

Feb. 21, 1928.

1,659,965

E. D. TILLYER

EAR TRUMPET

Filed May 7, 1923

2 Sheets-Sheet 1

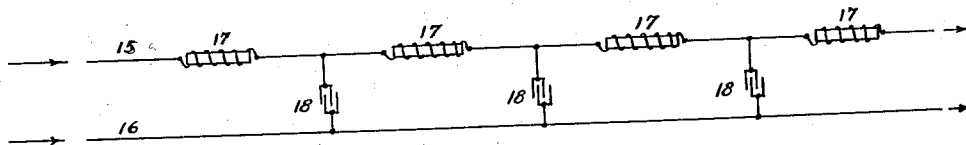


Fig. 1

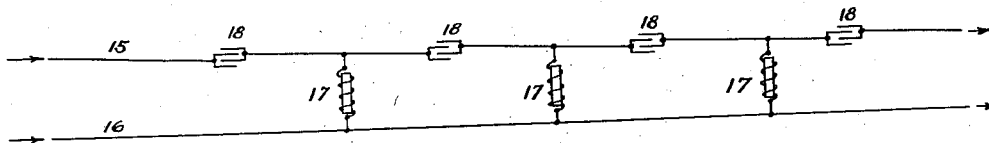


Fig. 3

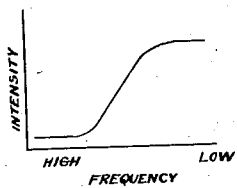


Fig. 2

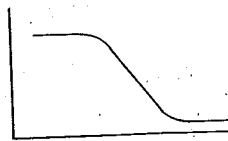


Fig. 4

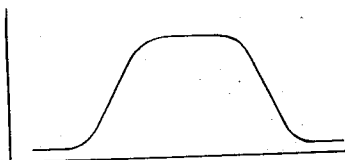


Fig. 5

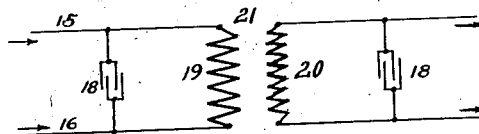


Fig. 6

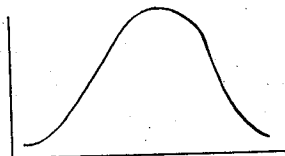


Fig. 7

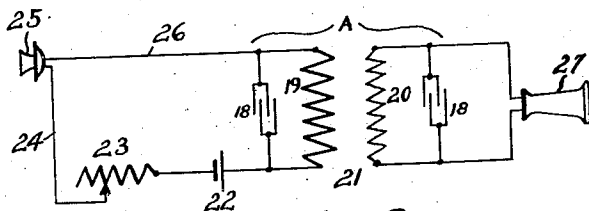


Fig. 8

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2 Sheets-Sheet 2

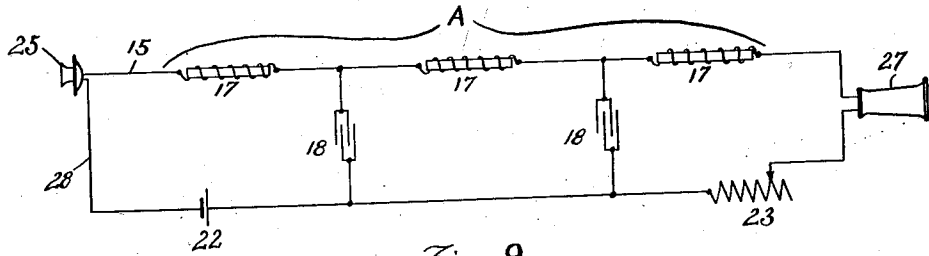


Fig. 9

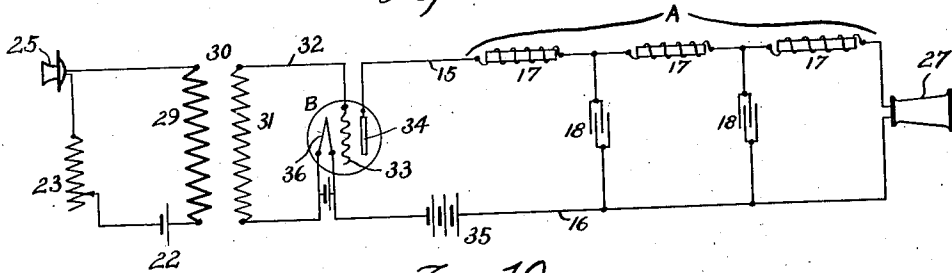


Fig. 10

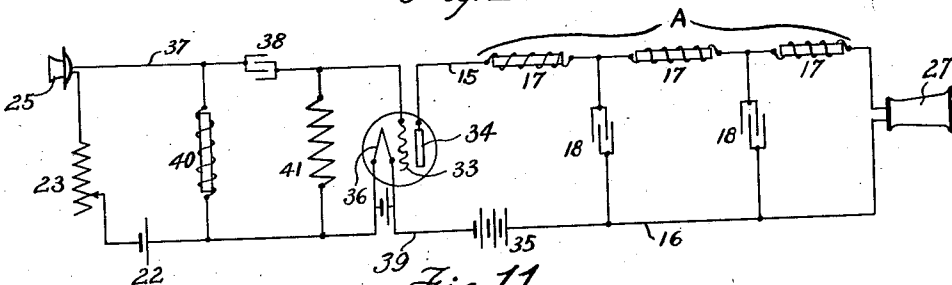


Fig. 11

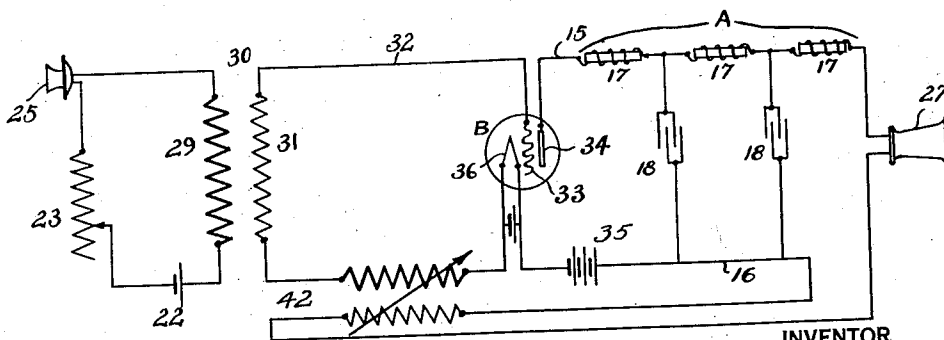


Fig. 12

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UNITED STATES PATENT OFFICE.

EDGAR D. TILLYER, OF SOUTHBRIDGE, MASSACHUSETTS, ASSIGNOR TO AMERICAN OPTICAL COMPANY, OF SOUTHBRIDGE, MASSACHUSETTS, A VOLUNTARY ASSOCIATION OF MASSACHUSETTS.

EAR TRUMPET.

Application filed May 7, 1923. Serial No. 637,189.

This invention relates to a new method in the correction of defective hearing, and an improved device for use with such method.

So far as I am aware, ear trumpets in use at the present time, while being of many different types, are not "prescribed" in accordance with any consideration for the defects of the particular person using the article. The degeneration which occurs in the ear and leads to deafness, is due to the fact that the vibrating members of the inner ear no longer respond to the long range of sound vibrations, but taper off on one end or the other of the normal vibration range of sound. This condition varies for different people, as can be understood from the fact that for some people having defective hearing a soprano voice is readily audible, while a bass voice cannot be heard, and with other people the reverse condition is true. The degree of amplification necessary varies also with different people and the proper correction of defective hearing can only be obtained by selective amplification of certain sound vibrations in various degrees. By means of a system of testing, the nature and extent of the defect in hearing can be determined and a correction prescribed for the individual needs of the patient.

One of the objects of the present invention is to provide an ear trumpet for the correction of imperfect hearing, whereby certain selected sound vibrations may be amplified.

Another object is to provide an ear trumpet whereby selective amplification of sound vibrations may be produced in various degrees.

A further object is to provide such a device wherein selective sound vibrations will be amplified to various degrees, while the remaining range of vibrations will not be amplified.

A further object is to provide such a device wherein the hearing curve of the patient will be matched by the amplification curve.

Other objects and advantages will be apparent from the following description taken in connection with the accompanying drawings, wherein similar reference characters designate corresponding parts throughout the several views.

In the drawings:

Figure 1 is a diagram of connections for a filter for attenuating the short sound vibrations. 55

Figure 2 is a graphic representation of the relationship between intensity and frequency.

Figure 3 is a diagram of connections for a filter for attenuating the long sound vibrations. 60

Figure 4 is a view similar to Figure 2 illustrating the results accomplished by the filter illustrated in Figure 3. 65

Figure 5 is a graphic representation of the relationship between intensity and frequency when the two circuits of Figure 1 and Figure 3 are combined.

Figure 6 is a diagram of connections for a closely coupled circuit. 70

Figure 7 illustrates the results produced by this circuit.

Figures 8 and 9 are simple wiring diagrams illustrating the application of my invention. 75

Figure 10 is a similar view of another modified form using the vacuum tube magnifier.

Figures 11 and 12 are wiring diagrams of two more modifications, Fig. 12 having an adjustable feed-back for increasing amplification at will. 80

In the practice of my invention I preferably make use of an electric circuit which includes an electric filter, in combination with a source of current, a transmitter and a receiver suitably connected to produce the desired results. The electric filter, which is of similar principles and the same dynamic equations as an acoustic filter, comprises inductance and capacity, the relationship of one to the other being variable according to the type of correction desired. The inductance corresponds to the mass of air in an acoustic filter, while the capacity corresponds to the restoring pressure. A mechanical analogue is a weight (inductance) on a vibrating spring (capacity), two or more of which may be grouped together to correspond to the coupled circuit of the electric filter. By simple experiment with this mechanical analogue the principles underlying the present development may be clearly shown. 105

In Figure 1 is shown a diagram of con-

nections for an electric filter used in letting through the longer sound waves and reducing or attenuating the shorter ones. This structure comprises the two lines 15 and 16 of an electric circuit, the line 15 having a plurality of inductance coils 17 arranged in series. Condensers 18 are provided in parallel connection between lines 15 and 16, the connections of same to the line 15 being intermediate the inductance coils, as clearly illustrated. With these connections the higher tones will be attenuated, the resulting relationship between the intensity and frequency being graphically illustrated in Figure 2. The sharpness in change in attenuation is controlled by the number of filter units and the conductivity of the oscillating circuit. By properly choosing the capacity and inductance and resistance the limiting point of attenuation may be varied to suitably correct individual defects of hearing of the patient.

When it is desired to attenuate the lower notes or those of higher frequencies, the inductances 17 and capacities 18 are interchanged from those previously given. This is clearly shown in Figure 3, and the resultant attenuation curve given in Figure 4. The circuits of Figure 1 and Figure 3 may be combined to attenuate sound vibrations on both ends of the scale of frequencies, the unattenuated portion being of any selected width at any point in the scale of frequencies and any degree of sharpness. The result of this combination is shown in Figure 5.

Another method of attenuation of both ends of the scale of vibrations is by the introduction of two more or less closely coupled circuits, as shown in Figure 6; wherein 19 and 20 are the primary and secondary windings, respectively, of a transformer 21. As shown in Figure 7, this latter construction produces an attenuation curve which is more nearly parabolic and does not lead to the accentuation of one wide region at the expense of another. This may be separated into a two peak curve for certain cases of deafness.

The simple connections illustrated in Figure 8 comprise a battery or other source of current 22, a variable resistance 23, said resistance being connected by the conductor 24 to a transmitter 25. The line 26 connects the transmitter 25 to the electric filter A, which in turn is connected, as illustrated, to the receiver 27 and the opposite side of the battery 22. In this diagram the filtering device A has been shown as that of Figure 6, but it will be readily apparent that any of the other filters shown and described may be interchanged therewith, the type used being dependent upon the results desired.

Figure 9 is a modification of Figure 8, wherein the source of current 22 is connected

by the wire 28 to the transmitter 25. After passing through the transmitter the current is conducted by line 15 through the filter A to the receiver 27, thence through the variable resistance 23, and returned to the source of current 22.

In Figure 10 the current travels from a primary battery 22 through the variable resistance 23, to the transmitter 25, and thence through the primary winding 29 of a transformer 30 back to the battery 22. The other side of the couple circuit includes the secondary winding 31 of the transformer 30 connected by the conductor 32 to the grid 33 of a vacuum tube B. The plate 34 of the vacuum tube is connected to the line 15 of the filter, which in turn is connected in the usual way to the receiver 27, the current passing through the filter and receiver by line 16, through a secondary battery 35 to the filament 36 of the vacuum tube B, and from there to the other end of the secondary winding 31 of the transformer 30; here again has been shown a filter of the type illustrated in Figure 1, which type may be interchanged with that of Figure 3, or Figure 6, according to the results desired.

In the arrangement of parts shown in Figure 11 the current travels from one side of the primary battery 22 through the variable resistance 23 to the transmitter 25, thence through the line 37, in which is placed a condenser 38 to the grid 33 of the vacuum tube B. Current also passes from the plate 34 of the vacuum tube through the filter A to the receiver 27, through the secondary battery 35, through the filament 36 of the vacuum tube and back to the other side of the filament battery by way of the conductor 39. An inductance 40 is shunted across the lines 37 and 39 on one side of the condenser 38, and a resistance 41 is shunted across the same lines on the opposite side of the condenser 38, in order to obtain efficient grid potentials.

The modification illustrated in Figure 12 includes the primary battery 22, from which current flows to the variable resistance 23 through the transmitter 25, through the primary winding 29 of a transformer 30 and back to the other side of the battery 22. This forms one side of the couple circuit, while the other side of the circuit includes the secondary winding 31 connected by the line 32 to the grid 33 of the vacuum tube B. The plate 34 is connected in the usual manner to the filter A through which current passes to the receiver 27, thence through the secondary winding of an adjustable regeneration transformer coupling 42 through the line 16 to the source of current 35, through the filament 36, through the primary winding of the adjustable transformer coupling 42 and back to the filament battery.

It will be obvious from the foregoing

description that any sound entering the transmitter 25 will be conducted to the receiver 27, and during transmission it will be first amplified and then a portion thereof will be attenuated by the filter. The degree of amplification is variable by the resistance 23, while the width of the band of attenuation may be varied by the proper selection of the inductance 17 and capacity 18 placed in the filter. Thus it will be seen that I have produced a new and novel ear trumpet for the correction of defective hearing, by the use of which a person will benefit from the corrections necessary to his own individual needs.

In the development of my invention changes may be resorted to in the arrangement of the parts, and I reserve the right to make such changes falling within the scope of the claims without departing from the spirit of the invention.

What I claim is:

1. The method of making audible certain tones to a patient's ear in which said tones are not audible comprising determining by test the tones that are not audible to said

ear, and the amount of change in said tones that is required to make them audible to the said ear, and inserting means in a telephone circuit that will alter the inaudible tones to a degree where they will become audible to the said ear.

2. The method of making audible certain tones to a patient's ear in which said tones are not audible comprising determining by test the inaudible tones, and the amount of change required to make them audible, and inserting in a telephone circuit means for amplifying certain of the tones and of reducing certain of the other tones to an amount necessary to make the tones audible to the said ear.

3. The method of making audible certain tones to a patient's ear in which said tones are not audible comprising determining by test the inaudible tones and the amount of change required to make them audible to the said ear, and inserting means in a telephone circuit to distort the said tones by the amounts found necessary by the test to make them audible to the said ear.

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