United States Patent

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[54] SOUND TO LIGHT VISUAL VOCALIZATION SYSTEM
11 Claims, 5 Drawing Figs.

[52] U.S. Cl. 353/15, 84/464, 35/35, 350/285
[51] Int. Cl. A63j 17/00
[50] Field of Search ..... 84/464 (Inquired); 353/1, 15; 35/35.3; 350/285; 179/1 (vis)

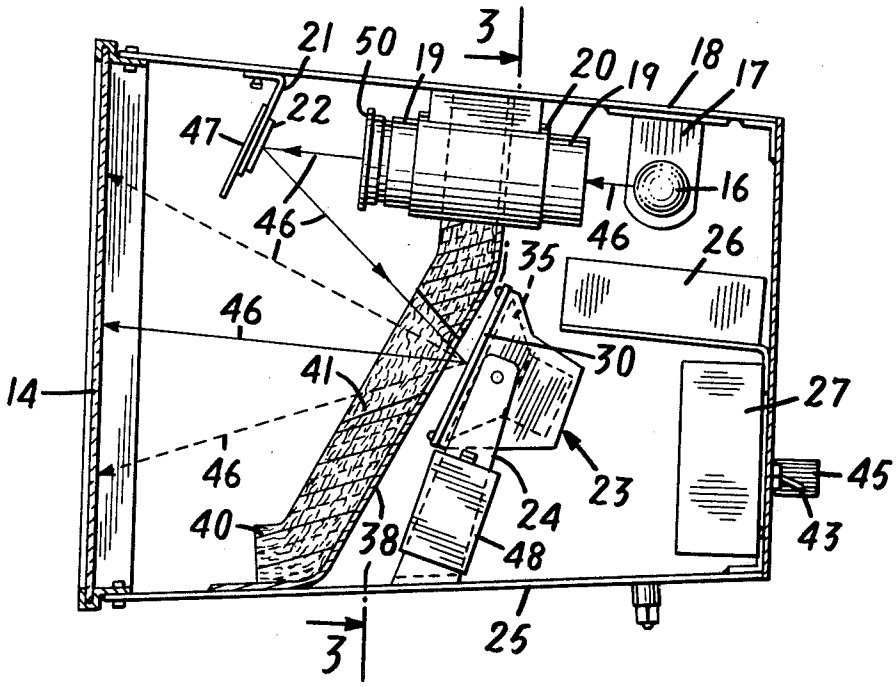
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ABSTRACT: A loudspeaker is closed by a resilient membrane mounted across its mouth and at least one reflective surface is attached to the membrane. The reflective surface receives a beam of light from a stationary source and reflects a spot of light onto a screen positioned in front of the resilient membrane. Sound waves emanating from the speaker cone cause the resilient membrane and attached reflective surface to vibrate in response thereto, thereby causing the reflected light spot to trace visible different patterns on said screen. These patterns help deaf persons learn to vocalize much sooner than they would with conventional therapies.



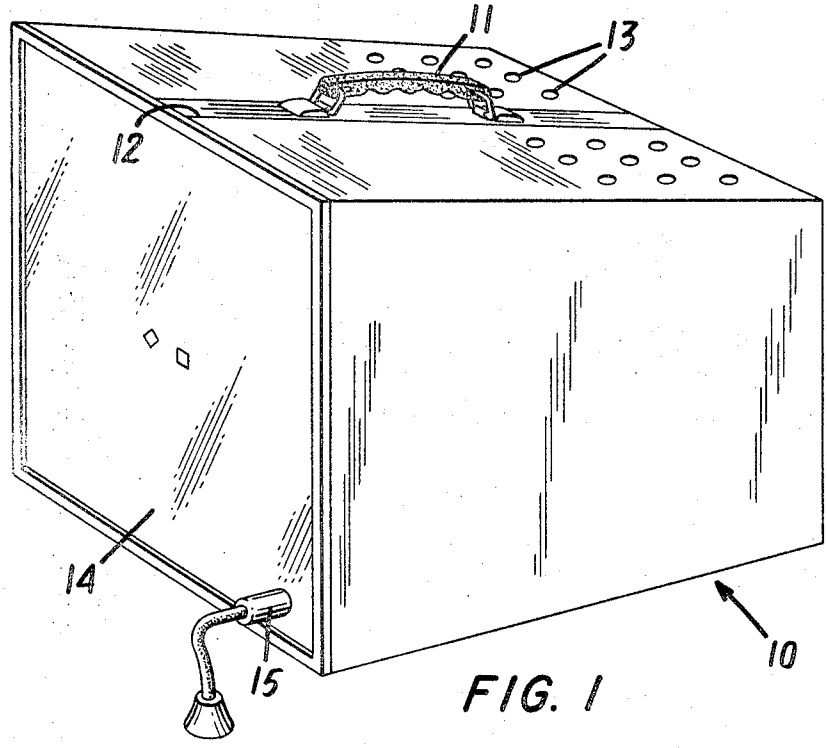


FIG. 1

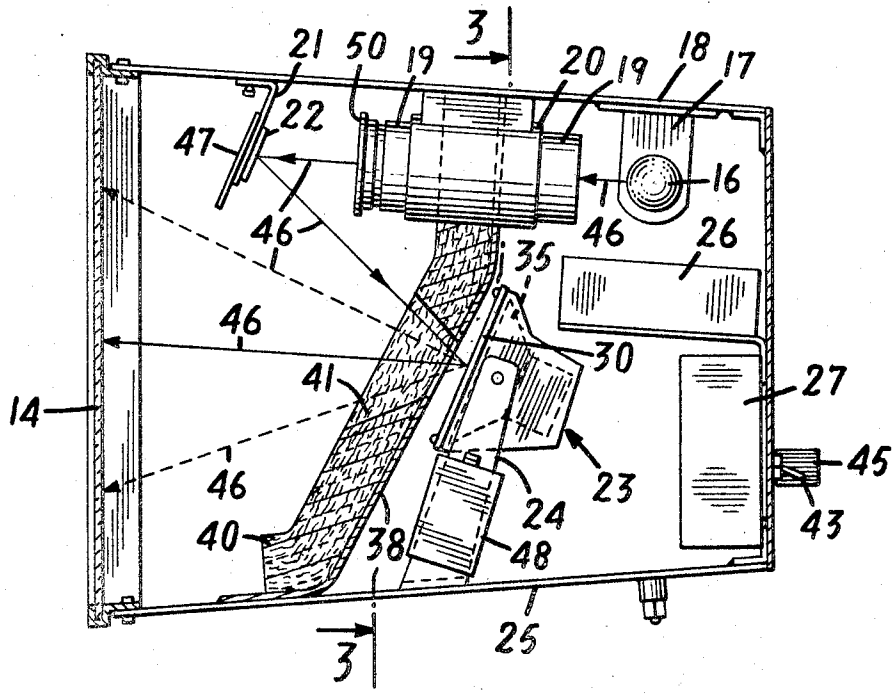


FIG. 2

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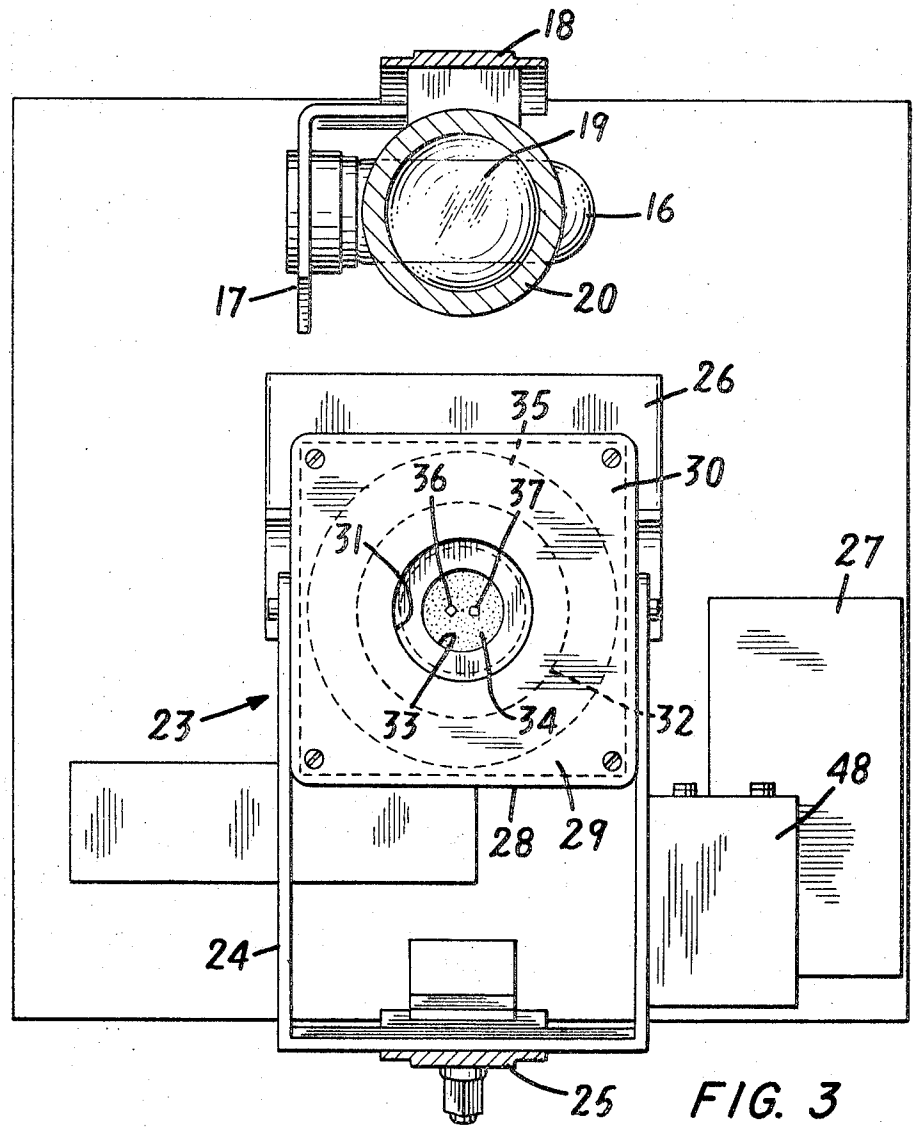


FIG. 3

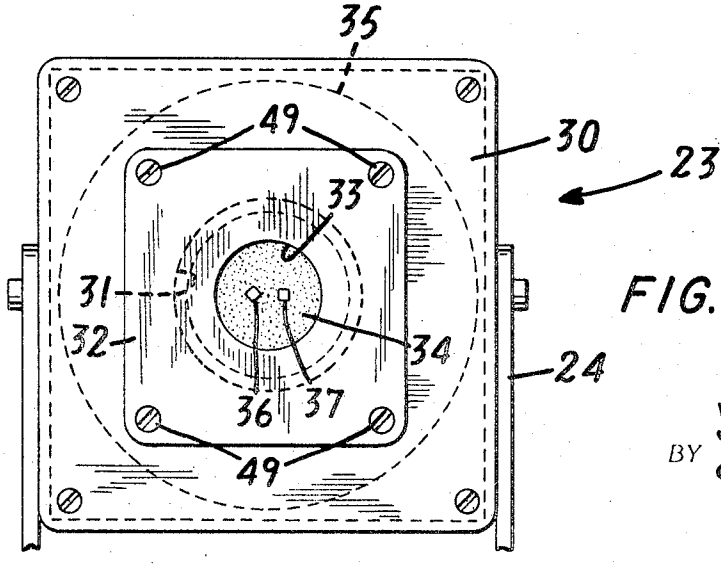


FIG. 5

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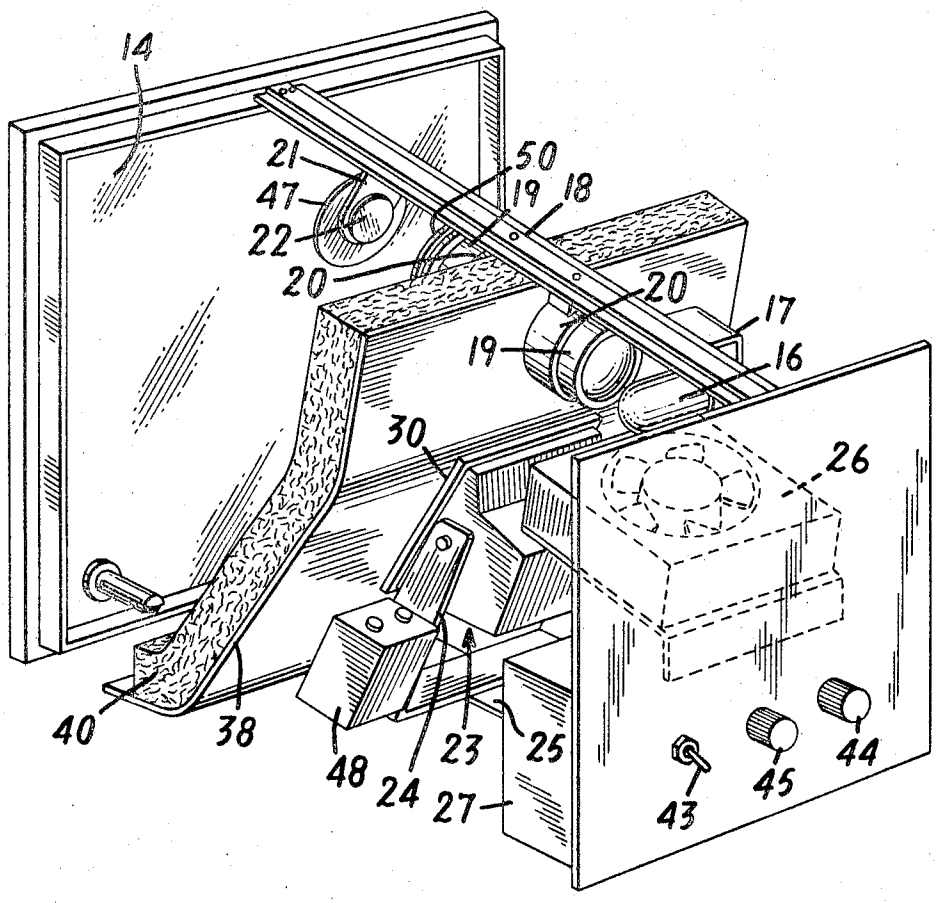


FIG. 4

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SOUND TO LIGHT VISUAL VOCALIZATION SYSTEM

This invention provides a very simple means of converting speech into an optical display. Basically, the invention consists of an enclosed loudspeaker having a thin, highly resilient membrane mounted across the loudspeaker mouth. The membrane has one or more small reflectors attached to it. A light source is provided along with means for focusing the light source on the reflectors. A conventional microphone is utilized as the transducer for converting speech into an electrical signal. Sound received by the microphone is fed to the loudspeaker coil-magnet coupling which in turn vibrates the loudspeaker diaphragm, thereby displacing air within the loudspeaker cone in response to said diaphragm vibrations. The displaced air reacts upon the resilient membrane and forces it to vibrate. The reflectors vibrate conjointly with the resilient membrane, causing excursions of the reflected light beam, said excursions being intercepted by a screen and forming a continuous visual display thereon. The visual display pattern is directly related to the mode of vibration of the resilient membrane, which is in turn determined by the mode of vibration of the speaker diaphragm. As a result, the visual display pattern is reproducible when the same sound is fed into the microphone.

In order to produce an operable apparatus in accordance with the invention, it is essential that the vibratable area of the membrane be smaller than the area of the mouth plane of the loudspeaker. If the vibratable area of the membrane is the same as the open mouth of the loudspeaker, the light reflected onto the viewing screen traces either no readily discernible patterns or such small patterns as to be of no practical value in speech therapy. However, when the vibratable area of the membrane is diminished so as to be appreciably less than the open mouth of the loudspeaker, the reflected light traces large, clearly-recognizable patterns on the viewing screen in response to the vocal inputs of the patient using the device. The reasons why the foregoing inequality relationship between vibratable membrane area and loud speaker mouth area has such a drastic effect on the light patterns are not entirely understood at this time. Nevertheless, it is a fact that the device of the invention has practical utility for its intended purpose only when the vibratable area of the membrane is made less than the open mouth area of the loudspeaker.

The device of the invention is primarily intended for use in speech therapy with the deaf and is especially intended for use by children who have not begun to vocalize. In this instance, a speech therapist will speak into the microphone, preferably vowels, which will appear as a visual pattern on the screen. The deaf child then attempts to recreate the pattern. The child must vocalize in order to recreate the pattern and when he does recreate the pattern, the vowel has been pronounced.

The visual display produced by the device is also dependent on pitch intensity and duration, thus providing the patient with visual recognition and appreciation of these variables, which is particularly helpful in those situations where a deaf person can speak, but lacks control of pitch intensity and duration. In speech therapy for the deaf, four major problem areas are a lack of spontaneous vocalization and vocal experimentation, lack of duration and breath control, lack of volume, and the lack of pitch control. Because the patterns produced in accordance with the invention are dependent on pitch intensity and duration, the patient can learn to over come the above problems simply by recreating visual patterns on the screen as created for him by the therapist.

Referring now to a particular embodiment of the invention in which like characters refer to like parts,

FIG. 1 is an isometric view of the assembled unit.

FIG. 2 is a horizontal cross-sectional view of the unit of FIG. 1 taken through line 12 of FIG. 1.

FIG. 3 is a front cross-sectional view taken along the line 3–3 of FIG. 2.

FIG. 4 is an isometric view of the various components of the invention shown in spacial relation to each other.

FIG. 5 is similar to FIG. 3 and shows another embodiment of the invention.

Referring now to FIG. 1, there is a casing 10 to which is attached carrying handle 11. The casing 10 is in two sections and is assembled along line 12 for easy maintenance, repair or inspection. The upper part of the casing has air holes 13 therein for removal of heated air generated by a high power bulb therein. To the front of the case is attached a screen 14, preferably of ground glass, and a microphone 15.

Referring now to FIG. 2 and 4, a high intensity light 16 is mounted on a bracket 17 which in turn is attached to the upper case frame member 18 (FIG. 4). In front of said bulb and displaced axially therefrom, is a combination projecting and condensing lens 19 mounted in a bracket 20, which is in turn attached to frame member 18. Mounted in front of the condensing-projecting lens is an amber colored light filter 50 which, by changing the color of the light beam from white to amber, produces a more pleasing visual effect on the screen 14 than does white light. It is contemplated that any color filter might be used, including the use of nonfiltered white light, depending on the user's desires. In front of the condensing-projecting lens combination is a bracket 21 on which is mounted a mirror 22 having an opaque plate 47 of larger area than the mirror attached to the bracket 21 on the side opposite the side to which the mirror 22 is mounted and whose purpose will be described hereinafter. A speaker assembly 23 is mounted on a bracket 24 which in turn is affixed to the lower frame member 25. Behind the speaker and underneath the bulb 16 is a cooling fan 26 and preamplifier-amplifier combination 27. The battery 48 forms a part of the preamplifier-amplifier combination 27 and is mounted to the bracket 24. Fan 26 provides cooling air which sweeps up and around the bulb 16 to cool it and then exits through the air holes 13 (FIG. 1). All connecting wires have been eliminated for simplicity.

Referring now to FIG. 3, 28 is a wooden speaker enclosure in which is mounted a speaker 29. The speaker enclosure has a front panel 30 with an opening 31 therein. Mounted to the back of this panel between the loudspeaker mouth and the front panel is a membrane panel 32 with an opening 33 therein, to which is attached a resilient membrane 34, preferably a thin rubber sheet. The resilient membrane can be mounted to the membrane panel by any suitable means, preferably epoxy. The membrane panel can be mounted to the speaker enclosure front panel also by any means, but preferably epoxy. The opening 33 in the membrane panel 32 is smaller than the open mouth 35 of the loudspeaker 29. Therefore, the vibratable area of membrane 34 exposed in the opening 33 is correspondingly also smaller than the open loudspeaker mouth 35, and in the disclosed embodiment the ratio of the area of the loudspeaker open mouth to the vibratable membrane area is about 20 to 1. The size of the opening 31 in the front panel is relatively immaterial, except in that it has to be smaller than the size of the membrane panel 32 in order to provide for mounting of the membrane panel.

Mounted on the membrane on either side of center are two small reflectors 36 and 37. Any orientation of the two reflectors can be used, however, it is preferable that they be in a line as shown. It has been found, however, that for deaf brain-damaged children, one reflector elicits better response than two, as the visual pattern appearing on the screen is less complex. Conversely, it has been found that more than two reflectors can elicit good response from non-brain-damaged deaf children. However, the visual patterns resulting from the use of more than two reflectors is rather complex, and therefore not as desirable in general as only one or two.

In front of the speaker enclosure (FIGS. 2 and 4) is a thin aluminum plate 38, whose surface is covered with a sound-absorbing foam 40. An opening 41 extends through the foam and aluminum plate in substantial alignment with the membrane 34. The aluminum plate and foam is substantially rectangular and equal to the cross section of the unit at the point of installation, thereby providing a sound absorber in order to dampen any undesirable background noise.

The back surface of the unit has an ON-OFF switch 43 and and adjustment knob 44 which is essentially a separate gain

control for the preamplifier module. However, a single amplifier may be used rather than a combination amplifier-preamplifier, in which case the separate preamplifier gain control may be eliminated.

Referring now to FIG. 2, light emanating from the bulb 16 along the arrows 46 enters the condensing-projecting lens 19 and is focused on the mirror 22. The opaque board 47, being larger in area than mirror 22, absorbs light emanating from the condensing-projecting lens not falling within the boundaries of the mirror, thereby preventing light falling outside the boundaries of the mirror from appearing directly on the screen 14. The mirror 22 is disposed at a predetermined angle to the frame member 18 so that it reflects light through the opening 41 on to the reflectors 36 and 37 on the membrane 34, which in turn reflect the light onto the screen 14 as two spots of light. When someone speaks into the microphone, the speaker sets the air mass inside the speaker cone in motion, thereby causing membrane 34 to vibrate. The vibration of membrane 34 causes the reflectors 36 to 37 to vibrate conjointly with said membrane. As the reflectors vibrate, they continuously change their position with respect to the plane of the loudspeaker mouth. This in turn causes an excursion of the light beam being reflected from the reflectors on the screen 14 as shown in phantom in FIG. 2, the nature of the excursion being dependent on the amplitude and response mode of the membrane, thereby causing a visual pattern to appear on the screen 14.

FIG. 5 shows another way of mounting the membrane to the loudspeaker in which the membrane becomes easily interchangeable, therefore allowing the pitch response or other performance characteristics of the unit controlled by the specific form of membrane to be varied at will. In this embodiment, the combination of the membrane panel 32 and the membrane 34 are releasably mounted by screws 49 to the front panel 30. Therefore, if it should be desirable to change the membrane of the unit, all one need do is remove the screws 49, remove the membrane mount with its attached membrane and replace it with another of different response characteristics.

It is to be understood that the preceeding detailed description is illustrative only and that various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art. It is therefore intended that the scope of the invention be limited only by the claims that follow.

I claim:

1. A device for converting sound waves into visual patterns comprising:
   a. a loudspeaker;
   b. a screen mounted in front of and spaced a predetermined distance from the mouth of said speaker;
   c. a resilient membrane disposed in front of the mouth of said speaker, said resilient membrane being effective to vibrate in response to sound waves emanating from said speaker;
   d. said resilient membrane having an area capable of vibrational response to said sound waves which is smaller by a predetermined amount than the area of the mouth of said speaker;
   e. at least one reflector mounted on said resilient membrane; and
   f. means to direct a beam of light at said reflector, said reflector being effective to reflect said light beam onto said screen and to change the position of said light beam on said screen in response to the vibration of said resilient membrane.

2. A device for converting sound waves into visual patterns as in claim 1, wherein said resilient membrane is made of thin rubber material.

3. A device for converting sound waves into optical patterns as in claim 1, wherein said means to direct a beam of light at said reflector comprises in combination a condensing and projecting lens disposed between a light source and a second reflecting mirror, said second reflecting mirror being effective to reflect the beam of light to said first reflector.

4. A device for converting sound waves into visual patterns as in claim 1, wherein said speaker is mounted within a wooden enclosure, said enclosure being effective to absorb the back waves generated by the loudspeaker.

5. A device for converting sound waves into visual patterns as in claim 4, wherein sound absorbing material is mounted in front of said speaker to attenuate background noise.

6. A device for converting sound waves into visual patterns as in claim 1, wherein said means to direct a beam of light at said reflector includes a colored filter therein, said colored filter being effective to change the color of the pattern appearing on said screen.

7. A device for converting sound waves into visual patterns as in claim 3 wherein said second reflector has an opaque plate mounted thereon, said opaque plate being effective to absorb light emanating from said condensing-projecting lens falling outside the bounds of said second reflector.

8. In a device for converting sound waves into visual patterns, the improvement comprising a resilient membrane disposed in front of the mouth of a loudspeaker, said resilient membrane having an area capable of vibratory response to said speaker substantially less than the area of the mouth of said speaker; at least one reflector mounted on said membrane, said reflector being effective to reflect a beam of light impingent thereon in a pattern congruous with the mode of response of said resilient member.

9. A device for converting sound waves into visual patterns comprising:
   a. a loudspeaker affixed to a mount;
   b. a screen mounted in front of and spaced a predetermined distance from the mouth of said speaker;
   c. a resilient membrane disposed in front of the mouth of said speaker, said resilient membrane being effective to vibrate in response to sound waves emanating from said speaker;
   d. said resilient membrane having an area capable of vibrational response to said sound waves which is smaller by a predetermined amount than the area of the mouth of said speaker;
   e. said resilient membrane being mounted in association with the speaker mount;
   f. at least one reflecting means mounted on said resilient membrane;
   g. means to direct a beam of light at said reflecting means, said means comprising in combination a condensing and projecting lens disposed between a light source directed toward the said screen and a second reflecting means, said second reflecting means being effective to direct the beam of light to said first reflecting means; and
   h. said second reflecting means having an opaque plate being effective to absorb light emanating from said condensing-projecting lens falling outside the bounds of said second reflecting means.

10. A device for converting sound waves into visual patterns as in claim 9, wherein said means to direct a beam of light at said reflector includes a colored filter therein, said colored filter being effective to change the color of the pattern appearing on said screen.

11. A device for converting sound waves into visual patterns as in claim 9, wherein sound absorbing material is mounted in front of said speaker to attenuate background noise.