

Dec. 11, 1945.

H. W. KOREN

2,390,840

ATTENUATOR

Original Filed May 31, 1941

Fig. 1.

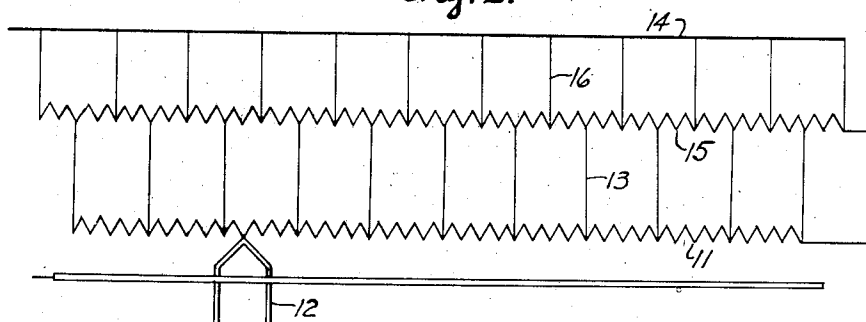


Fig. 2.

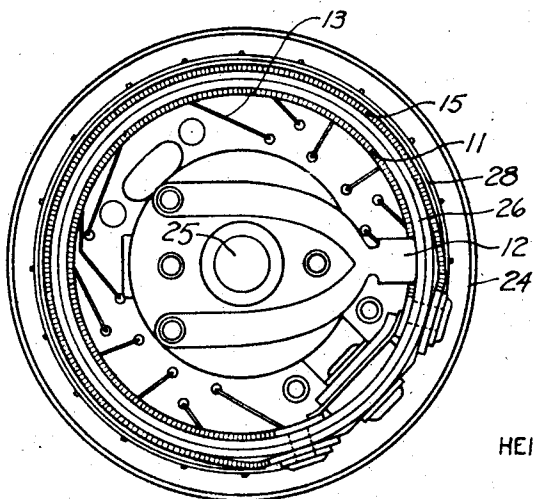
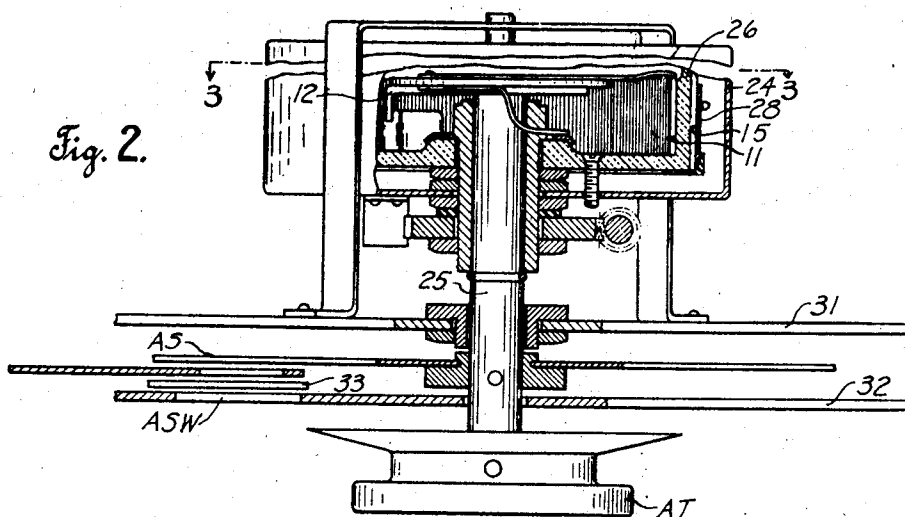


Fig. 3.

HEIMAN W. KOREN, INVENTOR

BY *Pinilla & Greene*
ATTORNEYS

UNITED STATES PATENT OFFICE

2,390,840

ATTENUATOR

Heiman W. Koren, Bronx, N. Y., assignor to Sonotone Corporation, Elmsford, N. Y., a corporation of New York

Original application May 31, 1941, Serial No. 395,927. Divided and this application November 6, 1943, Serial No. 509,306

5 Claims. (Cl. 201—55)

This application is a division of application No. 395,927, filed May 31, 1941, on which Patent 2,356,248 was issued, which in turn is a continuation-in-part of application No. 349,045, filed August 1, 1940, on which Patent 2,257,263 was issued.

This invention relates to attenuators and more particularly to continuously-variable wire-wound attenuators.

Among the objects of the invention is a wire-wound attenuator arrangement combining a wire-wound slider resistance with an additional wire-wound resistance having a sequence of spaced terminal-conductor taps connected to a common terminal conductor and another sequence of spaced taps located intermediate its terminal-conductor taps and interconnected to a sequence of spaced taps of the slider resistance, the resistances and their tap interconnections being so proportioned and arranged that movement of the slider contactor along the slider resistance varies a potential applied to the terminal conductor and a terminal of the slider contact resistance according to a predetermined decreasing function, such as a logarithmic function.

The foregoing and other objects of the invention will be best understood from the following description of exemplifications thereof, reference being had to the accompanying drawing wherein

Fig. 1 is a diagrammatic view of an audiometer attenuator based on the principles of the invention;

Fig. 2 is a cross-sectional view of a practical form of an audiometer attenuator based on the principles of the invention; and

Fig. 3 is a cross sectional view along line 3—3 of Fig. 2.

Attenuators of the type suitable for making accurate measurements have to be so designed as to enable attenuation of the electric output in accordance with a predetermined function, such as a logarithmic function. Thus, a logarithmic attenuator, used for making audiometric measurements, has to be designed to enable the attenuation of the electric output delivered to the receiver in accordance with a logarithmic function defined as the hearing loss in terms of decibels.

A logarithmic attenuator is analogous to an electric transmission line having a leakage resistance which may be represented by serially connected resistor sections representing the line and shunting leakage resistors connected between the individual series resistance sections and the ground representing the leakage resistance of the

line. As far as I am aware, heretofore all logarithmic attenuators having the degree of accuracy required for making accurate audiometric measurements have been made of wire-wound resistor elements connected into a ladder network formed of a plurality of series resistance elements and a plurality of shunt resistance elements interconnected between the junctions of the series resistance elements and a common conducting lead arranged so that the voltage applied to one end of the ladder network was logarithmically attenuated in steps along taps at the junctions between the serially connected resistance sections.

Such attenuators give correct logarithmic attenuations only if contact is established with the taps at the junctions between successive ladder sections, the intermediate points on the series resistors giving a deviation from the logarithmic attenuation which decreases as the attenuation per section is decreased. This for a 20 db. attenuator section the maximum error is about 5 db., for a 10 db. section about 1.75 db. and for a 5 db. section correspondingly much less.

I have found that cheaply manufactured wire-wound rheostat pads of the type generally used in cheap volume controls may be combined into a logarithmic attenuator network which permits accurate continuous logarithmic attenuation of the electric output by moving the contact point along the wire resistance of one rheostat as in the ordinary volume-control rheostat.

Inasmuch as the attenuator of the present invention was developed for use in an audiometer, such as described in my Patent 2,257,263, issued on an application of which the present application is a division of a continuation-in-part, I shall describe an exemplification of the present invention as applied to an attenuator used in such an audiometer.

One form of such attenuator exemplifying the invention and designed for use in the audiometer described in my Patent 2,257,263, is shown diagrammatically in Fig. 1 and structurally in Figs. 2 and 3. It comprises a uniform wire-wound resistor pad 11 arranged to be engaged by a relatively movable slider contact 12 in the way generally used in the known volume controls, a bus conductor 14 and an adjacently mounted second uniform wire-wound resistor pad 15. A plurality of equally spaced points along the resistor pad 11 are electrically connected by jumpers 13 to a plurality of equally spaced points on the resistor pad 15 and the mid points of the consecutive resistor sections of the resistor pad 15 are interconnected by jumpers 16 to the bus conductor 14. If the

resistor pads 11, 15 are uniformly wound, the consecutive resistor sections of the rheostat pad 11 represent the line resistance of a logarithmic attenuator and two adjacent resistor sections of the resistor pad 15, which are connected by jumpers 16 to the bus conductor 14 and act as leak resistors and represent the elements of the distributed leakage resistance along the line.

Two such wire resistor pads, interconnected by jumpers and provided with a slider contact in the manner explained above, will give as accurate attenuation as the cumbersome prior art wire-wound attenuators, and the error occurring when the slider contact 12 engages a point of the resistor pad 11 between adjacent jumper taps can be kept down to as small a fraction of a decibel as desired. Thus, in the specific exemplification of the invention shown as applied to an audiometer attenuator, an attenuation range of 125 decibels is secured by using a uniformly-wound wire rheostat pad 11 having a total resistance of 1780 ohms and a similar resistor pad 15 of 4600 ohms, and having the resistance pad 11 interconnected to the bus conductor 14, such attenuator giving continuous logarithmically uniform attenuation with an error much smaller than 1 db. by moving the slider contact 12 along the rheostat pad 11. The electric supply which is to be attenuated is impressed on the attenuator through two input leads which are connected to the input end of the slider resistance 11 and the bus conductor 14. The properly attenuated output is delivered by the attenuator through two output leads 18 which are connected to the output end of the slider resistance 11 and to the bus conductor 14.

The attenuator is shown provided with two attenuator scales ASA, ASB, for air conduction or bone conduction, which are arranged to indicate for each attenuator setting the intensity of the sound delivered by an air receiver or bone receiver, respectively, when suitably connected to the output leads 18, in terms of decibels hearing loss above the intensity of sound which produces a barely audible sound, i. e., above the sound intensity of the lower threshold of hearing. In the form shown, the slider contact 12 is affixed to the attenuator scale ASA and the attenuation index AI is in a fixed position so as to indicate on the attenuation scale the attenuation for the different positions of the slider contact 12 relatively to the resistor pad 11 of the attenuator.

Figs. 2 and 3 illustrate a practical construction of the attenuator shown diagrammatically in Fig. 1. A circular metallic housing 24 serves as the fixed support for the resistances 11, 15. To a suitable cup-shaped insulating support 26 affixed to the interior of the attenuator housing are secured the two resistances 11, 15, which are shown in the form of two circularly-bent continuous wire-wound resistance pads 11, 15, affixed to the inner side and outer side of the cup-shaped support 26, respectively.

An attenuator control shaft 25 which carries on an insulating support the slider contact 12, is revolvably mounted relatively to the attenuator housing 24 so that the slider contact 12 rides on the inwardly exposed side of the wire-wound resistance pad 11, in engagement with its exposed resistance wire turns, as in conventional volume controls. Jumpers 13 passing through holes in the bottom wall of the insulating cup 26 interconnect equally spaced taps of the resistor pads 11, 15 supported thereon, and similar jumpers interconnect taps on the exterior resistor pad

15 to the bus conductor 14 strung over an insulating collar 28 placed around the outer resistor pad 15.

The attenuator control shaft 25 is shown rotatably mounted in the mounting wall 31 of the attenuator device and has secured to its outer end projecting through the front panel 32 an attenuator control knob AT. A dial plate provided with the attenuation scales AS is secured to the attenuator control shaft 25 so as to expose through a window ASW in the front panel 32 a portion of the attenuation scale AS, a plate of transparent material 33 carrying an attenuation index in front of the exposed portion of the attenuation scale AS so as to indicate the setting of the attenuator.

It will be apparent to those skilled in the art that the novel principles of the invention disclosed herein in connection with specific exemplifications thereof will suggest various other modifications and applications of the same. It is accordingly desired that in construing the breadth of the appended claims they shall not be limited to the specific exemplifications of the invention described herein.

I claim:

1. In a potential attenuator arrangement: a contact resistance formed of a substantially continuous uniform resistance filament substantially uniformly wound into substantially uniform turns having an exposed contact region along which the consecutive turns of the resistance filament are exposed; a contact member arranged to engage said resistance along said exposed contact region and movably related thereto so that a relative motion between said contact member and said resistance brings said contact member into engagement with consecutive turns of said resistance; a conducting terminal member; an additional resistance formed of a continuous substantially uniform resistance filament substantially uniformly wound into substantially uniform consecutive turns; said additional resistance having a first sequence of substantially uniformly spaced taps connected to said terminal member and another sequence of substantially uniformly spaced taps uniformly located intermediate said first sequence of taps connected to a plurality of substantially uniformly spaced taps on said contact resistance; said resistances being so proportioned, and said taps being so arranged on said resistances that relatively continuous movement of predetermined direction between said contact resistance and said contact member continuously reduces the applied potential substantially according to a predetermined decreasing function.

2. In a potential attenuator arrangement: a contact resistance formed of a substantially continuous uniform resistance filament substantially uniformly wound into substantially uniform turns having an exposed contact region along which the consecutive turns of the resistance filament are exposed; a contact member arranged to engage said resistance along said exposed contact region and movably related thereto so that a relative motion between said contact member and said resistance brings said contact member into engagement with consecutive turns of said resistance; a conducting terminal member; an additional resistance formed of a continuous substantially uniform resistance filament substantially uniformly wound into substantially uniform consecutive turns; said additional resistance having a first sequence of substantially uni-

formly spaced taps connected to said terminal member and another sequence of substantially uniformly spaced taps uniformly located intermediate said first sequence of taps connected to a plurality of substantially uniformly spaced taps on said contact resistance; said resistances being so proportioned, and said taps being so arranged on said resistances that relatively continuous movement of predetermined direction between said contact resistance and said contact member continuously reduces the applied potential substantially according to a decreasing logarithmic function.

3. In a potential attenuator arrangement: a contact resistance formed of a substantially continuous uniform resistance filament substantially uniformly wound into substantially uniform turns having an exposed contact region along which the consecutive turns of the resistance filament are exposed; a contact member arranged to engage said resistance along said exposed contact region and movably related thereto so that a relative motion between said contact member and said resistance brings said contact member into engagement with consecutive turns of said resistance; a conducting terminal member; an additional resistance formed of a continuous substantially uniform resistance filament substantially uniformly wound into substantially uniform consecutive turns; said additional resistance having a first sequence of substantially uniformly spaced taps connected to said terminal member and another sequence of substantially uniformly spaced taps uniformly located intermediate said first sequence of taps connected to a plurality of substantially uniformly spaced taps on said contact resistance; said resistances being so proportioned, and said taps being so arranged on said resistances that relatively continuous movement of predetermined direction between said contact resistance and said contact member continuously reduces the applied potential substantially according to a decreasing logarithmic function within an error of the order of one decibel or less.

4. In a potential attenuator arrangement: a circular contact resistance element having a substantially continuous uniform resistance filament substantially uniformly wound into substantially uniform turns and having an exposed circular contact region along which the consecutive turns of the resistance filament are exposed; a rotatably mounted contact member arranged to engage said resistance turns along said circular contact region so that a rotary motion of said contact member brings said contact member into engage-

ment with consecutive turns of said resistance; a conducting terminal member; an additional circular resistance element formed of a continuous substantially uniform resistance filament substantially uniformly wound into substantially uniform consecutive turns; said additional resistance being concentrically mounted relatively to said contact resistance and having a first sequence of substantially uniformly spaced taps connected to said terminal member and another sequence of substantially uniformly spaced taps uniformly located intermediate said first sequence of taps connected to a plurality of substantially uniformly spaced taps on said contact resistance; said resistances being so proportioned, and said taps being so arranged on said resistances that relatively continuous movement of predetermined direction between said contact resistance and said contact member continuously reduces the applied potential substantially according to a predetermined decreasing function.

5. In a potential attenuator arrangement: a circular contact resistance element having a substantially continuous uniform resistance filament substantially uniformly wound into substantially uniform turns and having an exposed circular contact region along which the consecutive turns of the resistance filament are exposed; a rotatably mounted contact member arranged to engage said resistance turns along said circular contact region so that a rotary motion of said contact member brings said contact member into engagement with consecutive turns of said resistance; a conducting terminal member; an additional circular resistance element formed of a continuous substantially uniform resistance filament substantially uniformly wound into substantially uniform consecutive turns; said additional resistance being concentrically mounted relatively to said contact resistance and having a first sequence of substantially uniformly spaced taps connected to said terminal member and another sequence of substantially uniformly spaced taps uniformly located intermediate said first sequence of taps connected to a plurality of substantially uniformly spaced taps on said contact resistance; said resistances being so proportioned, and said taps being so arranged on said resistances that relatively continuous movement of predetermined direction between said contact resistance and said contact member continuously reduces the applied potential substantially according to a decreasing logarithmic function.

HEIMAN W. KOREN.