gaudet
Assistant Examiner—Lee S. Cohen
Attorney, Agent, or Firm—Woodard, Weikart, Emhardt & Naughton

[57] **ABSTRACT**

Apparatus for detecting the presence of nasal air escape during speech. A thermistor is placed in the path of nasal air flow, and air flow over the thermister lowers the temperature of the thermistor creating a voltage change in a bridge circuit. The voltage change is amplified and processed by an analog-to-digital converter, and relative values of the voltage change are displayed by a digital readout. The detected nasal air flow correlates closely with the degree of nasality of the human voice, which in turn is a correlation of nasal emission.

3 Claims, 2 Drawing Figures



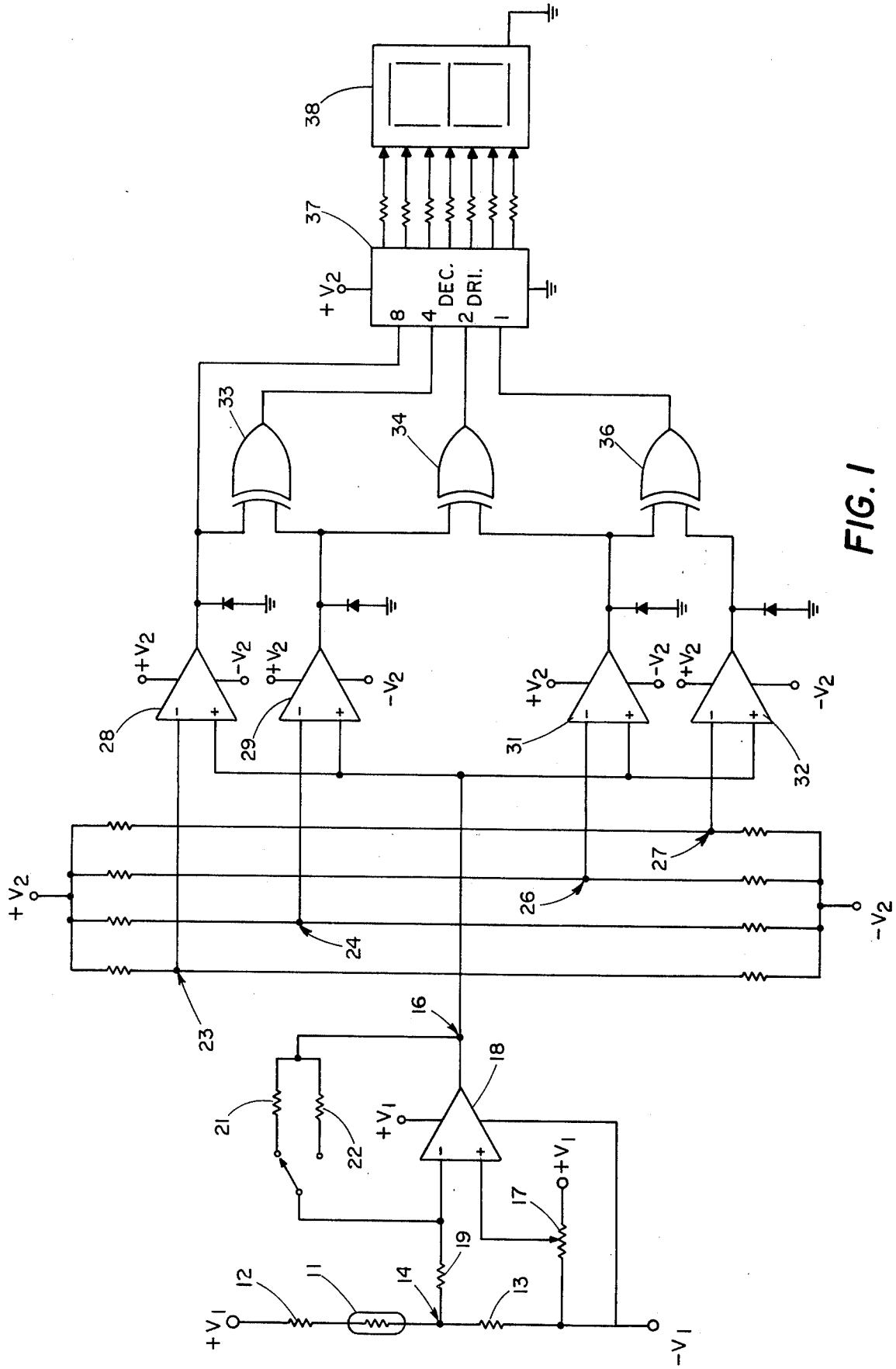

38
37
+V2
DEC.
DRI.
8
4
2
1
33
34
36
+V2
-V2
28
29
31
32
27
26
24
23
16
18
21
22
+V1
17
19
12
11
14
13
-V1

FIG. 1

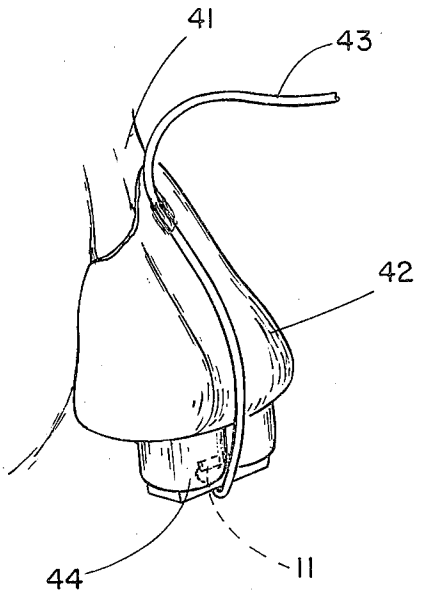


FIG. 2

NASAL AIR FLOW DETECTION METHOD FOR SPEECH EVALUATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention is in the field of speech analysis.

2. Description of the Prior Art

The presence of nasal emission in patients after reconstruction of clefts of the secondary palate, and in other physical pr physiological conditions, denotes an incompetence in the velopharyngeal valve mechanism. Other than in the obvious cases in which there is complete incompetence of the valve, there is usually a problem in evaluating the patient's condition. The incomplete incompetence of the velopharyngeal port can be hard sometimes to differentiate from articulation problems, neuromuscular incoordination, or functional nasality; and, in such conditions, testing for nasal escape has been found to be helpful in differentiating among the various problems encountered and a good adjunct to speech evaluation. The degree of nasal air emission correlates well with nasality of speech.

Several conventional and unscientific methods have been used by speech therapists and surgeons to detect the air escape during speech, such as fogging of a mirror placed beneath the nostrils, the blowing on small cotton threads, tissue paper or soap bubbles placed in front of the nostrils, or pinching of the nostril to detect change in voice quality. All of these methods typically have been utilized during the recitation by a patient of a given standard phrase, test sentence, vowel, or consonant which may be sibilant or plosive. Other recently introduced methods, with more scientific bases, such as spirometry measurement, air flow measurement with an anethesia mask, and ultrasonic devices are among the methods utilized by surgeons and speech therapists for these problems. More complex, and expensive, sophisticated methods have utilized transducer devices and ocilloscopic imaging, most of which methods are not used during a given speech or are invasive by nature of their use.

Two prior art devices for determining nasality of human speech, utilizing sound analysis, are disclosed in U.S. Pat. No. 3,281,534 to Dersch and U.S. Pat. No. 3,752,929 to Fletcher. Devices using thermistor which are for monitoring breathing are disclosed in U.S. Pat. No. 3,316,902 to Winchel, U.S. Pat. No. 3,645,133 to Simeth et al., and U.S. Pat. No. 3,735,752 to Rodder. U.S. Pat. No. 3,383,466 to Hillix et al. discloses a speech analysis and recognition system. U.S. Pat. No. 3,410,264 to Frederick discloses a pressure sensitive transducer for use in measuring nasal air resistance. U.S. Pat. No. 2,831,181 to Warner shows another respiration monitoring device utilizing a thermally sensitive element (i.e. a thermocouple).

SUMMARY OF THE INVENTION

One embodiment of the present invention is an apparatus for detecting the presence of nasal air escape during speech comprising a device presenting at an output an electrical characteristic dependent upon the temperature of the device, first means for positioning the device within a path of nasal air flow and not of oral air flow, and second means coupled to the output of the device for indicating relative values of the electrical characteristic.

An object of the present invention is to provide a quick and reliable, nonrestrictive and nonobstructive electrometric detection test method which is easy to use for the detection of nasal air emission in patients with rhinophonia.

It is a further object of the present invention to provide a nasal air flow detection method useful to differentiate dysarthrophonia, neuromuscular incoordination and physical defects from nasality due to incompetent velopharyngeal valve mechanism.

It is a still further object of the present invention to provide a nasal air flow detection method useful to a patient and his speech therapist during therapy sessions or speech exercise to detect any nasal air leak during speech, especially when it is variable.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a schematic diagram of a nasal air flow detector according to the present invention.

FIG. **2** shows a nose mask including, in a passageway for air flow, the thermistor of the circuit of FIG. **1.**

DESCRIPTION OF THE PREFERRED EMBODIMENT

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiment illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Referring in particular to FIG. **1,** there is shown a schematic diagram of an embodiment of the present invention. Thermistor **11** and resistor **12,** together with resistor **13,** form a voltage divider between $+V_1$ and $-V_1$. $+V_1$ and $-V_1$ and +12 volts and −12 volts respectively and are obtained from a standard DC supply. Thermistor **11** serves as a nasal air flow sensor which is positioned in the path of the subject's nasal air flow and is maintained at about 50°C. with no air flow across the thermistor. Thermistor **11** is a type GB32J2, and resistors **12** and **13** are selected to maintain sufficient current in thermistor **11** to keep it at the 50°C. temperature, with typical values of resistors **12** and **13** being 820 ohms and 1,500 ohms, respectively.

Potentiometer **17** is coupled to the $+V_1$ supply and is set so that point **16** is maintained at 0 volts when there is no air flow across thermistor **11.** Amplifier **18** receives its positive input from potentiometer **17** and its negative input from the voltage at point **14** coupled through resistor **19.** There is also a feedback resistor pair from point **16** at the output of amplifier **18** to the negative input of amplifier **18.** Either resistor **21** or **22** may be switched into the feedback circuit to determine the gain of amplifier **18.** Typical values for these resistors are 540K ohms and 270K ohms. Amplifier **18** is a type uA741c.

As stated, potentiometer **17** is adjusted so that there is a 0 output of amplifier **18** at point **16** when there is no air flow across the thermistor **11.** If there is air flow across thermistor **11,** its temperature goes down and its resistance increases. The increase in resistance of thermistor **11** causes the voltage at point **14,** and hence

at the minus input of amplifier **18,** to go down and the voltage at point **16** at the output of amplifier **18** to go up. The gain of the amplifier **18** is such that the voltage at point **16** varies between 0 and 5 volts.

The analog voltage signal at point **16** is converted to digital form by the next circuit stage. A voltage divider is established between $+V_2$ and $-V_2$, which are +5 volts and −5 volts, respectively. The resistance values in the divider are chosen so that the voltage at point **23** is 4 volts; at point **24,** 3 volts; at point **26,** 2 volts; and a point **27,** 1 volt. Each of these voltages is applied to the negative input of a different comparator. Comparators **28, 29, 31** and **32** are also uA741c operational amplifiers. The + input to each comparator is the voltage at point **16.** At the outputs of the comparators, the signal from amplifier **18** has been converted from analog to digital form. The diodes at the outputs of the comparators prevent negative voltage excrusions so that the input to exclusive OR gates **33, 34** and **36** is TTL compatible.

The exclusive OR gates **33, 34** and **36** decode the comparator outputs into binary coded decimal (BCD) form with only the numbers 1, 2, 4 or 8 possible. The BCD number is decoded by decoder driver **37** into seven segment display form and coupled to seven segment display **38.** The exclusive OR gates are type SN7486 and the decoder driver is type SN7447.

In operation, as an example, if the air flow across thermistor **11** increased its resistance sufficiently to increase the output of amplifier **18** to 3½ volts, 3½ volts is then applied to the positive input of each of comparators **28, 29, 31** and **32.** Comparator **32** will have a positive output since its negative input is at 1 volt and its positive input is at 3½ volts. Comparator **31** will have a positive output since its negative input is at 2 volts and its positive input is at 3½ volts. Comparator **29** will have a positive output because its negative input is at 3 volts and its positive input is at 3½ volts. Comparator **28** will have a 0 output because its negative input is at 4 volts and its positive input is at 3½ volts.

Therefore, exclusive OR gate **36** will have two high inputs and its output will be low. Exclusive OR gate **34** will also have two high inputs and its output will be low. Exclusive OR gate **33** will have a high input from comparator **29** and a low input from comparator **28,** and therefore the output of exclusive OR gate **33** will be high. The direct connection from the output of comparator **28** to the 8-input of decoder driver **37** will be low, as stated above. The only high input to decoder driver **37** will be at the 4-input and decoder driver **37** will drive seven segment readout **38** to display a **4.**

The use of exclusive OR gates **33, 34** and **36** will assure that only one digit is decoded at a time. While the analog-to-digital (A/D) conversion illustrated results in only four digits, it can be seen that the conversion scheme may be easily expanded by the addition of divider elements, comparators and exclusive OR gates up to, for example, ten digits rather than four.

In FIG. **2,** there is shown a nose mask **42** mounted on a nose **41** of a subject being tested for nasal air flow and nasality. Nose mask **42** has a pair of air channels such as **44,** one channel being provided for each nostril. Thermistor **11** is mounted within air channel **44** and a second thermistor may be mounted in the other air channel of nose mask **42.** If a second thermistor is used, it may be electrically connected in parallel with thermistor **11** in the circuit. As can be seen, nasal air flow will be directed through air channel **44** and across thermistor **11,** lowering its temperature and increasing its resistance, resulting in functioning of the circuit of FIG. **1** as described. Connecting cable **43** contains the necessary connecting leads for the thermistor and makes the necessary electrical connections from the thermistor in the nose mask to the detection portion of the circuitry as described above.

It can be seen that there has been provided a quick and reliable, nonrestrictive and nonobstructive electrometric detection test apparatus which is easy to use for the detection of nasal air emission in patients with rhinophonia.

It can also be seen that there has been provided a nasal air flow detector which is useful to differentiate dysarthrophonia, neuromuscular incoordination and physical defects from nasality due to incompetent velopharyngeal valve mechanism.

It can also be seen that there has been provided a nasal air flow detector, useful to a patient and his speech therapist during therapy sessions or speech exercise, to detect any nasal air leak during speech.

While there have been described above the principles of this invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation in the scope of the invention.

The invention claimed is:

1. A method in the area of speech evaluation for detecting the presence and extent of nasal air emissions of a subject during speech comprising the steps of:

positioning, within a path of nasal air flow of the subject, sensor means, including a first element sensitive to temperature, for presenting at an output an electrical characteristic dependent upon the temperature of the first element;

having the subject speak; and

detecting relative values of the electrical characteristic of the sensor means which are produced by nasal air emissions of the subject during said speaking for the purpose of evaluating the nasal air flow of the subject indicated by the electrical characteristic at the output of the sensor means with regard to what is spoken by the subject.

2. The method of claim **1** which comprises the additional step, after said detecting step, of:

producing a visual display corresponding to said relative values of the electrical characteristic.

3. The method of claim **2** in which the step of having the subject speak comprises having the subject speak a plurality of preselected test phrases.

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