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CARL-AXEL E. TEGNÉR ET AL

3,037,082

AUDIOMETERS

Filed Dec. 10, 1958

2 Sheets-Sheet 1

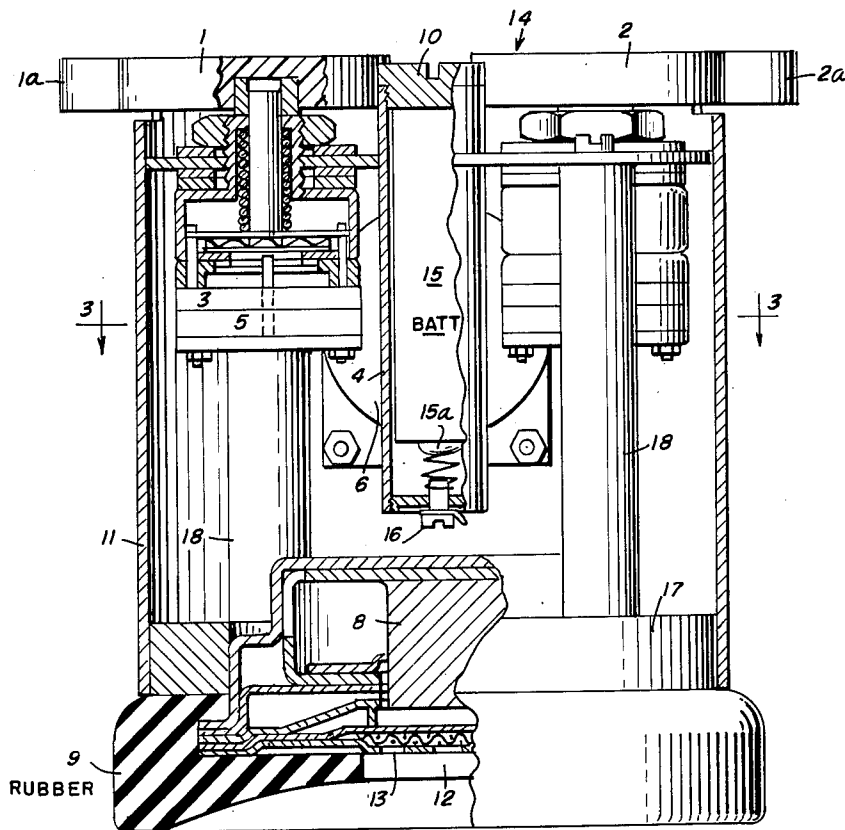


FIG. 1

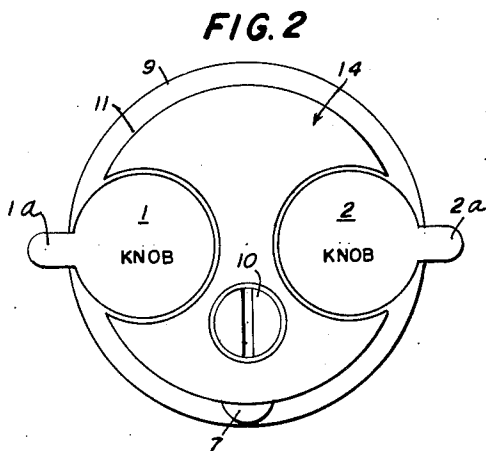


FIG. 2

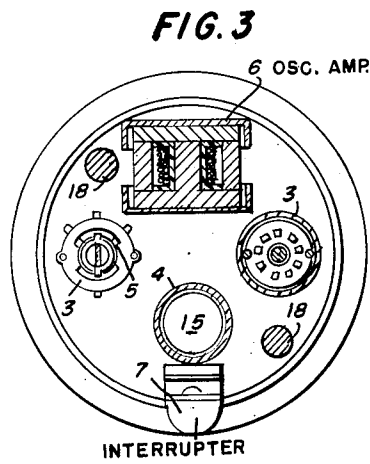


FIG. 3

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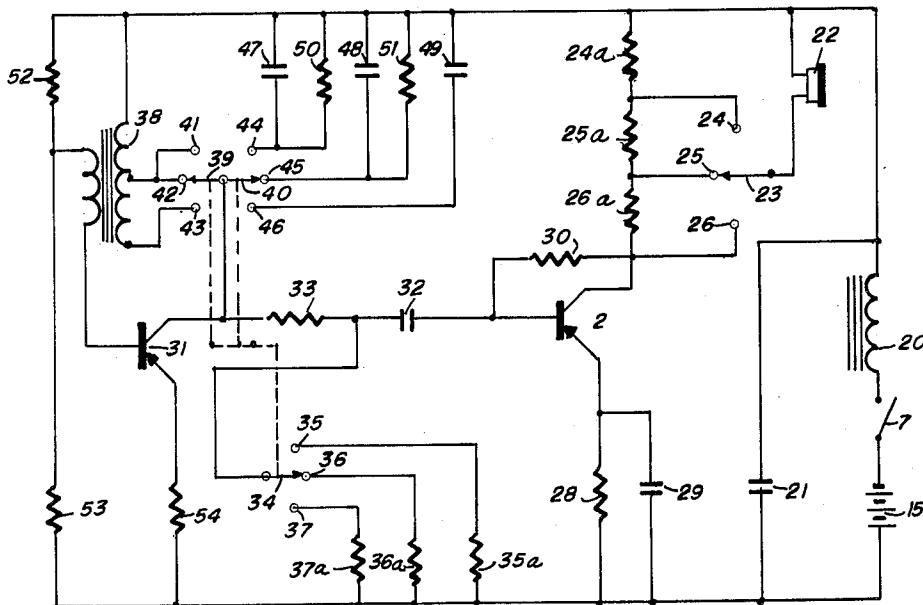


FIG. 4

1

3,037,082

AUDIOMETERS

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3 Claims. (Cl. 179—1)

This invention relates to an audiometer or apparatus for determining the threshold values of human hearing.

In known designs the electrical parts of the audiometer comprise an oscillator with at least one amplifying stage and an attenuation set. The audiometer can be connected either to the mains of an electrical supply system or to batteries. A cord connects the apparatus to a receiver which is applied to the patient's ear by means of a headband. The measuring is effected by adjusting the audiometer to emit a tone of a selected frequency and subsequently transmitting to the patient tone impulses of varying intensity and having a duration of about one second. Then the same test is performed with tones of other frequencies. When the patient perceives these tone impulses in his receiver he signals to the operator, and the operator then can ascertain the patient's threshold values for the different frequencies. The impulses are generated by operating a switch, called an interrupter, which opens and closes an electric oscillator circuit. The measuring is based on the condition that the patient will signal to the operator when he perceives the actual tone and not when he hears a click, a sliding frequency, or some other form of distortion of the tone, and the degree of permissible distortion as well as the time for the intonation and/or fading of the tone have been determined by international standards.

An interrupter which meets the demands of such standards can be designed in several ways. When an LC-oscillator is used, the impulses usually are derived by interrupting the anode voltage circuit of the oscillator tube. If an RC-oscillator or beat-frequency oscillator is used, the tone circuit is usually interrupted by blocking one of the amplifying stages which follow after the oscillator.

All known solutions of the interrupter problem entail complicated and expensive constructions, and, in addition, it is a disadvantage that no appreciable reduction of the consumption of current is obtained in the pauses when no tone impulse is emitted by the audiometer. In an audiometer supplied from the mains of a power-supply the current drain is of little importance, but in a battery-driven audiometer the current drain is an important factor since the size of the audiometer is largely dependent on the size of the battery or batteries. A measurement of hearing usually takes at least 20 minutes. During this period 100 to 120 impulses are emitted, each having a duration of about one second, that is to say, the audiometer emits a tone impulse during slightly less than a tenth of the time for measuring the hearing.

The main object of the present invention is to eliminate these disadvantages by connecting the interrupter in the oscillator circuit in series between the source of current and the oscillator.

A further object of the invention is to make the interrupter in itself free from distortion when connected in a transistor circuit and to render the interrupter adaptable to standard time constants. In this way the interrupter may have a simple and inexpensive construction.

A still further object is to provide an audiometer which consumes current when the impulses are emitted only, but not in the pauses, whereby the current drain of the audiometer will be reduced to a minimum. In this way the current may, for example, be reduced to less than a tenth compared with known constructions of similar type.

2

In all audiometers the interrupters comprise a resilient contact member and the tone is interrupted in the resting or inactive position of this contact member. Since, according to our construction an interruption of the tone is caused by an interruption of the current supply circuit, it is a further object of the invention to prevent the audiometer from remaining connected to the current supply by an oversight, which often happens with battery-driven apparatus of this type. One reason for this fault is that it is not possible to use a warning lamp indicating when the current supply is connected, since this lamp would consume more current than the whole audiometer.

A still further advantage of the invention is that the reduced current drain facilitates the use of small batteries. Also the overall dimensions of the audiometer may be reduced considerably, which is most desirable from practical point of view. In the construction according to the invention the oscillator and the amplifier units, together with the source of current and the operating or control means may be built together in a common casing which is small enough to be mounted directly on the receiver so that the operator, when making tests, can hold the entire set in his hand and press it against the patient's ear.

One embodiment of the audiometer according to our invention is illustrated as an example on the accompanying drawing, in which

FIG. 1 shows the audiometer in longitudinal section,

FIG. 2 shows a top view of the audiometer,

FIG. 3 is a cross section on the line III—III in FIG. 1, and

FIG. 4 is a diagram of the electrical circuits of the audiometer.

In the embodiment shown in the drawing the audiometer comprises a casing 11 having at one end a receiver provided with a rubber cushion 9 for instance, which is held against the ear of the patient during the testing. The receiver has a central aperture 12 through which the sound from a conventional telephone cap 8 with a diaphragm may penetrate into the ear of the patient. The top 14 and the bottom 17 of the casing 11 are interconnected by means of rods 18, holding the top 14 and the bottom 17 together. Within the casing 11 there is also arranged a battery box 4 secured to the top 14 of the casing 11 and closed by a screw cap 10. The box 4 encloses a battery 15 which supplies a tone oscillator 6 comprising an amplifier with transistors. One terminal 15a of the battery 15 contacts a fixed contact 16 connected to other elements of the circuit in a manner to be described with reference to FIG. 4, and the other terminal of the battery 15 contacts the metallic part of the top 14 which is conductively connected to certain elements of the circuits.

The oscillator 6 is of known design and need not be described. It is connected electrically to the telephone cap 8. The oscillator amplifier 6 is also connected to an attenuator set 3, a frequency switch 5 and an interrupter 7, which is connected in the circuit between the battery 15 and the oscillator amplifier 6. The interrupter 7 comprises a switch with one fixed and one resilient contact member, said members being brought into electrical contact with one another to close the circuit on operating the interrupter with the hand or finger of the operator. The attenuator set 3 is used for adjusting the intensity of sound by means of a knob 1, graded in decibels of loss of hearing. For adjusting the pitch of sound the frequency switch 5 is set by a knob 2, graded in cycles per second.

To enable operation with one hand each of the rotatable knobs 1 and 2 may be fitted with a projecting wing or flap 1a and 2a, respectively, to facilitate operation with the fingers of the operator.

FIG. 4 shows that the interrupter 7 is connected in series between the battery 15 (2.6 volts) and a choke coil

20, intended to eliminate the occurrence of clicks on breaking the circuit. Shunted across the choke coil and the battery is an electrolytic condenser 21 (50 mf.). The choke coil 20 is connected to a circuit including the receiver 22 and a change-over switch comprising a movable contact arm 23 which may be moved so as to contact a number of fixed contacts 24, 25 and 26 in succession, thereby varying the intensity of the emitted tone. Each fixed contact 24, 25, 26 respectively, is connected to a resistance 24a (2.5 ohms), 25a (24 ohms) and 26a (500 ohms) respectively.

In this way the intensity of the tone received in the receiver 22 will be varied. The contact position 24 corresponds to a value of 20 decibels, for instance, contact position 25 to a value of 40 decibels, and contact position 26 to a value of 60 decibels on the scale of the knob 1 in FIG. 1. Of course the invention is not restricted to these or other numerical values appearing in this specification, which are mentioned as examples only.

The amplifier circuit includes a transistor 27 connected to a resistance 28 (1 kilo-ohm) and an electrolytic condenser 29 (50 mf.) which has the purpose of supplying a predetermined base current to the transistor. A resistance 30 (20 kilo-ohms) is connected between the resistance 26a and the transistor 27.

A further transistor 31 is connected in the oscillator circuit and a resistance 33 (100 kilo-ohms) and a condenser 32 (0.04 mf.) are connected in series between the two transistors 31 and 27. For the control of the volume there is arranged a switch device comprising a contact arm 34 which can be moved to contact one of a plurality of fixed contacts 35, 36 and 37 in succession, each connected to a calibration resistance, 35a, 36a and 37a, respectively, calibrated to the value which gives the specified tone intensity for the frequency used.

38 is an oscillator coil from which different frequencies may be derived, by means of a switching device comprising interconnected movable contact arms 39, 40, and a plurality of fixed contacts 41, 42, 43 and 44, 45, 46 respectively. Contacts 41, 42 and 43 are connected to different tap points of the coil 38. Contacts 44, 45, 46 are each connected to a condenser 47 (0.01 mf.), 48 (0.2 mf.) and 49 (0.18 mf.) respectively. Contacts 44 and 45 are also connected to a resistance 50 (5 kilo-ohms) and 51 (2 kilo-ohms) respectively. The contact arms 39, 40 are interconnected mechanically to contact arm 34 so that they will move together, the result being that the frequency will be varied from 4,000 cycles/sec., for in-

stance (contacts 41, 46), to, say, 1,000 cycles/sec. (contacts 42, 45) and to 250 cycles/sec., for instance (contacts 43, 44). Other frequencies may be used and if desired one sole frequency (of instance 4,000 cycles/sec.) may be used, or two frequencies (for instance 2,000 and 4,000 cycles/sec.) may be used.

52, 53 and 54 are further resistances having a value of 26 kilo-ohms, 1.6 kilo-ohms and 2 kilo-ohms respectively.

While we have illustrated and described the preferred form of construction for carrying the invention into effect, this is capable of variation or modification without departing from the spirit of the invention. We therefore do not wish to be limited to the precise details disclosed but desire to avail ourselves of such variations or modifications as fall within the scope of the appended claims.

What we claim is:

1. An audiometer comprising an audio frequency oscillator and an amplifier connected to the oscillator output and comprised of electronic valves in the form of transistors, a speaker connected to the output of said amplifier, a source of current for supplying electrical energy to said oscillator and said amplifier, an interrupter connected in series between said source of current and said oscillator and amplifier, for interrupting the total current supply to said oscillator and amplifier, said interrupter having a manually operable actuating member, filtering means in the form of a choke connected in a series circuit with the current supply and switch and a capacitor shunting said series circuit for smoothing out the transients caused by the interrupter, when said current supply is closed or interrupted.

2. An audiometer according to claim 1, wherein said speaker, oscillator, interrupter and source of current are assembled in a casing so as to form one single unit that the operator can hold at the ear of the patient when making the test.

3. An audiometer according to claim 1, wherein said actuating member of said interrupter comprises a push-button in easy reach of one of the operator's fingers when he holds said casing in his hand, said push-button being spring actuated for restoring it to its non-actuated position.

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