

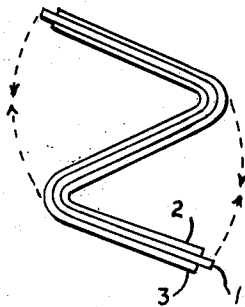
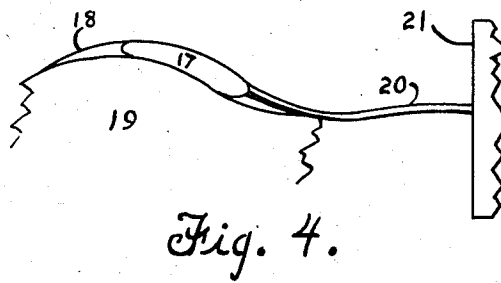
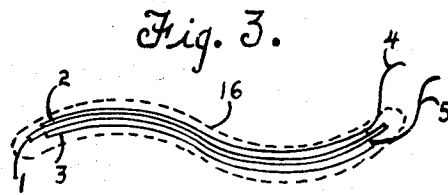
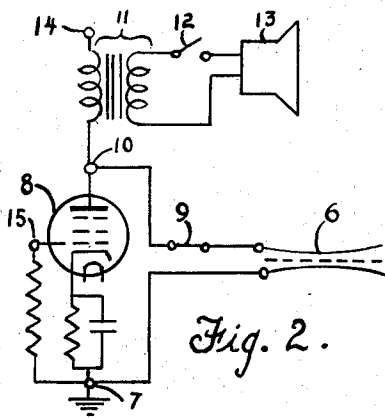
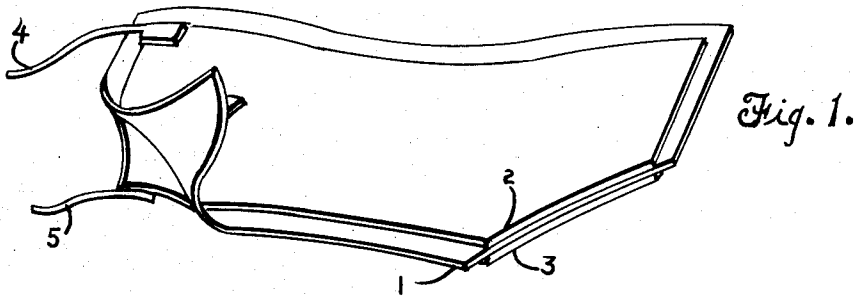
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P. CURRY
LOUD SPEAKERS

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2 Sheets-Sheet 1



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2 Sheets-Sheet 2

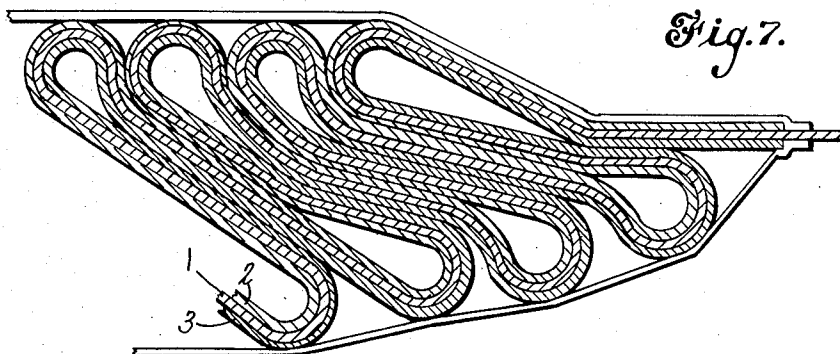
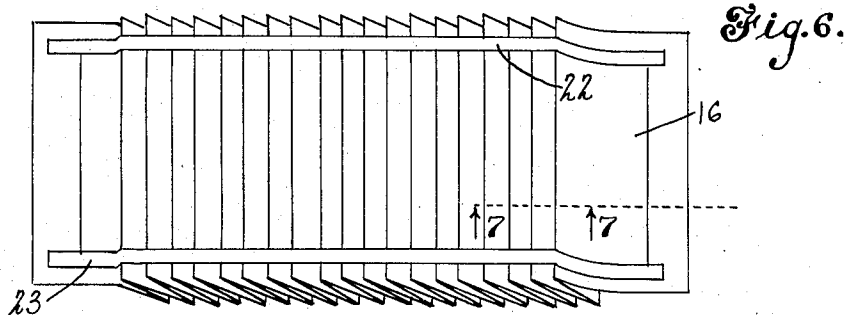


Fig. 8.

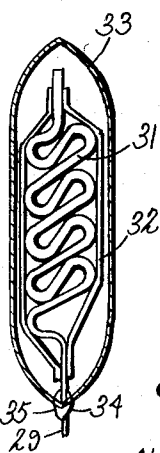


Fig. 9.

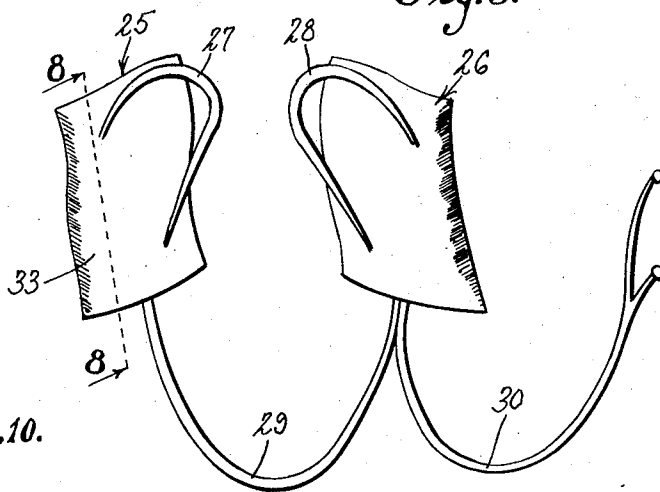
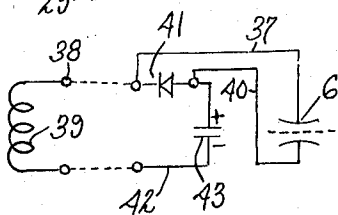


Fig. 10.



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2,855,467

LOUD SPEAKERS

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10 Claims. (Cl. 179—111)

The present invention relates to loud speakers and particularly to an electrostatic loud speaker adapted for individual listening, this application being a continuation in part of my application Serial No. 376,483, filed August 25, 1953, for Improvements in Loud Speakers and Circuits Therefor. Preferably the speaker unit is flexible so that it may be adjusted to pillows, the backs of arm-chairs and other places designed for relaxation with a view to achieving listening pleasure from radio and electrically transcribed sound and at the same time limit the loud speaker sound output so that the sound will be distinctly audible to the individual using the speaker but all others in the general vicinity will be excluded.

It has been found that when the two electrodes of an electrostatic loud speaker are thin metal diaphragms or metal foil and in physical contact with a high dielectric material which separates them, a polarizing voltage may be applied in series with the electrostatic unit and a signal applied to vary the polarizing voltage, the electrodes will vibrate in substantial fidelity with the character of the applied signal and thus faithfully reproduce the sound. Such a loud speaker may be made, for example, to consist of a pair of thin metal diaphragms, one loosely attached to each side of a sheet of thin, flexible, dielectric material so that the entire unit will be relatively thin and also highly flexible. When a polarizing voltage is applied to the diaphragms and a signal voltage applied to the circuit through an electronic amplifying tube, for example, the signal will be reproduced with reasonable fidelity.

One object of the invention is to provide a loud speaker which will be simple in construction, of flexible character, and which will occupy a comparatively small space.

Another object of the invention is to provide a loud speaker unit which may be of relatively small size and highly flexible so it may be inserted inside a pillow for an individual listener for use in hospitals or the like under circumstances where it is desired to exclude the sound from others.

A further object of the invention is to provide a simple, unobtrusive means by which the process generally referred to as sleep learning may be practiced.

Still another object of the invention is to provide an electrostatic loud speaker whereby a program of radio or transcribed sound may be heard by an individual listener without disturbing others in the same vicinity.

Still another object of the invention is to provide means whereby the electrostatic loud speaker may be connected to the output of a radio receiver, phono-amplifying unit or other signal transmission device by disconnecting the conventional reproducer from the device.

To these and other ends the invention consists in the novel features and combinations of parts to be hereinafter described and claimed.

In the accompanying drawings:

Fig. 1 is a cut-away view of an electrostatic speaker unit embodying the invention;

Fig. 2 is a schematic circuit diagram illustrating the operation of the invention;

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Fig. 3 is a cross sectional view of a pillow speaker;

Fig. 4 is a cross sectional view showing the speaker enclosed within the casing of a pillow;

Fig. 5 is a cross sectional view showing a method of folding the electrostatic speaker unit in order to increase the ratio of the sound-generating area to the effective sound projecting area;

Fig. 6 is a perspective view showing an electrostatic speaker folded by the method of corrugation;

Fig. 7 is an enlarged fragmentary sectional view of a folded electrostatic speaker on line 7—7 of Fig. 6;

Fig. 8 is a sectional view on line 8—8 of Fig. 9 showing the invention in the form of a flexible light weight earphone;

Fig. 9 shows a pair of earphones constructed as shown in Fig. 8 electrically connected together; and

Fig. 10 is a circuit diagram showing a method of using the electrostatic speaker without a polarizing voltage.

As illustrated in Fig. 1 of the drawings, the electrostatic speaker is shown as comprised of a sheet 1 of thin, flexible material having a high dielectric constant. This sheet may be made of any suitable flexible dielectric material. Loosely attached to the faces of the sheet 1 are thin metal diaphragms 2 and 3. These elements are also flexible and may, for example, consist of thin metal foil. This forms the core of the speaker unit.

A conductor 4 is electrically and mechanically connected to a diaphragm 2 in a firm fashion, and a second conductor 5 is similarly connected to the diaphragm 3 in order to connect the diaphragms with the signal source and also so that when desired a polarizing voltage may be applied thereto.

As illustrated in Fig. 3, for example, the speaker unit or core above described may be enclosed in a covering 16 of non-conducting material, this material also being flexible and may be of sheet plastic, for example. The lead wires 4 and 5 may project outwardly through openings in this cover. Such a unit as shown in Fig. 3 is well adapted to be inserted within a pillow, for example, for it will be of relatively light weight, of relatively soft character, and will be thin and flexible.

In Fig. 2 of the drawings there is shown a circuit diagram illustrating the operation of the invention wherein the speaker unit shown in Fig. 1 or 3 is designated by reference character 6. As illustrated, one terminal of the speaker unit is connected to the grounded terminal 7 of an electrical network associated with an output electronic amplifying tube 8 having the usual plate cathode and filament elements. The other terminal of the speaker unit 6 may be connected through switch 9 to the plate element 10 of the electronic tube.

Also connected to the plate element 10 is the primary winding of an output transformer 11. The secondary winding of this transformer is connected to a conventional loud speaker unit shown diagrammatically at 13, the connection being controlled by a switch 12 so that the speaker 13 may be cut off when desired.

It may be assumed that an electrical potential is applied from the grounded terminal 7 to the high potential terminal 14 of the electrical network which includes the electronic tube 8 in a manner well known in the art. A signal input terminal for the tube 8 is shown at 15.

Assuming that no signal is being applied to the signal input 15, there will be a steady polarizing potential applied across the input speaker 6. With a signal applied to input 15, there will be a variation of the potential across the speaker unit 6 which will have substantially the frequency of the signal input. No undesirable rectification of the signal will occur as long as the average polarizing potential is greater than the amplitude of the signal frequency.

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The electrical network from the ground terminal 7 to the high potential terminal 14 associated with the electronic tube 8, represents the output stage of conventional types of radio receivers or phono-amplifiers, and the arrangement shown in Fig. 2 illustrates means whereby the signal output of such radio receivers or phono-amplifiers may be cut off from the usual loud speaker and applied to a speaker unit 6 embodying the present invention for single individual listener use.

When the switch 12 is closed and the switch 9 open, it will be obvious that such an output stage will apply its signal to the conventional loudspeaker unit 13 in the usual manner, the speaker unit 6 being disconnected by the opening of switch 9. However, with the switch 12 open and the switch 9 closed, as shown in Fig. 2, the conventional loudspeaker will be disconnected and the speaker unit 6 will be connected to the output of the receiver, and the signal or sound will be reproduced by the speaker unit 6.

In Fig. 4 of the drawings, I have shown in somewhat diagrammatic form the speaker unit shown in Fig. 3 enclosed in a pillow or the like. Here the speaker unit designated at 17 has been inserted between the pillow casing 18 and the pillow 19 with the wires 4 and 5 enclosed in a cord 20 which is attached to the speaker unit 17, leading from the pillow casing to a signal source 21. This signal source may, of course, provide for the polarizing potential above described and illustrated in the wiring diagram shown in Fig. 2.

In Fig. 5 of the drawings, I have shown diagrammatically the folding by the principle of corrugation or accordion pleating of a speaker unit such as shown in Fig. 1. As previously stated, all of the elements 1, 2 and 3 of this unit are flexible and, if desired, the unit may be folded upon itself to provide a relatively large effective sound-projecting area within the hearing range of a listener. In other words, the speaker unit folded as shown will occupy a relatively small space and extend over a relatively small area, but will at the same time have a relatively great sound-generating area, i. e., it will have an increased ratio of sound generating area to the effective sound-projecting area.

In Fig. 6 of the drawings there is shown a speaker unit formed by the process of corrugation or folding illustrated in Fig. 5. In this case a speaker unit such, for example, as is shown in Fig. 3 having an outer covering 16, is folded upon itself a plurality of times, the folds lying upon each other in progressive fashion and being secured in place by strips 22 and 23 of masking tape or the like so as to hold the individual folds in place without detracting from the flexibility of the unit. It is understood that such a speaker as shown in the sectional view of Fig. 7 consists of the flexible dielectric sheet 1 to which are loosely attached the flexible metallic diaphragms 2 and 3. Similarly lead wires (not shown) are connected to the diaphragms 2 and 3 in order to connect the unit with the signal output. It has been found that a speaker folded in this fashion while occupying a relatively small space, particularly as to area, will reproduce the sound or signal with good fidelity but at the same time confine the sound to the listener whose ear will be in close proximity to the speaker.

My improved speaker unit may also be employed with soft flexible earphones of very light weight which may be supported upon the ear of the listener and render the sound audible to the listener while excluding it from others. It is of such light weight that it may be hung from and supported directly by the ears without harshness or discomfort to the user. Such a construction is shown in Figs. 8 and 9 wherein a pair of loudspeakers 25 and 26 are shown as provided with straps 27 and 28 by which they may be suspended from the ears.

The earphones are connected in parallel by cords 29 and 30 to a signal source (not shown).

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As shown in Fig. 8, these loudspeakers are constructed substantially like that shown in Figs. 6 and 7 in that the speaker unit is corrugated, as shown at 31, the corrugations being held together by tapes 32. The unit thus formed is enclosed within a soft covering 33 and the lead wires 34 and 35 extend without the covering to be embodied in the cord 29.

In Fig. 10 of the drawings, I have shown a circuit whereby the electrostatic loudspeaker of the present invention is connected to the signal voltage source without the use of a polarized voltage. In this case the loudspeaker is designated by the numeral 6 as in Fig. 2. One pole of the speaker is connected directly by the wire 37 to one pole 38 of the alternating current signal voltage source 39, while the other pole of the reproducer source is connected to this pole through the wire 40 and the diode rectifier 41. The conductor 40 is connected to the other pole of the alternating signal voltage 39 by the circuit 42 having therein a capacitance unit 43 so that a direct potential is derived from the signal source.

With the use of this circuit a direct potential is derived from the alternating signal voltage, and this direct potential is combined with the alternating signal voltage so that the value of the direct potential is at least as great as that of the alternating signal voltage. It has been found that with the use of such a circuit the electrostatic speaker embodying the present invention will reproduce the signals applied to it in a reasonably faithful manner without the employment of a polarizing voltage.

In the assembly of the core of the speaker unit the metal diaphragms 2 and 3 are loosely attached to the sheet 1 of dielectric material. Preferably this may be done by attaching the sheets together at their edges or at spaced points along their edges so as to locate one with respect to another but to leave them free or loose between their edges. This provides an entrapped air pocket or pockets between the diaphragms and the dielectric sheet which permit vibration of the diaphragms which would not be permitted if the diaphragms were cemented firmly to the dielectric sheet over their entire areas.

While I have shown and described some preferred embodiments of my invention, it will be understood that it is not to be limited to all of the details shown, but is capable of modification and variation within the spirit of the invention and within the scope of the claims.

What I claim is:

1. A loud speaker system comprising two electrically conductive flexible diaphragms separated by a thin sheet of flexible dielectric material having a high dielectric constant to which the diaphragms are loosely attached in a manner to provide random entrapped air pockets, means for applying a polarizing voltage between the two conductive diaphragms, and means for amplitude modulating said polarizing voltage by a signal source, whereby the amplitude modulations are translated into sound substantially responsive to the signal source.

2. A loud speaker system according to claim 1 wherein the diaphragms are secured to the dielectric sheet at their edges only and left free over their surfaces between the edges.

3. A loud speaker system according to claim 1 wherein the unit consisting of the two electrically conductive diaphragms separated by the sheet of dielectric material is repeatedly folded upon itself to increase the ratio of sound-generating area to the effective sound-projecting area.

4. A loud speaker system according to claim 1 wherein the unit comprising the diaphragms separated by the dielectric sheet is progressively folded upon itself by the process of corrugation to provide a series of overlapping folds to increase the ratio of sound generating area to the effective sound-projecting area of the system.

5. A loud speaker system according to claim 1, wherein the means for applying a polarizing voltage between the two conductive diaphragms comprises a rectifier and a

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capacitor connected in series across said amplitude modulating means, and means connecting said diaphragms to opposite terminals of said rectifier.

6. A loud speaker system comprising two electrically conductive flexible diaphragms separated by a thin sheet of flexible dielectric material having a high dielectric constant to which the diaphragms are loosely attached in a manner to provide random entrapped air pockets, input means for coupling the system to an audio frequency signal source, and rectifier means coupled between said input means and said diaphragms for rectifying a portion of said signal to provide a polarizing voltage for the diaphragms.

7. A flexibly supported electrostatic sound reproducing device comprising an assembly of two diaphragms of electrically conductive flexible vibratile foil material and a thin sheet of flexible dielectric material therebetween having a high dielectric strength, said diaphragms and said dielectric material being secured together at their marginal edges only, the entire body portions of said diaphragms inwardly of the marginal edges being unrestrained for vibration relative to said flexible dielectric sheet and forming therebetween random entrapped air pockets, a flexible enclosure within which the assembly is completely enveloped, and means extending through the walls of said enclosure for making independent electrical connection to each of said diaphragms.

8. A flexibly supported electrostatic sound reproducing device according to claim 7, wherein the assembly of said diaphragms and said sheet is repeatedly folded upon itself to provide accordion-like pleats throughout a substantial portion of its unrestrained surface area, whereby the ratio of sound generating area to the effective sound-projecting area is increased.

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9. An electrostatic sound reproducing device adapted for operation while flexibly disposed in close proximity to the listener comprising two diaphragms of electrically conductive vibratile foil material, flexible insulating material disposed between said diaphragms for establishing and maintaining electrical separation therebetween, means for securing said diaphragms in closely spaced relationship while permitting vibration thereof throughout substantially the entire surface area thereof, means for making independent electrical connection to each of said diaphragms, the assembly of said diaphragms and insulating material being repeatedly folded upon itself to increase the sound generating area within a given space, and means securing said assembly in folded relationship with the folded assembly being entirely flexible and non-restrained, whereby said assembly can be disposed within a flexible enclosure and subjected repeatedly to flexure without operation failure.

10. An electrostatic sound reproducing device according to claim 9, wherein the assembly of said diaphragms and insulating material and its fold securing means is completely enclosed in a casing of thin flexible electrical insulating material with said means for making electrical connection to said diaphragms extending through the walls of the casing.

References Cited in the file of this patent

UNITED STATES PATENTS

30	1,380,981	Langmuir	June 7, 1921
	1,764,008	Crozier	June 17, 1930
	2,615,994	Lindberg et al.	Oct. 28, 1952