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[54] **1 DB STEP ATTENUATOR**

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[52] **U.S. Cl.** ..... **333/81 R,** 323/80, 323/97

[51] **Int. Cl.** **Ho3h 7/26**

[58] **Field of Search** ..... 333/81 R; 323/74, 80, 97; 179/1 N

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[57] **ABSTRACT**

An attenuator for audiometers and including a 5 dB step attenuator ladder, additional 1 dB step attenuator resistances connected in series with each other and connected by means of switching areas and wiper contacts moving over such switching areas of a switching plate to sequentially connect all of such resistances in series with the attenuator ladder and progressively short each such resistance out of the attenuation circuit as the wiper contacts move across the switching areas and thereby obtain a 1 dB step attenuation while maintaining the large increments in the 5 dB step attenuator ladder.

6 Claims, 4 Drawing Figures

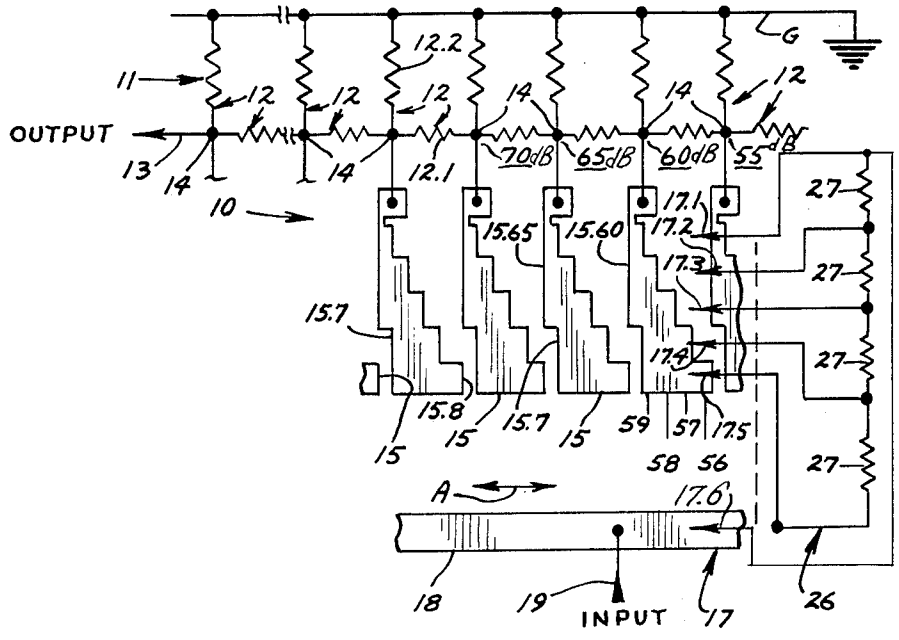


FIG. 1

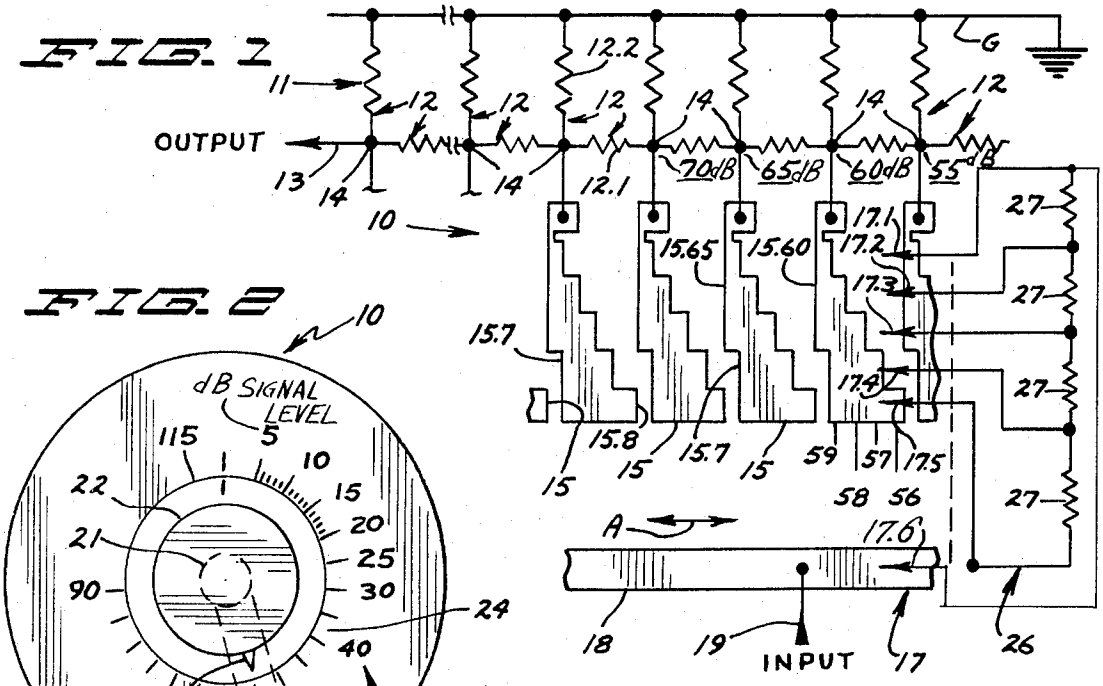


FIG. 2

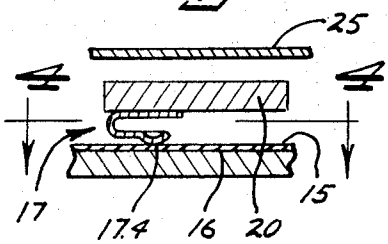


FIG 3

FIG. 4

1 DB STEP ATTENUATOR

BACKGROUND OF THE INVENTION

An audiometer generates audio frequency signals of varying frequencies which must be applied to a transducer, usually a headphone, to generate sounds of various frequencies in order to test the hearing capability of a person. These audio frequency signals are very carefully controlled on a calibrated scale so that the intensity of the sound generated, usually measured in dB, may be varied and accurately controlled to certain intensity levels with repeatable consistency.

The magnitude of the audio frequency signal which is applied to the transducer is generally varied by means of an attenuator ladder, by applying the signal input to the attenuator ladder at various locations along its length so as to vary the signal attenuation while taking the output from the attenuator ladder off its end. The incremental attenuation between adjacent sections of an attenuator ladder is regulated by the size of resistors in each section of the attenuator ladder and by the total number of resistors or the total number of sections in the ladder.

It is reasonably convenient to set up an attenuator ladder wherein there is a 5 dB attenuation between adjacent sections of the ladder, so that, as the input is successively applied to adjacent sections of the ladder during an attenuation changing operation, the attenuation of the signal will be changed incrementally by 5 dB increments.

Similarly, as the number of resistors and the size of resistors is properly selected, the incremental change of attenuation between adjacent sections of the attenuator ladder may be reduced to 1 dB of attenuation, but, in order to have an attenuator of sufficient sections as to sweep through the desired range of attenuation, the attenuator ladder becomes extremely bulky with a large number of sections to the ladder.

BRIEF SUMMARY OF INVENTION

This invention embraces an attenuator for an audiometer wherein the audiometer is to produce an incremental change of sound generated by the transducer of approximately 1 dB. The 1 dB change in attenuation of the signal is produced by an attenuator system which is substantially simpler with many fewer parts and sections than previously known attenuators.

By means of a multiple contact switching wiper, the various sections of a large increment, such as 5 dB, attenuator are sequentially and progressively connected, and while the wiper produces a connection to each successive attenuator section, a sequence of small increment signal attenuating resistors are first connected in series and then individually shorted out so as to cooperate with the resistance of the attenuator ladder between the input and output whereby the signal applied to the transducer will vary by very small increments while the attenuator ladder has relatively large incremental attenuation sections. More specifically, the present invention may be utilized in connection with an attenuator ladder wherein the successive sections of the ladder, when connected in, produce a 5 dB incremental change in the attenuation. By switching, the multiple contact wiper will initially connect only the several sections of the attenuator ladder between the input and output of the apparatus. As attenuation is to be increased, a small resistor is connected in series with the attenuator ladder to produce a 1 dB incremental change, then a second resistor is connected in series to produce another dB increment change. This switching is accomplished of a stepped conductor area on a printed plate forming a part of the circuit. The connection to any one section of the attenuator ladder is maintained until a positive connection to the next section of the attenuator ladder is produced through a series of small increment resistances so that there is no perceptible click or sound produced in the transducer as the wiper shifts to the various locations along the attenuator ladder.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a schematic view of a substantial portion of the attenuator.

FIG. **2** is an elevation view of the attenuator switching apparatus.

FIG. **3** is an enlarged detail section view taken at **3—3** in FIG. **2.**

FIG. **4** is a greatly enlarged detail section view taken approximately at **4—4** in FIG. **3** and showing the detailed shape of the stepped switching areas on the printed plate and the relationship of the multiple contacts on the wiper which move over the printed plate.

DETAILED DESCRIPTION OF THE INVENTION

One form of the invention is shown in the drawings and is described herein. The attenuator is indicated in general by numeral **10** and is illustrated diagrammatically and schematically in FIG. **1.** The physical arrangement of the attenuator is illustrated in FIGS. **2–4.** Whereas the physical arrangement of the attenuator is indicated to be based on the rotary movement of a wiper in a rotary type control, it is certainly understandable that the physical apparatus could use a linearly moving wiper, somewhat as suggested schematically in FIG. **1.**

The attenuator **10** includes an attenuator ladder indicated in general by numeral **11** of substantially conventional design wherein the attenuator ladder has a number of ladder segments **12,** each of which is substantially identical to the adjacent ladder segments. The output from the attenuator ladder may be taken at the terminal end **13** of the ladder and may be connected to a headphone for generating audio frequency signals. The attenuator ladder **11** has a connection point **14** at each of the ladder segments, and the signal input is applied to the attenuator ladder at one or another of these connection points **14** so as to connect in or short out the desired number of ladder segments and thereby produce the desired degree of attenuation of the signal between the input connection point and the output.

It is contemplated in this attenuator **11** that the attenuation will be changed in 5 dB steps or increments when the input is successively connected first to one connection point **14** and then to the next adjacent connection point.

Whereas each connection point **14** as illustrated is connected to each of the adjacent connection points **14** by a resistance **12.1** of the ladder segment, and each of the connection points **14** is also connected to ground G by another resistance **12.2** of the corresponding ladder segment, it may be that attenuator ladders of varying design may be used such that alternate ladder segments **12** may eliminate the resistance **12.2.** In a similar

way, the attenuator ladder may be varied in design, but in essentially all attenuator ladders there is some form of ladder segment whereby the attenuation is charged and there are a number of connection points **14** between which there is a significant incremental change in signal attenuation as the input to the ladder is changed from one connection point to another.

The several connection points **14** of the attenuator ladder **11** are electrically connected to conductive areas **15** printed or otherwise applied to an insulating rigid substrate or plate **16** of a switch over which a number of wiper contacts **17** will pass. The plate **16** also carries another conductive area **18** to which the signal input is applied at **19.** As the wipers **17** move across and engage the conductive areas **15,** the input signal conductive area **18** is also engaged and connected in the circuit as to be described. The switching assembly also has an insulating rigid rotary wiper arm **20** carried on a rotary hub **21** to revolve within and with respect to the center opening **16.1** of the stationary switchplate **16.** A knob or manual control handle **22** is physically affixed to the hub **21** to revolve the wiper arm **20** relative to the stationary plate **16,** and a pointer **23** on the knob **22** cooperates with a scale **24** on the closure panel **25** of the switching assembly to indicate the output level of the audio frequency signal in decibels at the various rotary positions or settings of the wiper arm **20** and the contact set **17.**

A minute increment attenuator **26** is connected through the contact set **17** between the signal input area **18** and the conductive areas **15.** The minute increment attenuator **26** comprises a plurality of series connected resistors **27,** and at the end of each of the resistors **27,** one of the set of wiper contacts **17.1 – 17.5** is connected. The wiper contacts **17.1 – 17.5** are equally spaced along the wiper arm **20** and are physically aligned as illustrated in FIG. **4** for passing across the conductive areas **15** in a line abreast. A wiper contact **17.6** of similar construction is also provided on the arm **20** for engaging and moving along the conductive area **18.**

The wiper contact **17.6** which supplies the input signal, is connected to one end of the minute increment attenuator, and is connected at the same point as the wiper contact **17.1.** It will therefore be apparent that when the wiper contact **17.1** engages a portion of one of the conductive areas **15,** the entire minute attentuator **26** will be shorted out and effectively out of the circuit; and in this condition, the input signal is applied directly from the conductive area **18** to the wiper contacts **17.6** and **17.1** to the conductive area **15** and directly to one of the connection points **14** of the attenuator ladder.

Whenever the wiper contact **17.2** is connected to one of the conductive areas **15,** and the wiper contact **17.1** is not connected to the corresponding conductive area **15,** the uppermost resistor in the attenuator **26** is connected in the circuit between the input **19** and the attenuator ladder **12** so that a small additional increment of signal attenuation is effected, and in the illustrated embodiment, 1 dB of attenuation is added. As each of the resistances **27** of the attenuator **26** is progressively added into or removed from the circuit, there is a **1** dB change in the attenuation of the signal generated at the transducer of the headphone.

The leading edge of each of the conductive areas **15** has a stepped configuration so as to define a number of engagement areas **15.1 –15.5** over which the wiper contacts **17.1 – 17.5** will respectively pass and engage. The several engagement or contact areas **15.1 – 15.5** are displaced relative to each other in a direction along the course of movement of the wiper arm as indicated by the arrow A so as to effectively cause sequential engagement between a conductive area **15** at each of its contact areas **15.1 – 15.5** as the wiper contacts **17.1 – 17.5** move, in line abreast, across the conductive areas.

By reason of the stepped configuration of the leading edge of each of the contact areas **15,** it will be observed that as the wiper arm is moved to the left in the drawings, any particular conductive area **15** will be first engaged at the contact area **15.5** by the wiper contact **17.5** so as to connect the entire minute increment attenuator **26** in series between the input **19** and the corresponding contact point of the attenuator ladder. As the wiper arm **20** is moved slightly to the left, the next adjacent wiper contact **17.4** will engage the corresponding contact area **15.4** of the conductive area **15** so as to short out one of the resistors **27** of the attenuator **26** and produce less attenuation and more output at the phones or transducer. This is the condition in which the attenuator is adjusted in the drawings with respect to the particular conductive area **15.60** representing the 60 dB signal output level. Because the wiper contact **17.4** is connected to the conductive area **15.60** at the contact area **15.4,** there are three of the resistors of attenuator **26** connected in series with the attenuator ladder **11** so that there is additional attenuation of the signal, and, accordingly, less output. As indicated by the scale markers superimposed diagrammatically in FIGS. **1** and **4,** the wiper arm **20** is actually in the 57 dB signal output position.

If the wiper arm is moved to the left from the position illustrated, additional resistances **27** of the attenuator **26** are shorted out so as to reduce the attenuation of the signal and produce a higher signal output at the transducer, as indicated by the scale.

As the set of wiper contacts **17** pass across the conductive area **15.60** so that finally the wiper contact **17.1** engages the conductive area **15.60,** the entire minute increment attenuator **26** is shorted out and provides no additional attenuation beyond that provided by the attenuator ladder **11.** Signal strength at the output **13** is then at the 60 dB level.

As the contact set **17** moves so that contact **17.5** engages the next adjacent conductive area **15.65,** the attenuation of the signal at the output is reduced by 1 and the signal strength at the output is raised to 61 dB because the connection point **14** of the attenuation ladder **11** at the 65 dB signal level is connected into the circuit and, in addition, all four of the resistances **27** of the minute increment attenuator **26** are in series with the attenuator ladder **17,** thereby adding four additional dB of attenuation to reduce the signal output from 65 dB to 61 dB. Of course, as the contact set moves to the left across the conductive area **15.65,** the several resistors **27** of the minute increment attenuator **26** are sequentially shorted out to reduce the attenuation of the signal and raise the level of signal output as indicated by the scale.

It will be noted that the rear or trailing edge **15.7** is stepped or notched and thereby spaced from the leading edge **15.8** of the next adjacent conductive area **15.** Accordingly, it is not possible for the contact **17.5** to

engage both of the adjacent conductive areas **15** simultaneously.

It should also be noted that there is a small degree of overlap between adjacent conductive areas **115** in a direction along the course of movement of the wiper arm **20** and contact set **17** as indicated by the arrow A. The overlap occurs at the leading edge **15.8** of each of the conductive areas **15** which extends slightly into the step or offset of the trailing edge **15.7** of the adjacent conductive area.

Because of the slight overlap between adjacent conductive areas **15,** the wiper contacts **17.1 – 17.5** will never be in a condition wherein they are not engaging any of the conductive areas **15,** and, of course, if this condition were to occur, it would essentially disconnect the input **19** from the attenuator ladder **11** and the output **13.** Accordingly, in such a condition, the audio signal being produced at the headset or phone would be intermittent. The overlap between adjacent conductive areas **15** requires that the wiper contacts **17.1** and **17.5** be in simultaneous engagement with adjacent conductive areas **15,** respectively, as the wiper arm **20** is swung in either direction. The effect of the simultaneous engagement by wiper contacts **17.5** and **17.1** with adjacent conductive areas **15** is to produce a slightly lower attenuation and the slightly greater signal output in accordance with the condition existing when only the conductor **17.5** is in engagement with the corresponding contact area **15.5.** However, this works no disadvantage and it produces the decided advantage that the conduction of signals is not terminated but is continuous as the attenuator is moved across its entire range by moving the arm **20** around and across the annularly grouped conductive areas **15.**

It will be seen that I have provided an attenuator for an audiometer whereby the audio frequency signals may be progressively attenuated in small increments of attenuation without greatly enlarging the number of segments in a conventional 5 dB step attenuator ladder. The minute increment attenuation is effected by progressively adding or substracting by switching, one or a number of small resistances which effectively are connected in series with the large dB segments of the attenuator ladder, and progressively switching such resistance into and out of the circuit on a sequential basis as the attenuator is progressively connected to the various segments of the attenuator ladder. The overlap between adjacent conductive areas so that the wiper contacts moving in line abreast prevents any interruption of the signal as the attenuator is adjusted for varying output and there is no perceptible click or other noise created by the switching as the wiper contacts move across the conductive areas.

What I claim is:

1. An attenuator for audiometers and the like having an input and output, comprising:

a large increment attenuator ladder having ladder segments and connection points between such segments to produce large increment dB attenuation change at adjacent connection points;

a minute increment attenuator including a plurality of series-connected resistances and having rigidly interconnected wiper contacts connected at the ends of the several resistances;

said output and input being applied to the terminal end of the attenuator ladder and a terminal end of the series-connected resistances; and

a switching plate having a plurality of adjacent conductive switching areas over which such wiper contacts pass in succession, each of said conductive areas being connected to a respective connection point of the attenuator ladder,

said conductive areas and wiper contacts being shaped and arranged relative to each other whereby as the contacts move over such an area, the contacts sequentially engage the conductive area to sequentially change the number of such resistances in series with a particular connection point of the attenuator ladder, and to repeat the sequence of engagement as the contacts move to an adjacent conductive area.

2. The attenuator according to claim **1** and said wiper contacts being arranged in and to move in a line abreast, the conductive areas of the switching plate having individual contact areas each along the course of movement of a particular wiper contact and each contact area being displaced relative to adjoining contact areas in a direction along the course of movement of the wiper contacts.

3. The attenuator according to claim **2** and each of the conductive areas of the switching plate having a stepped leading edge defining such individual contact areas which are displaced relative to each other.

4. The attenuator according to claim **1** and said plate also having an additional elongate unbroken input signal conducting area extending along and adjacent the conductive switching areas, and an additional wiper contact moving along said elongate signal input area and connected to the terminal end of such series connected resistances.

5. The attenuator according to claim **2** and the contact areas of each conductive switching area having various spacings from the next adjacent conductive switching area, the contact area of each conductive switching area which is closest to the next adjacent conductive switching area being engageable with a particular wiper contact which is connected to said terminal end of the series connected resistances.

6. The attenuator according to claim **5** and said contact area of each conductive switching area which is closest to the next adjacent conductive switching area being displaced, in a direction extending along the course of movement of the wiper contacts in overlapping relation with said next adjacent conductive switching area whereby the plurality of wiper contacts in line abreast will simultaneously engage a pair of adjacent conductive switching areas during movement of the wiper contacts in transition from one conductive switching area to the next adjacent conductive switching area.

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