June 8 , 1926. 1,587,833

C. G. HENSLEY

SOUND AMPLIFIER

Filed June 30, 1919 2 Sheets-Sheet 1

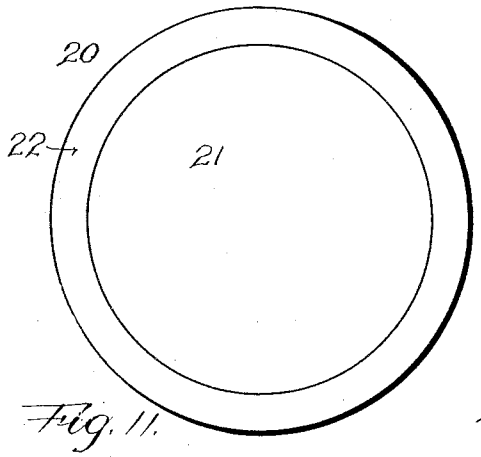

Fig. 11.

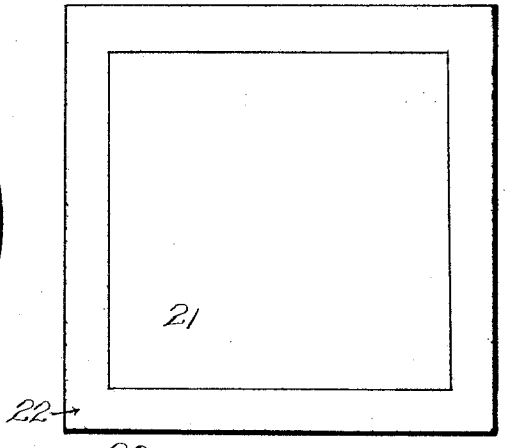

Fig. 10.

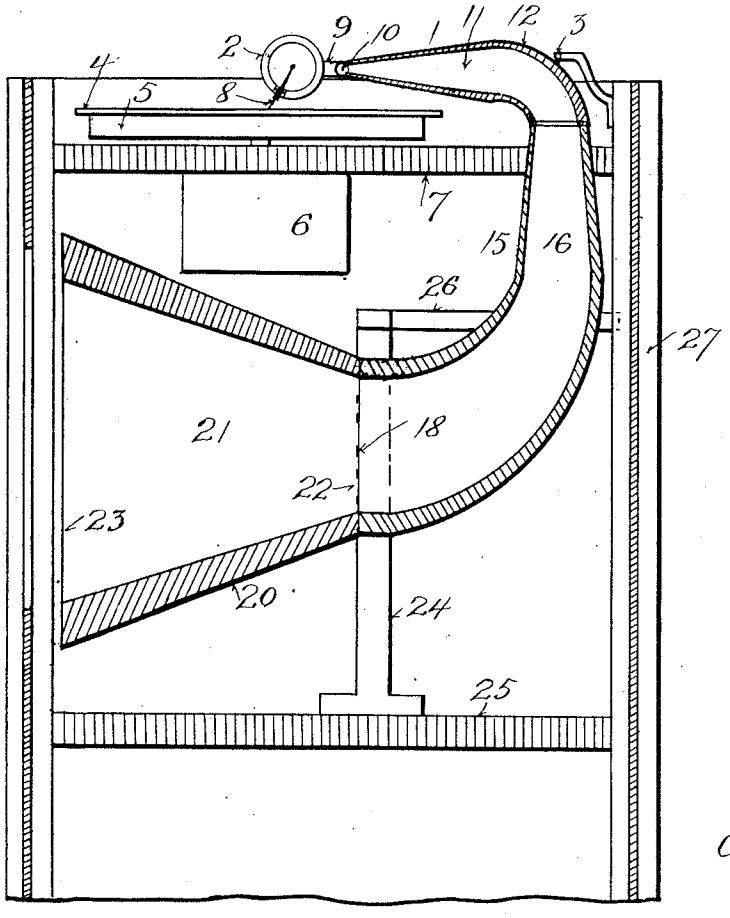

Fig. 1.

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Fig. 2

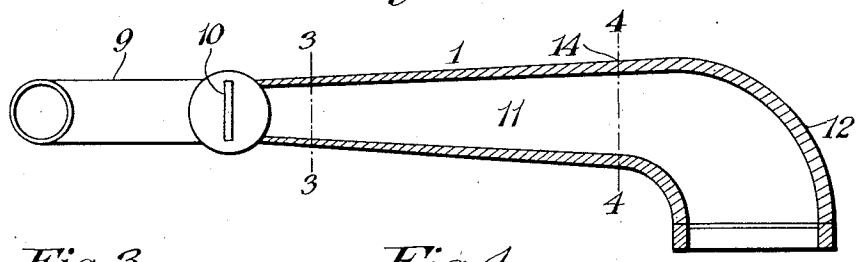


Fig. 3

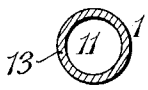


Fig. 4

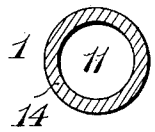


Fig. 6

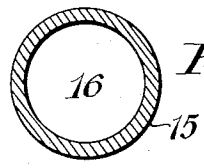


Fig. 5

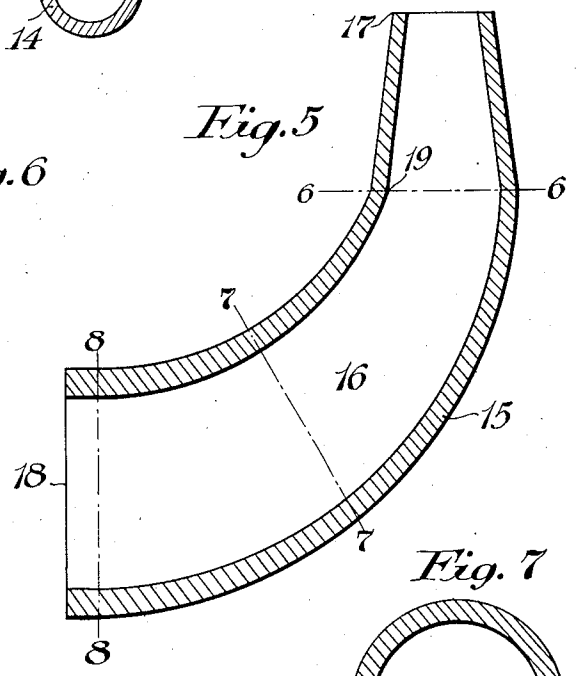


Fig. 8

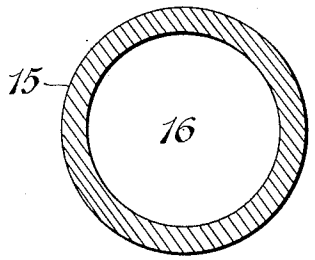


Fig. 7

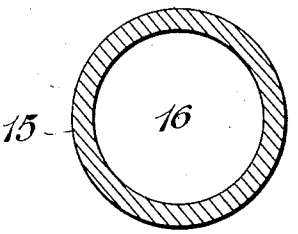
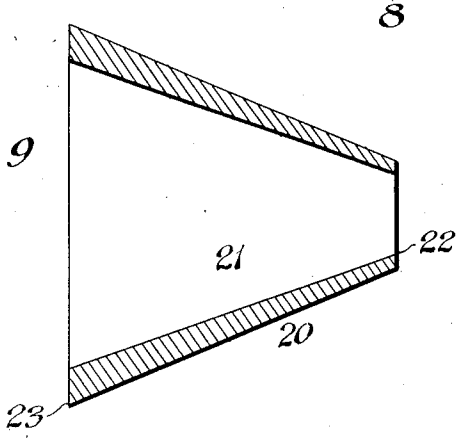


Fig. 9



Inventor
Charles G. Hensley

Patented June 8, 1926. 1,587,833

UNITED STATES PATENT OFFICE.

CHARLES G. HENSLEY, OF BROOKLYN, NEW YORK.

SOUND AMPLIFIER.

Application filed June 30, 1919. Serial No. 307,691.

My invention relates to improvements in devices for amplifying sound waves. I have applied my invention to the phonograph, in which adaptation it has special advantages, but I desire to protect the broad features of my invention whether used in a phonograph or any other device in which it is desired to amplify sound waves, or when used as a simple megaphone.

The ideal amplifier is one into which sound waves may be introduced and wherein they will be amplified to the highest degree and be propagated as sound waves of the exact character as those which are introduced therein. Megaphones, as heretofore made, have had the effect of not only amplifying sound waves but of modifying them, so that the sounds propagated from the amplifier have been different in character from the sounds introduced therein. Such amplifiers seem to change the pitch of the tones and they seem to affect different tones differently, so that some tones seem to be made more hollow or "tubby" than others. It has been said that every megaphone has an inherent tone of its own and that this must be true of every megaphone. The object of my invention is to overcome each and every defect of the amplifier.

My invention resides, broadly, in the application of certain laws of physics to the amplification of sound waves. Two bodies, for instance two flat boards, of the same material if struck alike, will be set into vibration and the number of vibrations per second in each will depend upon the two factors of area and thickness. If one board, for example, has a large area it will vibrate more slowly than a board of smaller area, provided both are of the same thickness. On the other hand, comparing two boards having equal areas but of different thicknesses, if both are struck alike, the one which is thicker will be set into more rapid vibration than the thinner one. The board of larger area will have a greater amplitude of movement than the one of smaller area and with boards of different thicknesses the thinner one will have a greater amplitude of movement. The two boards differ in resonance. This is true whether the two bodies are of wood or some other material. In order to amplify sound waves I apply these principles of physics in combination to amplify the sounds without changing their character. If the sound waves which are introduced into the smaller end of the amplifier are propelled at all portions alike during their passage therethrough, they will not be altered other than to be increased in intensity or expanded gradually so as to set larger bodies of air into vibration when released. To this end I combine the two factors of area and thickness to obtain the desired results, as will be more fully set forth hereinafter.

In the drawings forming part of this application,

Figure 1 is a sectional view through a cabinet phonograph embodying my invention, in which view, the cabinet cover and various parts are omitted,

Figure 2 is a longitudinal sectional view of the tone arm, showing the same full size,

Figure 3 is a sectional view taken on the line 3—3 of Figure 2,

Figure 4 is a sectional view taken on the line 4—4 of Figure 2.

Figure 5 is a longitudinal sectional view of the throat, showing the same approximately two thirds actual size,

Figure 6, 7, and 8 are sectional views, taken, respectively, on the lines 6—6, 7—7 and 8—8 of Figure 5,

Figure 9 is a sectional view of the horn showing the same about two thirds actual size,

Figure 10 is an end view showing the smaller end of the horn, and

Figure 11 is a similar view of a horn of frusto conical shape instead of frusto pyramidal shape.

It will be understood that my amplifier may be made in any size and in referring to the size in which it is shown in the drawings I am simply referring to a convenient size according to what is present practice.

The tone arm 1 is the member on which the reproducer 2 is mounted and it is adapted to swing from the axis 3 so that the reproducer may travel across the record 4 on the turn table 5. Any form of pivotal support may be used for the tone arm and it is to be understood that it may be arranged to swing for lateral or vertical cut records, these features forming no part of my present invention. The turn table 5 is revolved by a motor 6 arranged below the motor shelf 7, so that the stylus 8 will traverse the groove of the record 4.

I have shown a common form of goose-neck 9 for the reproducer, which pivots at 10 and it is connected with the smaller end of the

tone arm. The gooseneck is not an essential part of the present amplifier.

The tone arm, and, in fact, the throat and horn, are preferably made of wood because this material has the characteristic of conducting every tone quality, so that when these are made of wood in the correct manner they amplify the various sound waves without adding or subtracting quality. In its broadest aspect, however, my invention is not limited to a particular material. I prefer to use a hard wood such as maple because it is brilliant although I have had success with pine and other soft woods.

The tone arm 1 has a tapering air space 11 for conducting the sound waves or in which the sound waves received from the reproducer 2 through the gooseneck 9 travel. At the larger end of the tone arm there is a bend or elbow 12 for directing the sound waves downwardly and below the motor shelf 7. The wall of the tone arm is made tapering in thickness, the end 13 of smaller diameter having a thin wall and the larger end 14 having a thicker wall. The best results are attained when the wall of this arm is of uniform resonance throughout. By this I mean, that if different parts of the arm are struck substantially the same tone will be emitted. Although it is not necessary that the note be exactly uniform that is the ideal condition sought. This uniformity of resonance may be had by proportioning the thickness of the wall to correspond with its area at different places. If the taper of the bore 11 is regular, the proportions may be plotted in this manner: Given the thickness of the wall at the smaller end 13 and the inside diameters at the smaller end 13 and larger end 14 of the tone arm, the thickness at the larger end may be determined by the equation A is to B as X is to C; in which A represents the thickness of the wall at the smaller end 13; B the inside diameter at the smaller end; X the thickness of the wall at the larger end; and C the inside diameter of the tone arm at the larger end 14. By reducing the equation and finding the value of X we obtain the thickness which the tone arm should be at the larger end 14. The desired thickness at any other point may be determined in the same manner. If this method is followed, the tone arm will be of equal resonance throughout and yet it will have a tapering or increasing air space 11. It is not necessary that this formula be followed in the elbow 12 and for commercial reasons it may be desirable not to follow it, but for acoustical purposes the formula may be adhered to.

The larger the diameter of an elbow the more necessary it is to follow the formula. In practice I have found it satisfactory to make the elbow 12 of even thickness but to follow the formula in the throat.

In Figures 5 to 8 I have shown the preferred design of throat. This throat 15, is a kind of elbow and it receives the sound waves from the tone arm elbow 14 and again changes the direction of travel of the sound waves. The throat has an air or sound chamber 16 of increasing diameter from the smaller end 17 to the larger or outlet end 18. The upper portion of the throat may start with its axis straight and the throat then preferably curves on an arcuate line to bring the axial line of the outlet end horizontal. The wall of the throat is tapered in thickness like that of the tone arm. From the upper end 17 of the throat down to the point 19, at which the throat begins to curve the taper corresponds with the tone arm and preferably the thickness of the upper end 17 is about the same as the lower end of the elbow 14. The taper of the wall should be continuous throughout the tone arm, throat and horn these all being parts of the amplifier.

If the bend of the throat is on an arc of a circle then the wall should be circumferentially uniform on the different radii of the arc. For instance, if the throat were cut apart on the radial line 7—7, the ends would show a uniform thickness circumferentially as is indicated by sectional view 7. The thickness at any radial line may be plotted the same as in the tone arm. If A and B represent the thickness and internal diameter of the smaller end of the tone arm (or the thickness and diameter of the upper end of the throat) and if C represents the internal diameter of the throat on the radial line 7—7, then the equation A:B::X:C, when reduced, will determine what the thickness of the wall should be at the radial line 7—7. The formula may be followed at all parts of the throat, and at the curved portion it is preferable to plot it on the radial lines of the arc of the curve in the throat, so that while the thickness tapers axially thereof it is uniform circumferentially. I have shown in Figures 6, 7 and 8 how the thickness of the wall varies at three different places the sections being taken in each instance at right angles to the axis of the throat. The throat is of uniform resonance throughout, so that substantially the same sound is made if the throat is struck at different places and the sound space is tapering and curved.

In Figure 9 I have shown the horn, i. e. the member of the amplifier following the throat. The horn may be made either round or rectangular in cross section. So far as acoustic qualities are concerned it is preferable to make the horn round, but for manufacturing reasons it may be preferable to make it rectangular in cross section in order that flat boards may be used and the manufacturing put on a cabinet making basis to

avoid having to turn the horns on a lathe or to build them up on a form. In either case my improvements may be utilized. If the horn is round then it will appear as shown in Figure 11 at the smaller end and if it is square in cross section it will appear as shown in Figure 10.

The horn 20 has a tapering sound space 21. The wall is thinner at the smaller end 22 and it gradually increases in thickness toward the larger end 23 according to the increase in area of the horn. Preferably, the smaller end 22 of the horn starts off at the same thickness as the larger end of the throat to which it is connected, so that the taper throughout the amplifier will be continuous. The thickness of the different parts of the horn will correspond with the area and the formula used in computing for the tone arm and throat may be followed here. If A represents the thickness of the wall at the smaller end 22 of the horn, B the diameter at this end and C the diameter at the larger end 23 then by reducing the equation A:B::X:C we determine the thickness necessary at the larger end to secure uniform resonance. I have stated herein a method of estimating the thickness at different parts of the amplifier, but any other method may be employed in arriving at the result.

I prefer to support the amplifier at about the juncture of the throat and horn and for this purpose uprights 24 may be secured to the shelf 25 and to the amplifier, both connections being very rigid. I prefer to connect brace rods 26 between the upper ends of the uprights 24 and the rear posts 27 of the cabinet in order to brace the uprights against vibration as much as possible.

Where the amplifier is made of wood the quality of the different tones is accurately preserved and whereas, in former constructions, the brilliancy was considerably reduced by the use of wood the present device makes it possible to obtain most brilliant reproductions with a wooden amplifier.

The parts of the amplifier may be constructed in sections and then glued together. The straight portion of the tone arm consists of a tube turned from a single piece of wood and the elbow 14 may be made by turning a disk with a groove, quartering it and gluing two of the quarters face to face. The throat may be made of two sections representing each one half the throat divided on a longitudinal line and these halves may be glued together. Any other method may be employed, however, in constructing the several parts of the amplifier.

Having described my invention what I claim is:—

1. A sound amplifier comprising a body having an air or sound space of graduated area, the wall of said body being so graduated in thickness that said wall will have substantially the same natural period of vibration throughout.

2. A sound amplifier comprising a body having a tapered air or sound space therethrough said body having a wall of tapered thickness, and being thinner at the smaller end and graduated thicker toward the larger end.

3. A sound amplifier comprising a body having a tapered air or sound space therethrough, said body having its wall tapered in thickness in proportion to the area of the air space in the different portions thereof and being thinner at the smaller end and thicker toward the larger end.

4. A sound amplifier comprising a body having a tapered and curved air or sound space therethrough wherein the sound waves are changed in their direction of travel, said body having its wall tapered in thickness, axially thereof but of uniform thickness on radial planes said wall being thinner at the smaller end of said body and thicker at the larger end thereof.

5. A sound amplifier comprising a body made of wood and having an air or sound space therethrough of increasing area, said body having its wall graduated in thickness longitudinally of said body and being thinner near its smaller end and thicker near its larger end and of uniform thickness circumferentially.

Signed at the city, county and State of New York, this 27th day of June, 1919.

CHARLES G. HENSLEY.