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MECHANICAL DEVICE FOR IMPROVING HEARING

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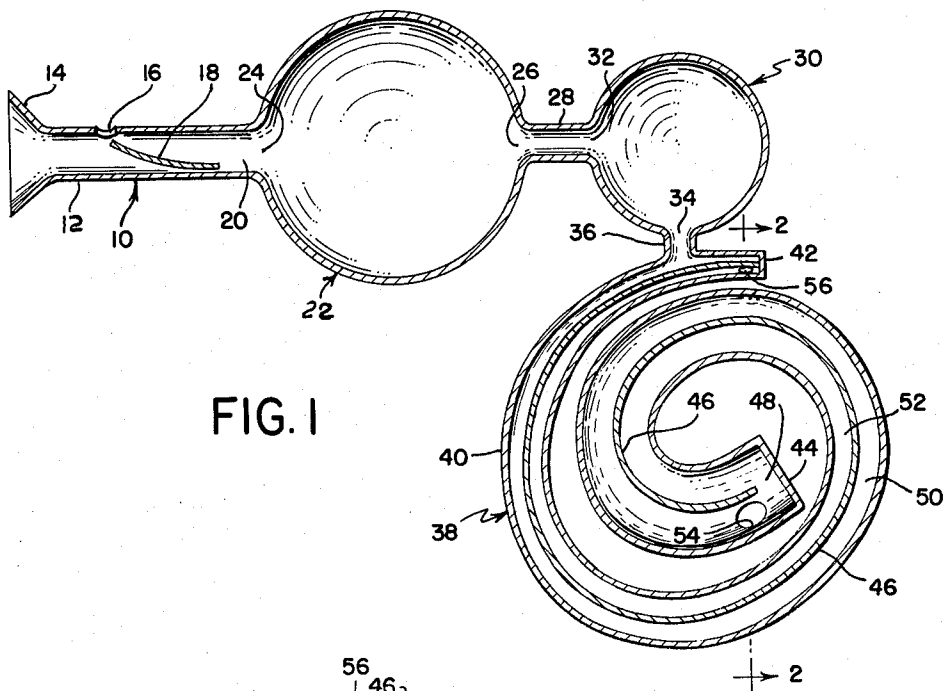
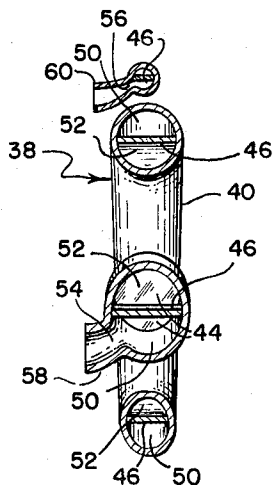


FIG. 1

FIG. 2



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MECHANICAL DEVICE FOR IMPROVING HEARING

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9 Claims. (Cl. 181-23)

This invention relates generally to devices for improving hearing, and pertains more particularly to a device having a mechanical construction in contradistinction to the more widely used electrical or electronic hearing aids.

On object of the invention is to provide a device for improving hearing which will both amplify and intensify sound mechanically. While it is contemplated that my device will have utility when employed independently, nonetheless, it is within the purview of the invention to couple it to a conventional electronic hearing aid, if the hearing impairment of the user is such as to make the combined use desirable. For instance, my device can be used in conjunction with an electronic hearing aid on the wrist or other part of the person's body so as to transmit the vibrations via what is normally regarded as a "touch" sensation. The vibrations resulting from the sound energy are introduced into the body by the vibrations that are felt by the user. My device will be particularly useful in this respect when the person is slightly hard of hearing and relies to some extent upon his natural hearing. On the other hand, the device is susceptible to sufficient miniaturization so that it can be worn within the outer ear passage. Still further, it is possible to place the device in the ear canal and utilize an electronic hearing aid externally thereof, so that my mechanical device picks up the amplified sound coming from the electrical hearing aid to further increase the volume of the signal. Consequently, it will be recognized that my mechanical device for improving hearing is quite versatile and can be adapted and used in a variety of ways that best suit the needs of a given individual and thus more effectively compensate for that person's hearing loss.

Another object of the invention is to concentrate or emphasize certain frequencies, mainly those that are low enough so as to contain a fairly large amount of energy therein. The emphasizing of the lower frequencies which are known to have a greater energy value makes the device constituting the subject matter of the present invention especially adapted for attachment to a portion of the person's body, the body being more responsive or sensitive to the lower frequencies than the higher ones. In this way, the sense of feel or touch alluded to above is utilized very effectively.

A further object of the invention is to provide a mechanical device of the foregoing character that will have a low amount of absorption as far as the acoustical system incorporated therein is concerned. Thus, while it is an aim of the invention to amplify and intensify the sound energy that is delivered to my device, it is to be borne in mind that the internal construction is such that there is very little attenuation at any frequency as the sound progresses from one end thereof to the other. More specifically, the invention envisages a smooth path that the sound energy is constrained to follow, which path is devoid of obstructions and projections that would otherwise reduce unduly the sound as it passes through the instrument.

Yet another object of the invention is to remove portions of the sound energy at optimum locations within the device. In other words, the device has been devised with the thought in mind of producing resonant conditions at certain locations within the device and removing such energy at the optimum location, thereby enhancing the

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effectiveness of the device as far as providing a strong output signal. More specifically, it is envisaged that at least one outlet be provided by which sound energy can issue from the best location therein where the amplitude is greatest for a particular frequency. Plural outlets can be utilized very effectively for the purpose of subjecting spaced regions or surface areas of the body to energy having a concentration of power at one frequency with respect to one outlet and a concentration of power at a different frequency with respect to a second or additional outlet, this enabling the user to sense and interpret even more advantageously the sound signals.

Still another object of the invention is to provide a hearing device that can be manufactured at a relatively low cost and which will not be apt to get out of order readily. As a matter of fact, the device is constructed of parts that will not wear out after prolonged usage and therefore the device can be employed for lengthy periods of time with little or no maintenance attention being devoted thereto, this being a distinct advantage compared to hearing aids of an electronic or electrical nature.

Briefly, the invention involves the use of a vibratory mechanism for enhancing the propagation of sound energy throughout a range of audio frequencies. The output from this mechanism is delivered to a first chamber capable of resonating at a preferred frequency toward the lower end of the range that is selected and the output from the first chamber is fed to a smaller second chamber which intensifies the sound due to its smaller size and which is capable of resonating at a somewhat higher frequency than the first-mentioned frequency, but still toward the lower end of the frequency spectrum that has been selected. The second chamber in turn is connected to a helical housing that has a special configuration so that the sound energy is effectively utilized. More specifically, the helical housing, which is also conically shaped, has extending longitudinally therein a thin membrane which conforms to the general curvature of the housing and which divides the interior of the housing into two passages that are smaller at one end than at the other, but which have tapering walls so that the sound energy is transmitted with very little absorption. It will also be appreciated that the conical shape of the housing provides a varying cross section along its entire length with the result that the resonant frequencies are not evenly spaced, thus producing even as well as odd numbered harmonics. In its preferred form, one outlet bell is provided so as to allow one portion of the energy to exit at a preferred location and a second bell allows the remaining energy to exit also at an optimum location.

These and other objects and advantages of my invention will more fully appear from the following description, made in connection with the accompanying drawing, wherein like reference characters refer to the same or similar parts throughout the several views and in which:

FIGURE 1 is a sectional view taken through a central plane of my device, and

FIGURE 2 is a sectional view taken in the direction of line 2-2 of FIGURE 1, the view being principally for the purpose of showing the tapered configuration of the helical housing and the progressively increasing area of the membrane contained therein.

Referring now in detail to the drawing, my device comprises a vibratory mechanism for propagating sound within the audio range of frequencies, which mechanism has been denoted generally by the reference numeral 10. This mechanism 10 includes a riser tube 12 having a flared mouth at 14 via which the sound energy enters my device. The vibratory mechanism additionally is formed with an opening 16 and associated with the opening 16

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there may be a resilient reed 18 so that air and vibration may be introduced to improve the propagation of sound. The movement of the reed 18 starts the air in the instrument to vibrating more vigorously. The vibratory mechanism 10 has an outlet at 20 which delivers the energy propagated therethrough into a first chamber labeled 22, the chamber being of a size such as to cause resonance at a frequency toward the lower end of the audio range. In this regard, it will be appreciated that the particular frequency is influenced by the volumetric size of the chamber 22 and this size can be selected to comply with the requirement or need of the individual user. This same situation prevails throughout the device, for the particular impairment of the person for which the device is to be used must be taken into account. At any rate, it will be noted that the spherical chamber 22 has an inlet at 24 which is connected directly in the illustrated instance with the outlet 20. The outlet for the chamber 22 has been given the reference numeral 26 and it is joined directly to a transfer tube 28 leading to a second chamber 30 of smaller dimensions than the first chamber 22, the second chamber 30 thereby being capable of resonating at a somewhat higher frequency than that selected for the chamber 22, but still within the selected range. The chamber 30 has an inlet identified by the reference numeral 32 which is joined directly to the transfer tube 28 and has an outlet at 34 which leads into a second transfer tube 36.

It will be discerned that the transfer tube 36 is connected directly to a helical mechanism denoted generally by the reference numeral 38. The mechanism 38 comprises a rigid wall housing 40 having a relatively small cross section end at 42 and a relatively large cross section end at 44. Within the interior of the housing 40 and extending lengthwise therethrough is a membrane 46 which terminates in a spaced relationship with respect to the end 44 so as to provide a communicating opening 48. The opening 48 connects one passage indicated by the reference numeral 50 to a second passage indicated by the reference numeral 52. In other words, the membrane 46 serves as a divider or partition which forms a first passage 50 and a second passage 52, these passages being smaller in cross section near the end 42 and increasing in cross section toward the other end 44 by virtue of the tapered configuration of the housing 40. Adjacent the larger end of the passage 50 is an outlet opening 54 and adjacent the smaller end of the passage 52 is an outlet opening 56. The outlet opening 54 is connected to a downwardly projecting bell 58 and the outlet opening 56 is similarly connected to a bell 60.

An explanation on what is believed to transpire as the sound energy passes through the device will be of some help in appreciating the benefits to be derived. First, the sound to be processed enters the flared end 14 of the vibratory mechanism 10, although it will be appreciated that the sound energy to be propagated can be introduced through the agency of an electronic amplifier or the like.

After passing through the mechanism 10, the sound energy enters the chamber 22 and when the sound waves reach the volume of the air enclosed in this chamber, there is an accompanying increase in sound pressure which compresses the air in said chamber. The resilient action of the air within the chamber 22 tends to push the compressed air out. When the alternating rarefaction and condensation of the sound waves reach the chamber 22 at the same time, the amplitude thereof is increased by the resonant action that takes place. Of course, true resonance occurs only at a particular frequency, but for practical purposes, there is an increase above and below the precise resonant frequency. At any rate, there is an increased movement when the rate of arrival of the sound waves equals or corresponds to the natural frequency of the volume of enclosed air and the resonant action greatly enhances the operation of the hearing device. Similar

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action occurs within the chamber 30 and it will be appreciated that such action occurs at a resonating frequency that is higher than the frequency for the chamber 22, this being by reason of the smaller size of the second chamber 30. There is also an intensification of sound as it travels from the larger chamber 22 to the smaller chamber 30.

When the sound energy exits from the chamber 30, it enters the smaller end of the passage 50. Inasmuch as the membrane 46 has a relatively small surface area adjacent the end 42 of the housing 40, being relatively thin and lightweight at this point but becoming increasingly thicker and more massive as it progresses, it will have an amplitude of vibration at a higher frequency than at its larger surface end. Therefore, the energy emanating from the chamber 30 causes the membrane to vibrate in the region of the outlet 56 and while there is no direct route at this end that the energy can traverse so as to issue from the outlet 56, nonetheless, the energy impinging upon the membrane 46 at this end assists in producing sound vibrations that, when added to the energy that has traveled the completed path to the passages 50 and 52, will cause a predominant frequency to exist in the energy that is discharged via the outlet 56.

At the moment, we are most concerned with the sound energy that advances through the passage 50 toward the larger end 44 of the housing 40. Since the surface area of the membrane 46 is larger and thicker at the end 44, the membrane has an amplitude of vibration that corresponds to a lower frequency than the amplitude that the smaller surface end of the membrane 46 has. Thus, the membrane 46 vibrates with a greater amplitude adjacent the end 44 of the housing 40 than it does at the end 42 of said housing. This causes the greater portion of the lower frequency energy to exit via the opening 54 and through the bell 58 onto whatever surface or into whatever region confronts the bell 58. The energy not discharged through the opening 54 continues its travel through the passage 52, there being the opening 48 between the passages 50 and 52 which allows this to occur. Owing to the tapered configuration of the housing 40 and also the passages 50 and 52, the cross section of the passage 50 decreases toward the smaller end 42 where the outlet 56 is located. In this way, there is a concentration or intensification of the energy due to the narrowing of the passage 52 and the remainder of the energy is discharged through the opening 56 and the bell 60.

Due to the fact that the surface area and the thickness of the membrane 46 progressively increase from the end 42 toward the end 44, it will be appreciated that various resonant conditions can exist throughout the length of the membrane. What has been done, for the purpose of illustrating the invention, has been to place an outlet 56 adjacent the small end of the membrane and another outlet 54 adjacent the larger end of the membrane. Depending upon the result desired for the particular user, other outlets can be placed intermediate the outlets 54 and 56; however, the two outlets that have been depicted will suit a large number of conditions. It will be observed that the bells 58 and 60 have their large ends residing in the same plane and this particular arrangement is especially suited for contacting a portion of a person's body, such as his wrist.

Since dimensions will depend upon the end result that is sought, only suggestive dimensions that have been utilized is an actual device embodying my invention will be given. In this regard, the diameter of the chamber 22 can be made on the order of 9.0 millimeters in diameter and the chamber 30 on the order of 6.0 millimeters. The tubes 28 and 36 would then have a diameter approximating two millimeters. The housing 40 in the device alluded to would have a total length of 70 millimeters. The small diameter end 42 of the housing would approximate 0.16 millimeter in diameter and the larger end 2.0

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millimeters in diameter. Since the membrane 46 is substantially coextensive in length with the coiled housing 40, it will correspond generally in length, it actually having a length of 64 millimeters in the illustrative instance. The membrane 46 should be quite thin and a thickness of 0.0254-0.0508 millimeter has been utilized in the exemplary embodiment being described. While not part of the present invention, it can be stated that the method of making the mechanism 38 involves the coiling of the membrane 46 into 2½ turns. Application of wax to either side thereof having the appropriate diameter for the housing 40 is then resorted to. By a plating process, the wax can be metallically coated and then when the wax is removed, only the membrane 46 remains anchored within the housing 40 formed of the metallic coating to provide the two passages 50 and 52. As with the dimensions that have been given, the technique for making the mechanism 38 is susceptible to modification.

It will, of course, be understood that various changes may be made in the form, details, arrangements and proportions of the parts without departing from the scope of my invention as set forth in the appended claims.

I claim:

1. A mechanical device for improving hearing comprising a tapered housing, a membrane dividing said housing into two passages each having a relatively small end and a relatively large end, said relatively large end being connected for the transfer of sound energy from one passage to the other, means for introducing sound energy into one of said passages adjacent its smaller end, and said passages having at least one opening for removing sound energy from said housing.

2. A mechanical device in accordance with claim 1 in which said opening is located at the smaller end of the other of said passages.

3. A mechanical device in accordance with claim 2 in which a second opening is provided, said second opening being located adjacent the larger end of said one passage.

4. A mechanical device in accordance with claim 1 in which said means for introducing sound energy provides energy containing therein increased amplitude at two different frequencies.

5. A mechanical device in accordance with claim 3 in which the means for introducing sound energy provides energy containing an increased amplitude at two different frequencies, said membrane causing energy at the lower of said two different frequencies to issue principally through the opening adjacent the larger end of said passage and the energy at the higher of said two different frequencies to issue principally through the opening at the smaller end of said other passage.

6. A mechanical device for improving hearing comprising first and second chambers of different sizes, a tapered housing having a relatively small cross section end and a relatively large cross section end, a membrane disposed within said housing to divide the housing into two

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passages each having a small cross section end and a larger cross section end, the larger cross section ends being in communication with each other, the smaller end of one of said passages being connected to the second of said chambers, and means for removing sound energy from said housing at a preferred location.

7. A mechanical device for improving hearing comprising vibratory means for propagating sound energy throughout a particular range of audio frequencies, said vibratory means having an inlet and outlet, a relatively large chamber capable of resonating at a frequency within said range having an inlet and an outlet, said inlet being connected to the outlet of said vibratory means, a relatively small chamber also capable of resonating at a frequency within said range which is higher than the resonant frequency of said first chamber having an inlet and outlet, the inlet of said relatively small chamber being connected to the outlet of said relatively large chamber, a tubular housing forming a tapered duct having a first end of relatively small cross section and a second end of relatively large cross section, a membrane extending generally between said first and second ends to form first and second tapered passages to either side thereof, said membrane terminating in a slightly spaced relation from said second end to permit sound energy to pass from said first passage to the second passage, the smaller end of said first passage being connected to the outlet from said relatively small chamber, a first outlet bell disposed at a preferred location so as to allow sound energy to issue from said first passage, and a second outlet bell disposed at a preferred location so as to allow sound energy to issue from said second passage.

8. A mechanical device in accordance with claim 7 in which the first outlet bell is located at the large cross section end of said first passage and the second outlet bell is located at the small cross section end of said second passage.

9. A mechanical device for improving hearing comprising an elongated member having a tapered interior, a flexible membrane extending longitudinally within said interior so as to form first and second passages to either side thereof, each passage having a relatively small cross section at one end and a relatively large cross section at its opposite end, said opposite passage ends being joined together, means for introducing sound energy into the smaller end of one of said passages, means for removing a portion of said energy adjacent one of said opposite passage ends, and means for removing another portion of said energy adjacent the smaller end of the other of said passages.

References Cited by the Examiner

UNITED STATES PATENTS

1,814,554	7/1931	Hutchison	181—27
2,641,327	6/1953	Balmer	181—23

LOUIS J. CAPOZI, *Primary Examiner*.