# United States Patent

**Lamp**

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[54] **DIGITAL HEARING AID GAIN ANALYZER**


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[52] **U.S. Cl.** .....**179/175.1 A**, 179/107 R

[51] **Int. Cl.** .....**H04r 29/00**

[58] **Field of Search**.....179/175.1 A, 175.1 R, 107 R, 179/1 N, 1 MN; 181/0.5 AP



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,156,316 | 11/1964 | Barney et al | 181/0.5 AP |
| 2,571,979 | 10/1951 | Webster | 179/175.1 A |

FOREIGN PATENTS OR APPLICATIONS

| | | | |
|---|---|---|---|
| 909,969 | 5/1942 | Germany | 179/175.1 A |



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[57] **ABSTRACT**

A digital display hearing aid gain analyzer is provided for measuring the gain of hearing aids over a predetermined frequency range. A sine wave oscillator generates a predetermined sine wave frequency in an anechoic chamber. The hearing aid to be tested is then connected in the chamber to a microphone pickup housed in a 2 cubic centimeter coupler and picks up and amplifies the sine wave signal in the chamber which is then converted from a linear sine wave signal to a logarithmic signal to a digital type signal indicative of the gain of the hearing aid which is then displayed on Nixie tubes.


**9 Claims, 2 Drawing Figures**

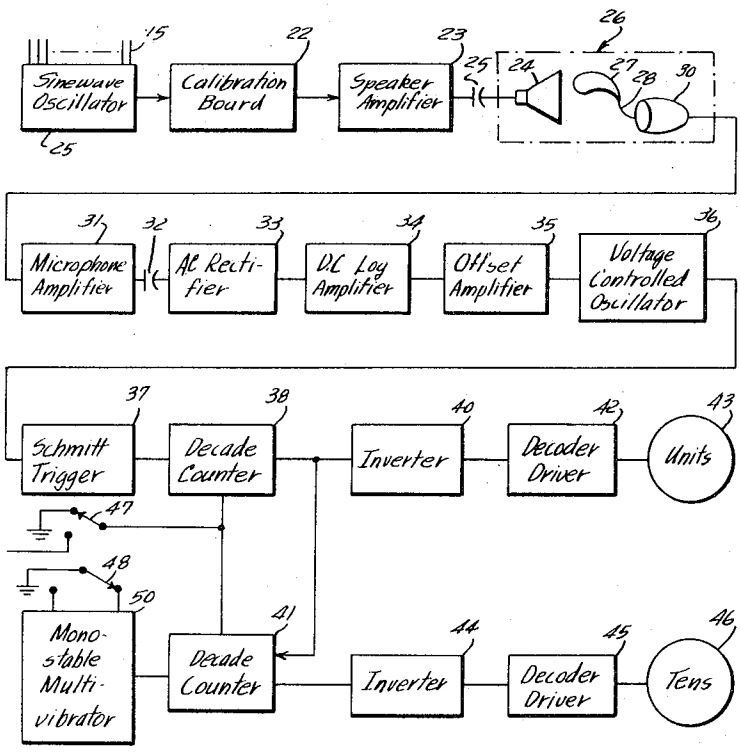


Fig. 2

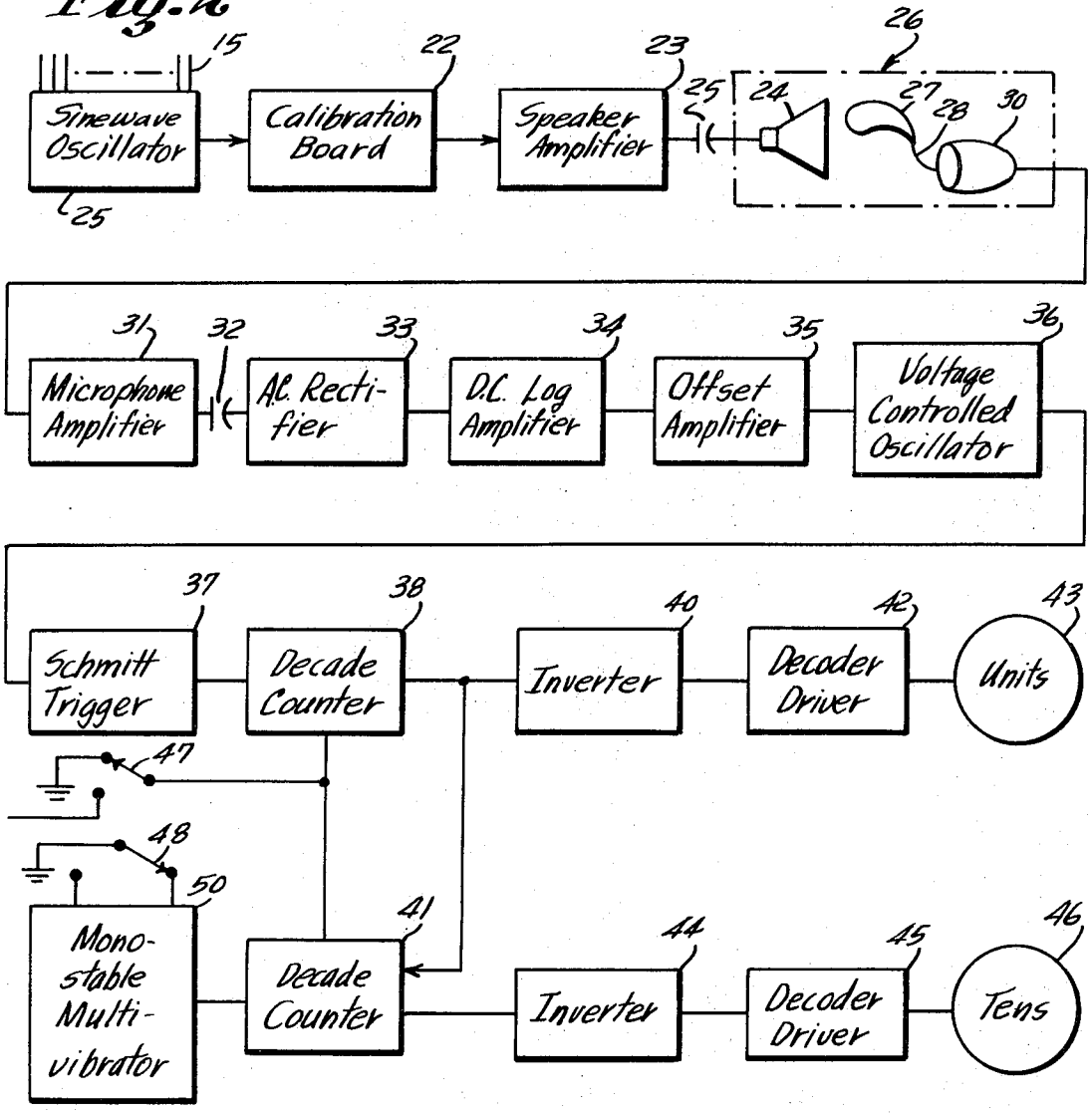
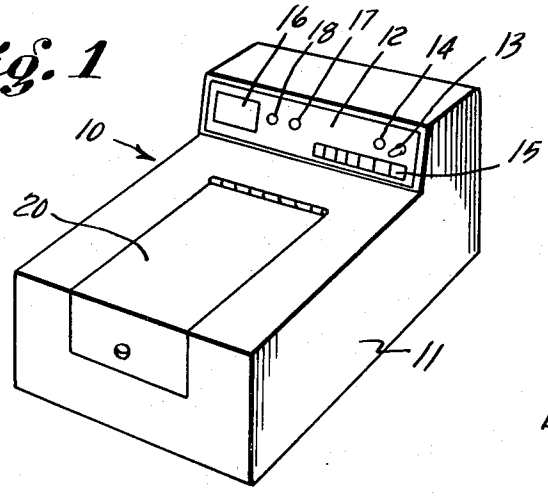



Fig. 1




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# DIGITAL HEARING AID GAIN ANALYZER

## BACKGROUND OF THE INVENTION

The present invention relates to gain analyzers and especially to gain analyzers for analyzing the gain of hearing aids displaying the gain in digital form.

In the past it has been common to provide various types of gain analyzers for different types of amplifiers. This has been especially true in audio amplifiers in which the gain is measured as the ratio of the output voltage to the input voltage. These circuits generally relate to the input and output voltages, and are measured by isolating the circuit from the remaining circuit and providing means for measuring the input and output voltages and comparing these voltages. However, these types of gain analyzers have not been satisfactory for hearing aid testing in that they require that the hearing aid be dismantled and a predetermined voltage applied to the amplifier section and measured at the output, which voltage must be measured across various ranges of frequencies. The hearing aid microphone and receiver of the hearing aid must be tested separately.

Accordingly, it is one object of the present invention to provide a gain analyzer for hearing aids in which the hearing aid can be easily attached without disassemble and the gain rapidly measured and displayed in digital form across a range of stepped frequencies to determine how well the hearing aid is operating and whether it requires repair or replacement.

## SUMMARY OF THE INVENTION

The present invention relates to a gain analyzer for hearing aids, or the like, having a digital display. A sine wave generator or oscillator is provided which can generate a sine wave over a wide range of frequencies in predetermined steps which waves are converted to sound by a transducer located in an anechoic chamber. The hearing aid to be tested is placed in a chamber with its receiver end connected to a microphone pickup in a 2 cubic centimeter coupler which coupler simulates the cavity of a human ear and isolates the microphone from the chamber. With the hearing aid turned on the microphone will pick up signals generated by a sine wave oscillator. Analog-to-digital conversion circuitry converts the signals from the hearing aid to digital signals indicative of the gain of the hearing aid. The digital signals are counted and displayed on Nixie tubes in digital form.

## BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of this invention will be apparent from a study of the written description and the drawings, in which

FIG. 1 is a perspective of a gain analyzer illustrating the inputs and digital displays; and

FIG. 2 is a block diagram of one embodiment of the electrical components of the present invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, a gain analyzer is illustrated in a casing 11 and having a control panel 12 with an on-off switch 13 and a light 14 to indicate when the apparatus is in an operative position. Push-switches 15 allow the selection of any one of a plurality of frequencies, in this case starting with 250 through 4,000, having steps of 500, 1,000, 1,500, 2,000 and 3,000. The control panel also has a digital display output 16 which displays the gain of an amplifier in decibels in digital form for easy reading and has a reset switch 17 and a count switch 18. A liftable top 20 allows a hearing aid to be inserted inside an anechoic chamber for testing.



Referring now to FIG. 2 each of the switches 15 controls the sine wave oscillator 21 to generate a predetermined sine wave frequency which is applied to a calibration 22. The calibration board consists of a series of parallel connected adjustable resistors or rheostats each in series with a switch so that each one can be switched and adjusted to assure the correct output level for that frequency. THe signal is next applied to a speaker amplifier 23 where the signal is amplified which amplifier is coupled to a speaker 24 through a coupling capacitor 25. Speaker transducer 24 is located in an anechoic chamber 26 and reproduces the sine wave at a predetermined frequency and gain in the chamber 26. The chamber 16 may have a hearing aid 27 placed therein with its receiving tube 28 connected to a microphone or similar transducer 30. Thus with the hearing aid turned to an on position, the sine wave oscillator operated at a predetermined frequency, the hearing aid will pick up the sound generated in the chamber 26, amplify it, and produce the amplified sound in the sound tube 28 which is picked up by the microphone 30 housed inside a commercially available 2 cubic centimeter coupler which simulates the human ear and also isolates the microphone 30 from the chamber 26. Microphone 30 impinges the signal upon a microphone amplifier 31 which amplifies the signal and couples it through a capacitor 32 ro a precision AC rectifier 33. The AC rectifier 33 converts the alternating current signal to direct current which direct current may be intermittent in nature. The AC rectifier 33 applies the signal to a DC logarithmic amplifier 34, which amplifier provides an amplified output which is a logarithmic function for conversion of linear-to-log, hence decibels, of the input, which signal is then applied to an offset amplifier 35 and then to a wide band voltage controlled oscillator 36. The voltage controlled oscillator is one in which the oscillator frequency varies in proportion to the controlled voltage being applied to the oscillator. These signals are then applied to a Schmitt trigger 37 which gives fixed output levels for predetermined input levels. The output of the Schmitt trigger is applied to the first decade counter 38 which provides one pulse output for each pulse applied to the input decade counter. The output of the decade counter is applied to inverter 40 into a second decade counter 41. Inverter 40 inverts the signal from a decade counter for the decoder driver 42 which drives a units Nixie tube 43 for displaying the units portion of the output in decibels. Second decade counter 41 receives only one input pulse for every 10 input pulses to decade counter 38 and therefore counts in tens. The output from the decade counter 41 is applied to a second inverter 44 for inverting the signal and applying to the decoder driver 45 for providing the output for the display Nixie tubes 46 which is a tens unit. A reset switch 27 discharges the decade counter for resetting the display tubes for the next frequency test. A counting switch 48 is connected to a one-shot or monostable

multivibrator **50** which is activated by the count switch **48** and will actuate the monostable multivibrator **50** for gating counting signals to the decade counter **41**. The monostable or one-shot multivibrator **50** has only one condition of steady state equilibrium in which the circuit can remain for an indefinite period of time and there is one condition of momentary equilibrium in which the circuit remains on for one millisecond period of time. Each time the triggering pulse from the count switch **48** is applied the circuit first switches to the momentary equilibrium condition and then after a finite period of time reverses to the original condition and remains in that condition until another pulse is applied. Thus, by pushing the count switch **48** a gate is opened for 1 millisecond by the monostable to allow counting of pulses from the voltage controlled oscillator to the decade counter. Although the voltage controlled oscillator runs at a 5 digit frequency, the 1 millisecond gate allows only the first two digits to be counted, hence increasing the count accuracy 1,000:1.

Thus it should be clear at this point that a digital hearing aid gain analyzer has been provided which will accept a head worn type hearing aid and measure its gain displaying it in decibels by virtue of Nixie display tubes. The power supply for the electronic circuits is not illustrated since it is of course assumed that power supply will be required which may include simple half wave and full wave bridge rectifiers to provide the desired voltages. The analog circuitry may comprise the sine wave oscillator **15**, a voltage control oscillator **36**, a microphone amplifier **31**, a precision rectifier **33** and direct current logarithmic amplifier **34** and an offset amplifier **35**. Sine oscillator **15** is a Wien bridge type which produces a pure sine wave to drive a speaker **24** with pure tone. This tone in turn is sensed by the hearing aid **27** to be measured; the gain of the hearing aid is in turn sensed through a microphone **30** and amplified by the microphone amplifier **31**. This amplified signal is rectified by the precision rectifier circuit **33**. The output of this rectifier **33**, which is a varying minus DC voltage, drives a DC logarithmic amplifier **34** converting a linear voltage into a logarithmic one, hence converting it to decibels. DC log amplifier **34** drives the offset amplifier **35** which in turn supplies the voltage controlled oscillator with a voltage comparable to the gain of the hearing aid **27**. The voltage controlled oscillator **36** is a wide-band complimentary type flip-flop driven by a current source. Its frequency will vary depending upon the gain of the hearing aid. It is this frequency that is fed to the digital counter which in turn displays it as decibel gain. The digital displaying counter circuitry enhances a units and tens counter of the binary type. Units to be counted are produced by a voltage control oscillator **37**, shaped through a Schmitt trigger **37** and fed into the unit counter **38**. The counting time is determined by one-shot multi-vibrator **30** which may be set to a 1 millisecond time period. Since this is a manual type counter, the reset switch **48** must be operated before the count switch will allow the counter to count. The individual circuits used in the present invention are of conventional design and other circuits of the same general type can be utilized as desired. Accordingly this invention is not to be construed as limited to the particular forms disclosed herein since these are to be regarded as illustrative rather than restrictive.

I claim:

**1**. A gain analyzer apparatus for measuring the gain of audio amplifying devices comprising in combination:

a. chamber means;

b. signal generating means for generating predetermined audio frequencies;

c. transducer means coupled to said signal generating means and located in said chamber means for producing said audio frequencies in said chamber means;

d. microphone means located in said chamber means and having means for acoustically coupling the output of an audio amplifying device thereto, whereby said audio amplifying device is adapted to amplifying said audio frequencies in said chamber means and apply said amplified audio frequencies to said microphone means;

e. analog to digital conversion means coupled to said microphone means for generating digital signals from the output from said microphone means, said digital signals being indicative of the gain of the amplifying device being analyzed; and

f. counting means coupled to said analog to digital conversion means for counting digital signals received from said analog to digital conversion means.

**2**. The apparatus according to claim **1** in which said chamber means is an anechoic chamber.

**3**. The apparatus according to claim **1** in which said counting means includes Nixie display tubes for displaying the counted digital signals as the gain of said amplifying device at a predetermined input frequency.

**4**. The apparatus according to claim **3** in which said transducer means is a speaker.

**5**. The apparatus according to claim **4** in which said microphone means includes a microphone in a 2 cubic centimeter coupler for coupling the amplifying device to said microphone.

**6**. The apparatus according to claim **5**, in which said microphone is located in a coupler having a simulated human ear cavity.

**7**. The apparatus according to claim **6** in which said signal generating means is a sine wave oscillator.

**8**. The apparatus according to claim **7** in which said amplifying devices are hearing aids having microphones amplifiers and receivers with said receivers coupled to said microphone means for transmitting sound picked up and amplified by said hearing rectifying

**9**. The apparatus according to claim **1** in which said analog to digital conversion means includes a rectifying means for rectifying said signals from said microphone means and a logarithmic amplifier for converting linear signals from said rectifying means to logarithmic signals whereby the output of said analog to digital conversion means will be in decibels.

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