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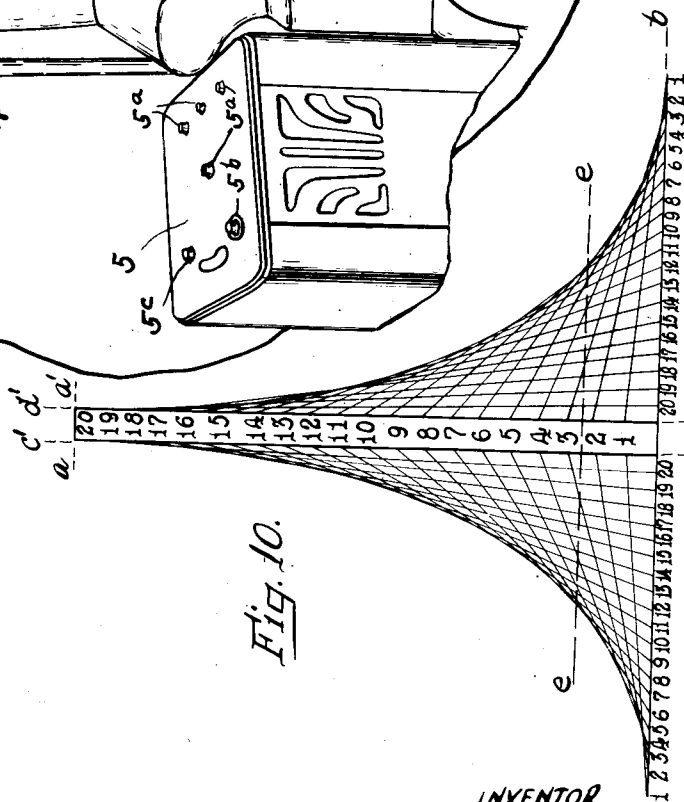
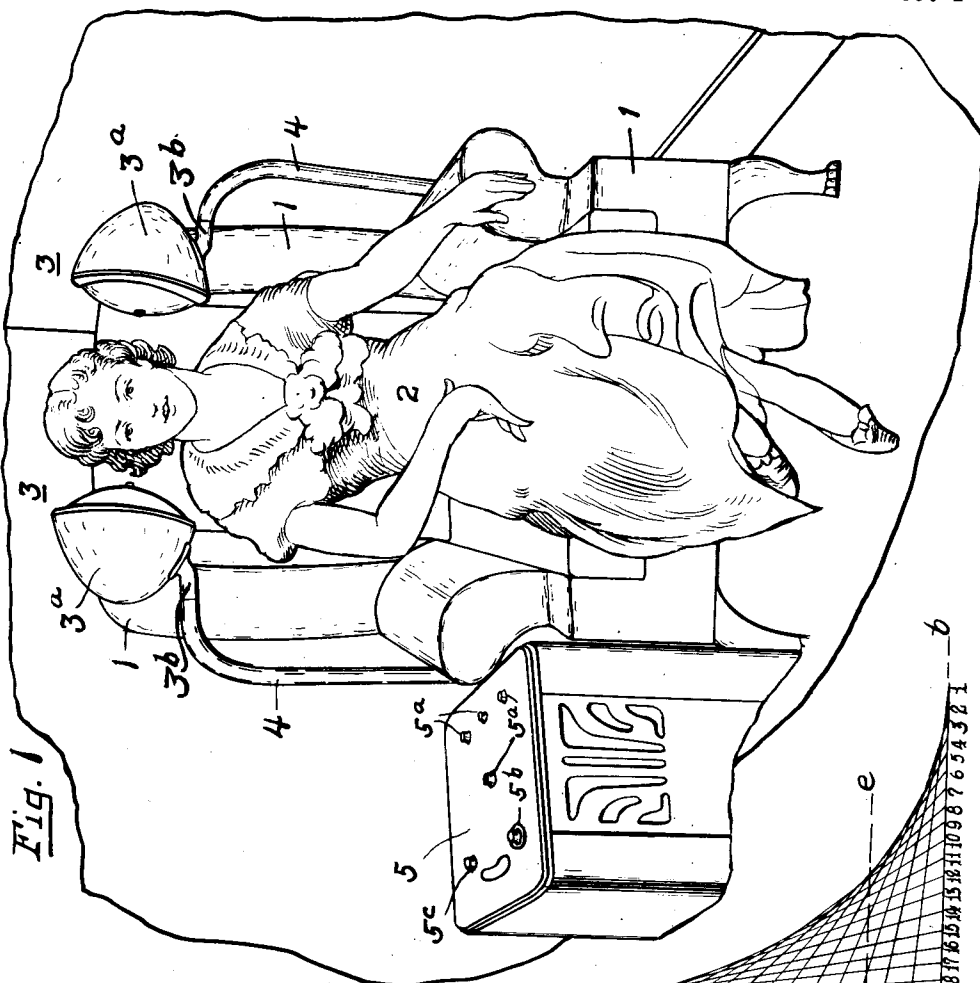
A. T. CAHILL

2,161,995

SPEAKER AND LISTENING DEVICE

Filed July 22, 1935

3 Sheets-Sheet 1



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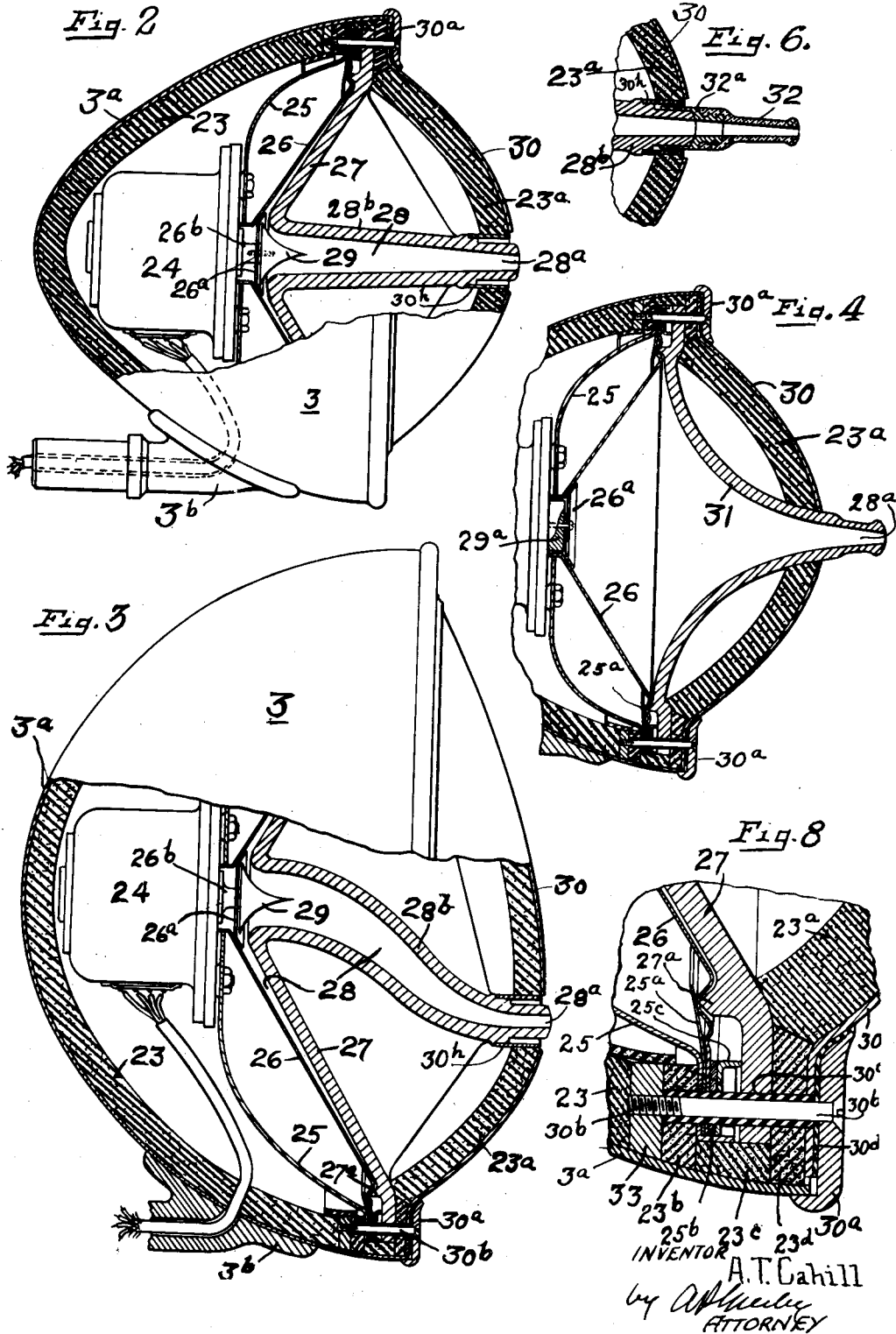
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3 Sheets-Sheet 3

Fig. 9.

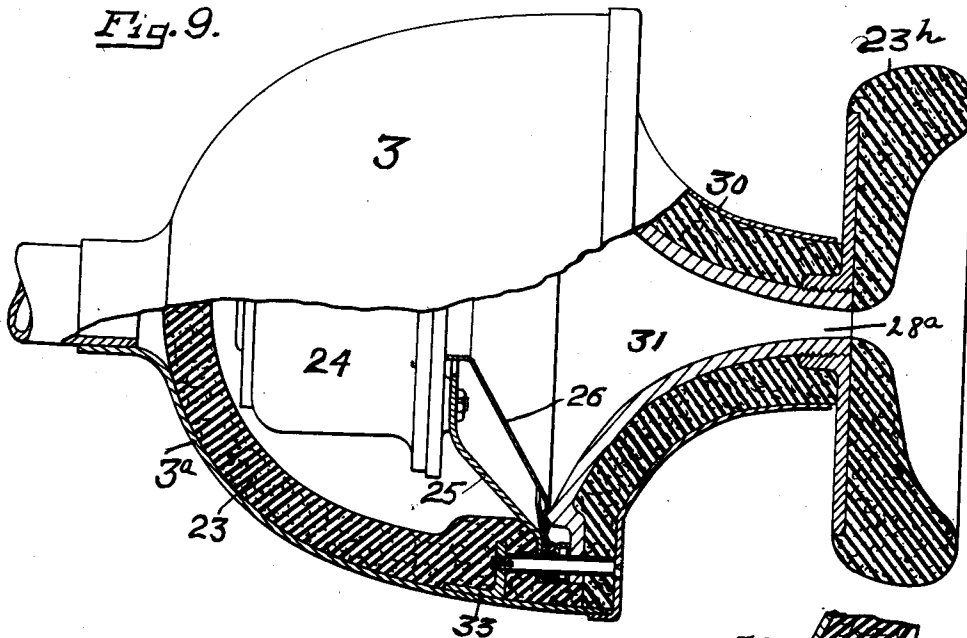


Fig. 7

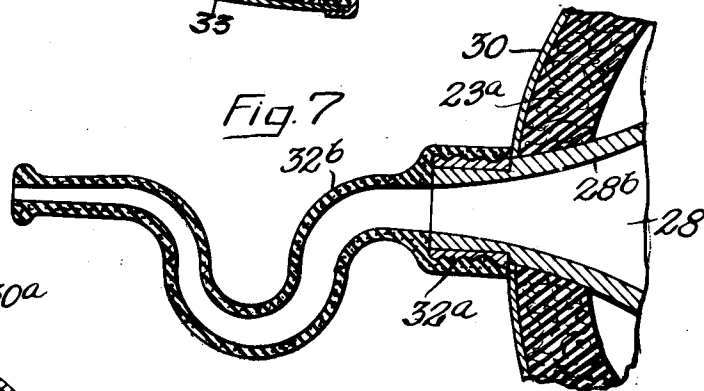


Fig. 5.

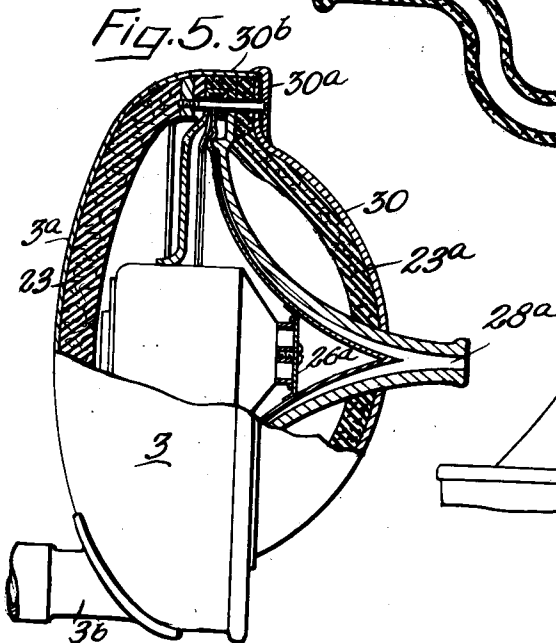
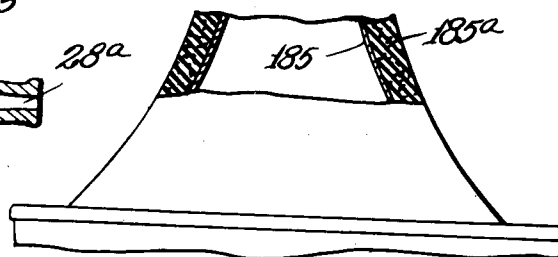


Fig. 11



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2,161,995

SPEAKER AND LISTENING DEVICE

Arthur T. Cahill, Weehawken, N. J.

Application July 22, 1935, Serial No. 32,619

4 Claims. (Cl. 181—31)

My present invention relates to improvements in what I may term radio easy chairs, or rests for the body, in or on which the listener sits, reclines or lies comfortably, with his head near one or between two speakers, that are in proximity to his ear or ears; that speak into them softly or loudly as the listener desires; that yet do not produce much sound, or at least too much sound, in the rest of the room; and that, therefore, do not interfere with the work or play of other people in the room or in the rest of the house, as loud speakers now so frequently do, and when I say a speaker or speakers, I mean to include both a speaker or speakers near to the listener's ear or ears, or a speaker or speakers at some distance therefrom, whose vibrations are brought to the listener's ear or ears by a suitable tube or conductor or by suitable tubes or conductors, whose free end or ends are held adjacently near to the listener's ear or ears. Several constructions of radio easy chairs are disclosed and claimed in the copending application of Thaddeus Cahill, Serial No. 660,667, filed March 14, 1933, as a continuation of his application Serial No. 548,587, filed July 3, 1931, said copending application now having become Patent 2,009,138, granted July 23, 1935.

The principal object of my invention is to produce an apparatus which enables the listener to have all the volume of sound, speech or music he desires without producing much sound in the rest of the room. This I accomplish preferably by putting the speakers in cases or shells, which may be of metal, "Bakelite," hard rubber or any other suitable material. The more sound deadening the material is the better for my purpose of suppressing vibration and so preventing the transmission of sound to the room. Inside of the case, immediately forward of the vibrating cone or diaphragm, but not touching any of the vibrating part of the diaphragm, is a casting or plate, preferably of metal so shaped and positioned with relation to the diaphragm as to direct toward a central outlet all the air moved by the diaphragm or cone, and finally to force out through a small orifice vibrations which are far more intense than were the vibrations originally produced by the diaphragm itself. By such means, I greatly increase or multiply the amplitude of vibration in the small stream of air delivered close to or into, the ear or ears of the listener seated in my chair beyond the amplitude of vibration of the diaphragm which initiated them. I have discovered that the smaller the amplitude of vibration of the diaphragm is, the

more perfectly it responds to the electrical vibrations which actuate it, and the less it introduces uncalled for vibrations on its own account, as it is most prone to do when it vibrates intensely, and that by my new invention I can cause the vibrations delivered to the ear or ears of the listener in my radio easy chair to be of an intense, and, therefore, impressive character, although the diaphragm which initiated them may be vibrating only gently. Consequently, the sounds which I produce in the ears of a listener seated in one of my radio easy chairs are more perfect, truer, smoother and more beautiful than the sounds of the same volume—vibrations of the same amplitude—are, when produced by a loud speaker throughout the whole area of a room.

And I insulate my cases or shells carefully acoustically, with thick layers of rubber, sponge rubber, cork, felt, or any other suitable vibration deadener or sound insulator.

It is highly important that this insulation cover all parts of the inside of the shell and be as airtight as is convenient so that no part of the inside of the shell be exposed to the aerial vibrations produced by the diaphragm, or to the physical vibrations of the speakers themselves where they are clamped into the cases or shells, because if any part of the shell is so exposed the vibrations will be transmitted to the shell and the vibrations of the shell will produce similar vibrations or sounds in the room. One means of insulation which I have found very satisfactory is to have the rubber or the sponge rubber molded right onto the inside of the shell—vulcanized to it—so covering all parts of the inside of the shell and leaving no exposed surfaces of the cases or shells which vibrations can enter. In this way the sound transmitted from the shells or cases is rendered almost wholly negligible and the only sounds to reach the outside air are the very small streams of highly concentrated vibrations which emerge from the small central orifices, and so are delivered near to, or directly toward the ear or the ears of the listener. A sound which is thus delivered in a concentrated stream of intensified vibrations directly toward, and very close to the ear, or ears of the listener need be only a very small fraction of the sound which it is necessary for a loud speaker to make in order to fill the whole room so as to produce an equal volume of sound in the ears of the listener. The result, with my invention, is almost total quiet in the room. In fact, it is frequently difficult for a person a few feet away, to tell whether or not any sound is being pro-

duced in the ears of the person seated in the chair, though the sounds may be very loud to the person in the chair. In this way the person listening in the chair and the other people in the room, or in the rest of the house, are about as independent of each other as if they were in different houses.

An important object of my invention is to so shape the air space between the movable diaphragm and the vibration-limiting plate forward of the diaphragm, that the relatively small amplitude of vibrations over a large area initiated by the diaphragm may be transformed into relatively intense vibrations over a small area before they are delivered to the ear of the listener, and to do this with the least possible loss of power, with constant and smooth acceleration, and without creating eddy currents, distortions, or resonances.

Another object of my invention is to enable people whose hearing is defective, to yet enjoy radio at their ease and without disturbing other people in the same room, or in other parts of the same house, or even their neighbors. This I do by producing unusually powerful vibrations of the diaphragm and by delivering the highly concentrated and very powerful resulting jets of vibratory air very close to (or even directly into), their ears.

Another object of my invention is to enable people whose hearing is quite defective, to again hear the speech and conversation of their families and friends. By the use of a microphone or microphones and amplifying devices, I pick up the speech vibrations in the room and amplify them greatly, and then, by feeding these amplified electrical vibrations to my speakers, and concentrating the resulting aerial vibrations through the specially-shaped air passages referred to, intensifying them as above indicated, and delivering them near to or directly into the ear of the listener in the chair, I enable him to hear ordinary conversation in the room—not merely words spoken directly into a microphone, but also general conversation throughout the room. I thus enable people who are hard of hearing—even the very hard of hearing—to again enjoy family life and again hear the conversations of their family and friends, and, also, to conduct their regular business.

Another object of my invention is to improve the reception of telephone messages. This I do by mounting one, or preferably two, speakers on an office chair, or desk chair (though any other suitable type of chair or support for the body may, of course, be used), and connecting them with the telephone lines. With two speakers attached to the chair in such a position that when the user leans back in the chair his head is between the speakers, see for example Fig. 1, the incoming telephone voice will be spoken directly into his ears—not a whisper in one ear only, but a loud, clear voice, and talking into both ears. In other words, a voice as loud and practically as clear as if the one telephoning to him were seated at his side in his office. This may be done by feeding the incoming telephone vibrations, directly or first through an amplifier desirably having a volume control, as mentioned below, into the voice coils of the dynamic speakers, but is, of course, much better done, and is much louder and clearer when the relatively weak vibration over a large area is transformed into an intense vibration over a small area by my special speakers. And while the incoming

voice may be many times as loud as it now is, it will, on account of my acoustical sound suppressing devices, be inaudible to a person seated at the listener's elbow—not nearly so audible in fact as it frequently now is on the ordinary telephone, even though the ordinary telephone voice is so much weaker. By this arrangement, when a man is working at his desk, leaning forward as he ordinarily does, his head is well away from, and entirely clear of the speakers. The instant the telephone rings, he simply leans back in his chair, which brings his head between the speakers above referred to, and swings the microphone, which is over at one side out of the way, in front of his mouth and proceeds with the conversation. Both his hands are left free for writing, for handling books, papers, price lists, discount sheets, or for the making of notes or the taking of orders, etc. With an ordinary volume-control device in the circuit he can regulate the loudness of the sounds and make them just as loud or just as soft as he wishes, according to circumstances. The effect produced is far and away better than in telephony today. About all the sounds we have ever heard except telephony, we have heard with both ears, and for easy, clear, natural hearing, and for full satisfaction, it seems necessary that the sound be produced in both ears. One ear does not fully satisfy and this, taken in conjunction with the feebleness of the ordinary telephone voice, is the cause, it is submitted, of the extreme nervousness of most people when they are using the telephone, a nervousness which is entirely absent from people using my chairs.

Another object of my invention is to reduce the cost of a combined radio easy chair and a chair in which people whose hearing is quite defective can hear conversation in the room. This I do preferably by using a part of my radio set—the audio part of a radio set—as an amplifier for the microphone voice, and so, without much additional expense, to have a radio easy chair, and also an easy chair for the deaf. My combined chair may then serve as any easy chair for the deaf alone; that is to say, a chair, a speaker, an amplifier with its necessary controls, and a microphone, in which case radio could not be heard in it; a radio easy chair, where no members of the family are hard of hearing; or a combined radio easy chair and a chair for the deaf, using a microphone and the latter stages of the radio amplification, or a separate amplifier for the microphone.

Another object of my invention is to produce for bedridden people, who wish to hear either the radio or the amplified human voice, the same results as are produced by my radio easy chairs.

Another object of my invention is to make vibrating cones or diaphragms of special designs which are better suited to my particular requirements than are those now in common use. One such cone is illustrated in Figure 9, in which the cone is made with curved sides tapering up to a point, though of course right line angular sides may be used also, if desired. This does away with the dead spot in the centre over the magnet which is injurious in my work and under my conditions. They also work much better when used in regular loud speakers, because there is no dead spot in the centre. The whole area of the cone moves forward as a piston and all the air enclosed or in front of it must move forward with it. Part cannot rush backward and escape through the spider down

into the magnet or out around the voice coil. All the air must go forward and without any of the eddy currents or distortions which are due to the dead spot over the magnet in ordinary cones.

- 5 By properly shaping and proportioning the vibrating cone and front piece or retaining shell it is possible to make the enclosed air chamber or cavity or any desired form, such as exponential, parabolic, etc., for example, so as to reduce resonance and other objectionable effects.

Other objects of my invention will appear from the drawings and as the description proceeds.

Referring to the drawings:

- 15 Figure 1 is a perspective view of my radio easy chair carrying two speakers, one near each ear of a listener, and of a console and separate loud speaker;

Figure 2 is a vertical axial sectional view, partly in elevation of a speaker illustrating one embodiment of this part of my invention;

- 20 Figure 3 is a view somewhat similar to that of Figure 2 showing a construction in which the tube 28b has been bent downward to permit the use of a large speaker, 3, without touching, or interfering with the shoulder of the listener;

- 25 Figure 4 is a view somewhat similar to that of Figure 2, but which involves a different principle in the formation of the vibration-chamber and vibration-restraining and directing wall or plate 31;

Figure 5 is a view similar to that of Figure 2, but showing a further modification of the diaphragm and of the vibration chamber;

- 30 Figure 6 is a detailed vertical sectional view of one form of the delivery end of the air chamber of one of my speakers, and of a flexible tip attached thereto;

- 35 Figure 7 (sheet 3) is a view somewhat similar to that of Figure 6, but showing a much longer flexible tapering tip;

Figure 8 is a sectional view, on an enlarged scale, of the construction shown at the lower right hand corner of Figure 3;

- 40 Figure 9 is a view partly in elevation and partly in section, of one of my speaker units especially adapted for contact with the side of the head;

- 45 Figure 10 shows one manner of determining the contour of my special type of horn or concentrator or concentrating and accelerating front plate;

- 50 Figure 11 is a detail view, partly in section, of the diaphragm end of the tube which, with the diaphragm, forms the air chamber forward of the diaphragm and leads to the ears or ear of the listener.

Similar reference characters refer to similar parts in all the drawings.

- 55 Some of those reference characters, together with brief notation as to the parts to which they refer, follow:

- 1 Chair
2 Listener
3, 3 Speaker; 3a back shell; 3b supporting casting; 3c horn
4, 4 Pipes for loud speaker
5 Console; 5a controls; 5b rotary switch; 5c microphone
23 Insulating material inside 3a; 23a insulating lining of 30; 23b ring between 33 and 25; 23c insulating ring, ring between 25 and 27 and 3a; 23d insulating ring on top of 23c and 27
24 Speaker pot

- 25 Speaker shell; 25a spring washer disc; 25b washer; 25c reinforcing angle for shell 25
26 Diaphragm; 26a spider; 26b spacer
27 Front plate; 27a ridge on front plate
28 Air passage or chamber; 28a orifice; 28b tube
29 Conical filler piece; 29a straight topped filler piece
30 Closure plate; 30a clamping ring; 30b bolts; 30c insulating tube around 30b; 30d insulation between 30a and 30
31 Preferred type of front plate or concentrator
32 Soft rubber ear piece; 32a thimble in 32; 32b bent flexible ear piece
33 Speaker shell bracing and anchoring ring.

In the drawings, and particularly in Figure 1, 1 indicates a body-supporting means for the listener, 2 who is to receive music or other sounds from the speakers, 3, 3, which are so carried by arms or supports, 4, 4, extending from beneath the body supporting means, 1, which is here shown as a chair, preferably a stuffed or easy chair, but which may be a couch, or a bed, or any other suitable means for supporting the body of the listener, so that his head will be between the speakers, 3, 3 whose orifices are approximately opposite to, and in line with the openings of his ears.

5 (see Figure 1) indicates a console containing the principal parts of the set, except the loud speaker, and which carries on its top the usual controls, 5a, also my special controls, 5b and 5c. 5b is a switch, such as a rotary switch, by which the amplified current from the set may be thrown either into the loud speaker, or to the speakers on the chair as desired, or when desired, into both at the same time, by setting it on the 1st, 2nd, or 3rd positions. The 4th, 5th, and 6th positions cut off the radio signal and connect the microphone through the audio stages of amplification of the set or, if desired, through a special amplifier separate from the set, and also deliver the amplified microphone current to the chair, the loud speaker, or both as desired. 5c is the microphone current control.

Also, instead of horns expanding from a small end up to a much larger bell, I sometimes reverse this, and have the large end down near the diaphragm, the tube gradually tapering up to a small end or ends close to the ear or ears of the listener. See Fig. 11.

The speakers 3, 3, (see Figures 2 to 9) comprise an outer or back case or shell 3a, here shown of concave form which is in shape somewhat like the small end of an egg, and having on, or against its interior surface a thick lining of sound-insulating material 23, such as rubber, felt, or sponge rubber, though any other suitable insulation may be used. Within this outer shell is the speaker pot, 24, carried by a support or frame, 25, constituting the speaker frame. In front of said frame 25 is a cone shaped vibrating diaphragm 26; and in front of this diaphragm is a front plate, concentrator, accelerator, and intensifier, 27, so shaped as to form, between it and the diaphragm, a passage 28, of such form and proportions that it will accelerate, concentrate, intensify, and direct the vibrations of the air arising from the movements of the diaphragm toward the small orifice 28a. In the constructions shown in Figures 2 and 3, the diaphragm 26 has a central opening over the center pole of the magnet. Into this opening a spider, 26a, is secured. The central portion of this spider is held fast between the spacer, 26b, attached to magnet and filler piece, 29, which is screwed fast to spacer 26b.

This filler piece 29 is somewhat conical in form, and of such size and shape as to form a passage, 29, near the central portion of the diaphragm, of the constantly decreasing area necessary for the smooth and continuous acceleration of the vibrations necessary for the proper concentration of sound at the orifice, 28a.

When the speaker unit 24, 25, and 26, with the front plate 27 or 31 as shown in Figs. 2, 3, 4, 5 and 8 has been put into the cases or shells, and they have been closed the result should be that insulating lining 23 comes up tight under reinforcing ring 33. On top of ring 33 rests insulating ring 23b. On top of 23b rests the rear peripheral surface of speaker frame 25, upon whose upturned edge, and reinforcing angle 25c, rests rear peripheral portion of front plate 27, or 31. Outside of these two between them and the shell 3a, is inserted insulating ring 23c, which is pressed down tight on 23b. On top of 27 and 23c rests insulating ring 23d. On top of 23d rests rear peripheral surface of closure plate 30. On top of that rests insulating disc washer or gasket 30d. On top of 30d rests clamping ring 30a. All of these parts are held tightly together by the insulated screws or bolts 30b, 30b which are threaded into ring 33. The bolts 30b, 30b, pass down through tubes 30c, 30c of insulating material, and hold all the above parts tightly together.

Inserted between the diaphragm, 26, and the frame or support, 25, is a disc washer 25a, of spring material, most of whose center has been cut away. On front plate 27 is formed a rib or ridge, 27a, which holds the diaphragm, 26, tightly down on to the spring washer 25a, and so closes off air chamber or passage 28.

In the speakers shown in Figures 6 and 7, the chamber or space, 28, between the diaphragm and the front plate, increases in depth, or distance from diaphragm 26 to front plate 27, to a point near the center of the diaphragm, where it turns forward and forms a tube, 28b, of gradually reducing diameter, which terminates in the orifice 28a.

The intent is that the area of the air chamber shall be of a predetermined form, such, for example, as that of the air chamber of an exponential horn, or one designed on my curve shown in Fig. 10. The outer end of this tapering tube 28b is, in Figures 2, 3 and 6, shown as spaced away from the opening in closure plate 30 by a sound-insulating ring 30h. An ear piece 32 of soft rubber, or the like, adapted to fit into the outer opening of the ear of a listener, and attached to the tapering tube 28 by a sleeve or thimble, 32a, may sometimes be used when a louder effect in the ear of the listener is desired.

Figs. 4, 5 and 9 show speakers with a front plate, 31, quite different from the type of front plate 27 previously described. In this type of front plate, the sides curve forward and inward from its periphery to its orifice at 28a. When this type of front plate is used in conjunction with my diaphragms shown in Fig. 5 no filler piece, 29, is needed. But if they are used in conjunction with ordinary diaphragms with a hole in center, filler piece 29a, Fig. 4, which is flat on top, and which comes just up to the edge of diaphragm, is necessary for best results. This type of front plate moves the air forward and accelerates it with very great smoothness, and without the danger of eddy currents or distortions which may occur in the other. In Figure 5 the diaphragm, 26, is of the inverted type, and terminates in a sharp point which extends forward into the

throat of front plate 31. The air chamber enclosed between diaphragm and front plate is of predetermined area.

Loud speakers are ordinarily so constructed as to set all of the air in a room into vibration so as to produce the sensation of sound throughout the entire room, as loudly or softly as may be desired. The object of my invention is not to produce the sensation of sound throughout a room or a house, but to so confine, concentrate and accelerate the movement of air produced by a diaphragm of large surface, and very small amplitude of vibration, that it will produce a small stream or jet of vibratory air of very much greater amplitude of vibration than the amplitude of vibration of the diaphragm which produced it. I then deliver these streams of vibratory air close to the ears of the listener. A sound vibration of quite small amplitude, if delivered close to the ear, or better the ears of a listener, will ordinarily produce all the sensation of sound he desires. Therefore, these very small streams (frequently $\frac{1}{4}$ " or even less in diameter) of small amplitude vibrations, emerging close to the ears of the listener, produce only a negligible sound in the rest of the room. For best and most quiet results, however, it is necessary to enclose the speaker in an insulating shell, or an insulated shell, or case, as here shown, so as to prevent vibrations, other than the useful vibrations from orifice 28a, from escaping into the room.

In the construction shown in Figures 2 and 3, the air passage beginning at the peripheries of the diaphragm and front plate decreases in capacity at a predetermined rate, preferably that of an exponential horn from bell to small end, or on that of my curve shown in Fig. 10. In the construction shown in Figure 2 the air passage extends from the peripheries of the diaphragm and front plate inward and rearward to near the centre, and then turns forward into tube 28b, the rate of decrease at the turning into this tube being maintained by the conical filler piece 29. The tube 28 in Figure 2 extends directly forward from the turning, while in Figure 3, in which the diaphragm and front plate are larger than in Figure 2, the tube is bent downward to bring it into line with the ear of the listener, so as to allow the bottom of the speaker case to clear the listener's shoulder.

The front plate 27, or 31, is in effect a horn of the type known as exponential but reversed, that is, with the vibratory diaphragm at the large end, and of substantially the full diameter of that end, so concentrating and accelerating all the air moved by the entire area of the diaphragm, and forcing it out through the orifice 28a, which, in most of my chairs, is almost microscopically small in comparison with the area of the diaphragm.

This horn, or concentrator, may be shaped on a curve which I have shown in Fig. 10. To lay out this curve I draw a line $a-a'$ to indicate the small end of the horn and a line $b-b'$ parallel with $a-a'$ to indicate the other or larger end. Perpendicular to these end lines, and midway between their ends, I draw lines $c-c'$ and $d-d'$ spaced apart a distance corresponding to the diameter of the opening at the small end of the horn. On line $b-b'$ the distance between b and c is divided into a definite number of equal spaces, and the distance between b' and d' is also divided into the same number of equal spaces. Lines $c-c'$ and $d-d'$ are each marked off for

the same number of equal spaces as are lines $b-c$ and $b'-d'$, though the spaces so marked off on lines $c-c'$ and $d-d'$ need not be and as shown are not equal to the spaces marked off on lines $b-c$ and $b'-d'$. The number of divisions here indicated on lines $c-c'$ and $d-d'$ is twenty but may be more.

Lines are then drawn from the first division point at the outer end of line $b-c$ to the first division point above line $b-c$ on line $c-c'$ forming line 1-1; from the second division point from the outer end of line $b-c$ to the second division point on line $c-c'$ above line $b-c$ forming line 2-2, and so on to form a series of lines 1-1, 2-2, etc., each drawn from a numbered point on a horizontal line to a correspondingly numbered point on a vertical line, and so on till all 20 lines have been drawn. Then complete the other side likewise. Each of these lines will cross many of the other lines and the junction points on the outside of the figure will give a curve which from the experience of many years, I have found to give very satisfactory results acoustically both as a horn and as a concentrator.

In all of the forms of loud speakers shown, the interior of the shell is lined throughout with insulating material, and the closure plate is also lined throughout with insulating material, preferably rubber or sponge rubber, and the front or closure plate is so cushioned at its periphery that vibrations will not be transmitted from one to the other.

Figure 9 shows, partly in side view and partly in vertical central section, a completely-insulated speaker in which the rubber or sponge rubber vibration deadener has been vulcanized on to the parts. The front closure plate, 30, is provided with an extension, 23h, adapted to fit over the ear of the listener. The recess for the ear in 23h is made of approximately the size and shape of the human ear.

Fig. 11, which is a detail view, partly in section, shows a modification 185 of the tube, leading from the speaker, to which flexible sound-conducting tubes may be secured. This, if formed of sheet metal, is to be covered, or lined, with a sound-insulating material 185a.

From the foregoing description, and by reference to the drawings, for example, Figs. 2 and 3 and particularly Figs. 4, 5 and 9, it will be apparent that novel principles of substantial utility are embodied in the disclosed means. In my speakers, the enclosed chamber, which is divided by the diaphragm into two parts, namely, the outer or upper part and the inner or lower part, serves as an infinite baffle, since the air moved forward by the diaphragm is prevented by the case or shell from whirling around and reaching the rear side of the diaphragm. Also there is involved the important principle of utilizing two air chambers of dissimilar sizes and dissimilar shapes, which are divided from each other by the diaphragm and thus prevent resonances. The front plate may be made on an exponential curve, or any other curve which may be formed to reduce resonances to the lowest point. The rear chamber formed by the shell and the insulating material is also designed with such a form as to give the least resonance possible. The insertion of the speaker frame and pot in this air chamber also tends greatly to reduce resonance and the areas of the two chambers, that above or at the outer side of the diaphragm and that below or at the inner side of the diaphragm, are of widely differing contents, thus making

the resonance points, if there be any, far apart, and so tending to work against each other, all of which is further accentuated by the fact that the upper or outer air chamber is open to the outer air through an orifice such as 28a, whereas the lower or inner air chamber, that below the diaphragm, is completely enclosed. The soft yielding insulating lining of the walls of the lower chamber also tend greatly to reduce resonance. The results may be further heightened by making the inside of the case, or of the insulating material within the case, rough in form or surface, so as to impede the movement of air as much as possible. Where sponge rubber is used, this can be easily done by using a rough male mold when the sponge rubber is vulcanized into the shell. Also, other screens or baffles may be placed inside of the lower chamber further to impede any possibility of resonances being set up.

My invention is not limited to the particular embodiments thereof illustrated and described herein, its scope being set forth in the following claims.

Having thus described my invention what I claim is:

1. A sound reproducing device or speaker particularly adapted for the reception of sound by a single listener exclusively, comprising, in combination, a rear shell of substantially hemi-ellipsoidal form, a conical diaphragm having its periphery secured to the peripheral portion of said shell so as to provide a closed chamber rearwardly of the diaphragm, actuating means for the diaphragm disposed axially at its rear, means for concentrating, accelerating and intensifying the aerial vibrations at the front of the diaphragm and delivering them in a relatively small stream of vibratory air close to the ear of a listener, said means comprising a cone-like front plate having a conical sound-delivery passage, said plate being attached peripherally to the speaker shell adjacent the periphery of the diaphragm, said conical sound-delivery passage forming between the front plate and the diaphragm an air chamber of constantly decreasing area forwardly in planes perpendicular to the axis of the diaphragm, said conical sound delivery passage terminating and opening outwardly at its plane of minimum area, and front cover means comprising a forwardly convex member connected peripherally with the shell and having remote from its periphery an opening for the outward passage of the reduced portion of the front plate.

2. A sound reproducing device or speaker particularly adapted for the reception of sound by a single listener exclusively, comprising, in combination, a rear shell of substantially hemi-ellipsoidal form, a conical diaphragm having its periphery secured to the peripheral portion of said shell so as to provide a closed chamber rearwardly of the diaphragm, actuating means for the diaphragm disposed axially at its rear, means for concentrating, accelerating and intensifying the aerial vibrations at the front of the diaphragm and delivering them in a relatively small stream of vibratory air close to the ear of a listener, said means comprising a cone-like front plate having a conical sound-delivery passage, said plate being attached peripherally to the speaker shell adjacent the periphery of the diaphragm, said conical sound-delivery passage forming between the front plate and the diaphragm an air chamber of constantly decreasing area forwardly in planes perpendicular to the

axis of the diaphragm, said conical sound-delivery passage terminating and opening outwardly at its plane of minimum area, and front cover means comprising a forwardly convex member connected peripherally with the shell and having remote from its periphery an opening for the outward passage of the reduced portion of the front plate, said shell and said cover means having sound-insulating means over substantially their entire inner surfaces.

3. A sound reproducing device or speaker particularly adapted for the reception of sound by a single listener exclusively, comprising, in combination, a rear shell of substantially hemiellipsoidal form, a conical diaphragm having its periphery secured to the peripheral portion of said shell so as to provide a closed chamber rearwardly of the diaphragm, actuating means for the diaphragm disposed axially at its rear, means for concentrating, accelerating and intensifying the aerial vibrations at the front of the diaphragm and delivering them in a relatively small stream of vibratory air close to the ear of a listener, said means comprising a cone-like front plate having a conical sound-delivery passage, said plate being attached peripherally to the speaker shell adjacent the periphery of the diaphragm, said conical sound-delivery passage forming between the front plate and the diaphragm an air chamber of constantly decreasing area forwardly in planes perpendicular to the

axis of the diaphragm, said conical sound-delivery passage terminating and opening outwardly at its plane of minimum area, and means at the front of the speaker providing an opening for the outward passage of the reduced portion of the front plate.

4. A sound reproducing device or speaker particularly adapted for the reception of sound by a single listener exclusively, comprising, in combination, a rear shell of substantially hemiellipsoidal form, a conical diaphragm having its periphery secured to the peripheral portion of said shell so as to provide a closed chamber rearwardly of the diaphragm, actuating means for the diaphragm disposed axially at its rear, and means for concentrating, accelerating and intensifying the aerial vibrations at the front of the diaphragm and delivering them in a relatively small stream of vibratory air close to the ear of a listener, said means comprising a cone-like front plate having a conical sound-delivery passage, said plate being attached peripherally to the speaker shell adjacent the periphery of the diaphragm, said conical sound-delivery passage forming between the front plate and the diaphragm an air chamber of constantly decreasing area forwardly in planes perpendicular to the axis of the diaphragm and terminating and opening outwardly at its plane of minimum area.

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