Jan. 31, 1956 J. LÉON 2,732,907

SOUND TRANSDUCERS

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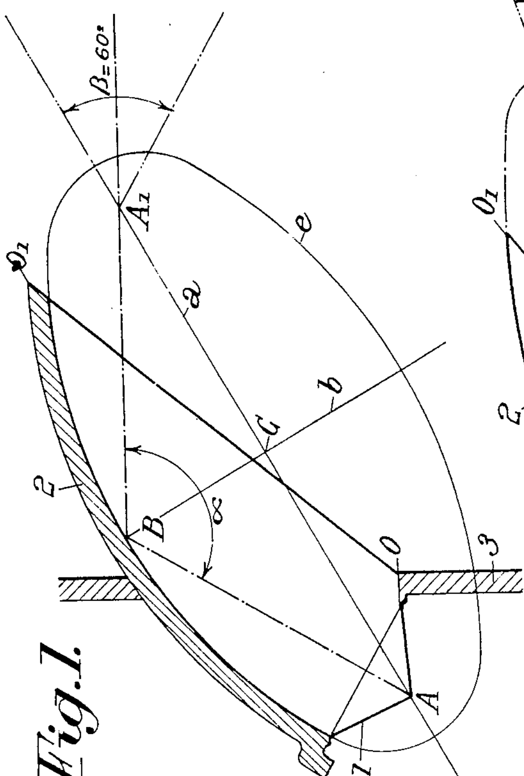

Fig.1.

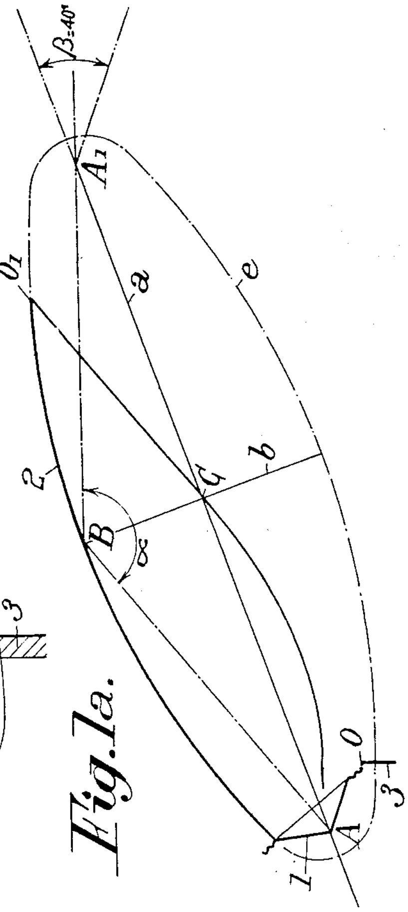

Fig.1a.

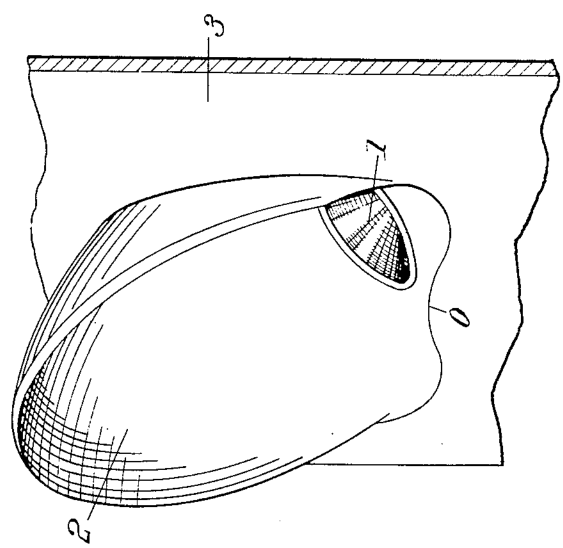

Fig.2.

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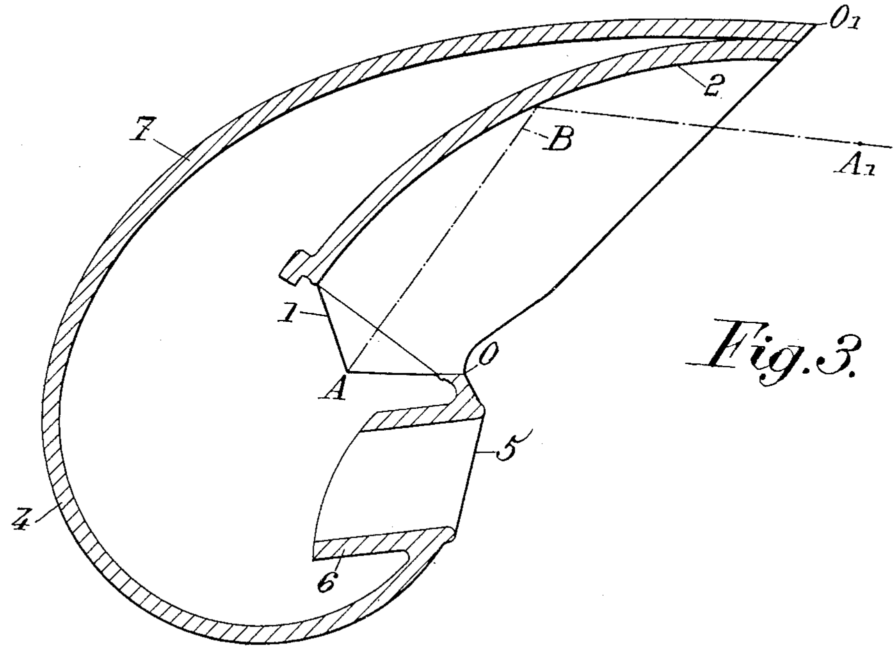
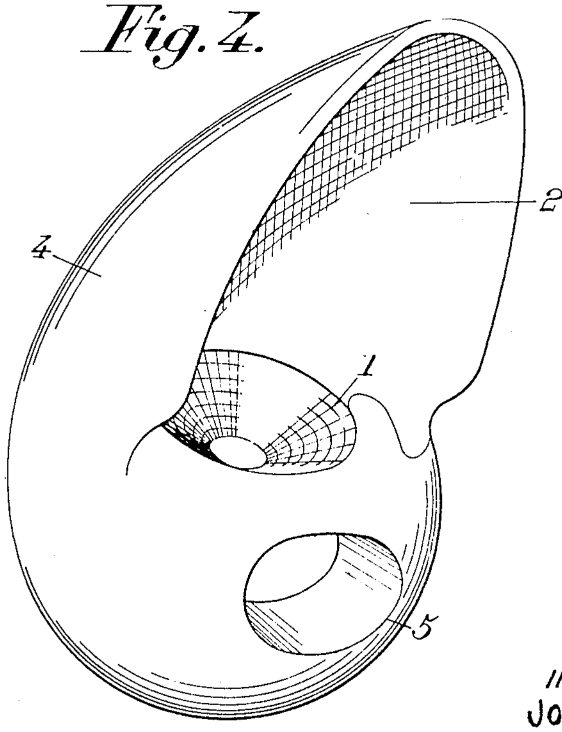


Fig. 3.

Fig. 4.



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4 Claims. (Cl. 181—31)

The present invention relates to sound transducers of the kind including a sound generator, in particular a diaphragm loud speaker, in combination with a reflecting surface constituted by a portion of an ellipsoid of revolution, this surface being arranged in such manner that the point forming the virtual acoustic source (substantially the center of the diaphragm or, when this diaphragm is of conical shape, the apex of the cone of this diaphragm) is located at one focus of the ellipsoid whereas the other focus, toward which the reflected sounds converge, is located outside of the reflecting surface and downstream of the outlet aperture thereof.

The object of my invention is to provide an improved sound transducer of this kind.

According to my invention, the axis of the incident sound beam from the acoustic source is so inclined with respect to the reflecting surface that the angle made by this axis with the axis of the reflected sound beam is greater than 90° and the outlet aperture of the reflecting surface extends to the immediate vicinity of the sound generator.

With such an arrangement an acoustic transmission is achieved such that the point from which the high frequency sounds are transmitted is spaced from the point from which the low frequency sounds are transmitted.

This phenomenon is quite audible for an auditor, high-pitched sound seeming to be transmitted from the focus of the ellipsoid remote from the diaphragm and low-pitched sound from the diaphragm itself.

When, in order to achieve the transmission of low frequencies, it is necessary to prevent the return toward the front of the sound waves produced by the rear face of the diaphragm, a baffle is provided at the place where the diaphragm is in close vicinity to the outlet aperture or mouth of the reflecting surface. This baffle is then located in a plane substantially perpendicular to the axis of the reflected sound beam.

Preferred embodiments of the present invention will be hereinafter described with reference to the accompanying drawings, given merely by way of example, and in which:

Figs. 1 and 2 are a vertical axial section and a perspective view, respectively, of a sound transducer according to my invention;

Fig. 1*a* is a view similar to Fig. 1 and relating to a modification.

Figs. 3 and 4 are views of the same kind as Figs. 1 and 2 respectively but relating to another embodiment of my invention.

The device shown by Figs. 1 and 2 includes, on the one hand, an acoustic source constituted by a diaphragm **1** of conical shape energized through suitable means not shown, and, on the other hand, a reflecting surface **2**.

This reflecting surface is in the form of a portion of an ellipsoid of revolution the outlet aperture or mouth of which is located in plane $O—O_1$ (the remainder of the ellipsoid surface being shown by line *e*). The foci of the ellipsoid are A and A_1 located along the major axis *a*.

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The apex of the conical diaphragm **1** is located at focus A so that the sounds which strike surface **2** and are reflected therefrom are concentrated at point A_1.

According to the present invention, the plane of the base of conical diaphragm **1** is so inclined with respect to axis $A—A_1$ that the axis AB of this diaphragm intersects reflecting surface **2** and makes an angle α greater than 90° with the axis BA_1 of the sound beam reflected from said surface **2**. Furthermore, the outlet aperture or mouth of the reflecting surface (located in plane OO_1) extends into close vicinity to diaphragm **1**. In Figs. 1 and 2, O designates the point where the edge of this mouth is closest to the diaphragm.

Advantageously, the point B where the axis AB of the loud speaker diaphragm **1** intersects the reflecting surface **2** coincides with the point of intersection with said surface **2** of the minor axis *b* of the section of the ellipsoid by plane at right angles to the plane OO_1 and passing through the axis of symmetry of the ellipsoid (i. e. by the plane of Fig. 1).

The reflected beam has in this case the shape of a cone the apex of which is at A_1.

The apex angle β of this sound cone is the smaller as angle α is greater. On the other hand, α is the greater as the ellipsoid is of a more elongated shape, that is to say as the distance between foci A and A_1 is greater.

It is always advisable to adapt the angle β of the reflected sound cone to the space where the apparatus is to be used. For instance, in a church, where acoustic reverberation is high, angle β is advantageously chosen relatively small. On the contrary, in spaces where acoustic reverberation is smaller, angle β is advantageously chosen greater.

Comparison of Figs. 1 and 1*a*, both of which show reflecting surfaces made according to the invention, makes it possible to understand the influence of the shape of the ellipsoid on the aperture β of the cone.

The ellipsoid of Fig. 1 gives a sound cone having an angle β equal to 60°, whereas that of Fig. 2 gives a sound cone having an angle β equal to 40°.

When, in order to transmit low frequency sounds, it is necessary to prevent the return toward the front of the sound waves produced by the rear face of the diaphragm, I provide a baffle in the form of a wall **3** located at point O, the plane of this wall being at least approximately at right angles to axis BA_1. This wall, through which passes reflecting surface **2**, may be, for instance, the wall of a radio set to which the transducer system belongs.

The operation of the device above described is as follows:

Experiment has shown that when the diaphragm is excited in order to transmit sounds, including both high frequency and low frequency components, the high frequency components in particular form a beam the axis of which coincides with AB. This beam is reflected by the reflecting surface and is concentrated at focus A_1. The direction of this reflected beam is indicated by axis BA_1. On the contrary, the low frequency components, which have a wave length too great to be influenced by the reflecting surface, travel through space immediately from point O since it has been found that the low frequency transmission of the diaphragm takes place substantially in the plane of the base thereof. There is therefore a substantial distance between the point from which the low frequency components are transmitted, and the point A_1 from which the high frequency components are transmitted. Intermediate frequencies appear to have sources between the points O and A_1, the lower intermediate frequencies having virtual sources near O, and the higher intermediate frequencies having virtual sources near A_1.

The sound transducer shown by Figs. 3 and 4 is made according to another embodiment of the invention and includes in combination a reflecting surface made as above described and a resonator of the Helmholtz kind tuned to the natural frequency of oscillation of the movable system of the loud speaker. This resonator is essentially constituted by a sphere **4** including the space at the rear of diaphragm **1**, provided, in close vicinity to said diaphragm, with an outlet aperture **5** fitted with an inwardly extending tubular portion **6**. Reflecting sphere **4** is prolonged upwardly by a wall **7** which surrounds the rear of the reflecting surface **2** located above diaphragm **1** and is arranged in the same manner as above described with reference to Figs. 1 and 2. Between reflecting surface **2** and wall **7**, there is an upwardly tapering free space.

In a general manner, while I have, in the above description, disclosed what I deem to be practical and efficient embodiments of my invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

What I claim is:

1. A sound transducer which comprises, in combination, a sound generator, a reflecting surface constituted by a portion of an ellipsoid of revolution, this surface being located and arranged with respect to the sound generator in such manner that the point forming the virtual acoustic source of said generator is located at one focus of the ellipsoid, the second focus of said ellipsoid, toward which the reflected sounds converge, being located on the outside of the reflecting surface and downstream of the mouth thereof, the reflecting surface being shaped and the sound generator being positioned with

respect to said reflecting surface so that the axis of sound transmission of said generator intersects said reflecting surface and makes with the axis of the sound beam reflected from said surface an angle greater than 90°, and the mouth of the reflecting surface extending to a point in the immediate vicinity of the edge of the sound generator.

2. A sound transducer according to claim 1 in which the axis of sound transmission of the sound generator intersects the reflecting surface at the point where the minor axis of the section of the ellipsoid by an axial plane at right angles to the plane of the mouth of the reflecting surface also intersects this surface.

3. A sound transducer according to claim 1 further including a baffle mounted at the place where the edge of the sound generator is closest to the mouth of the reflecting surface, this baffle being at least approximately perpendicular to the axis of the reflected sound beam.

4. A sound transducer according to claim 1 further including a substantially spherical resonator mounted at the rear of the sound generator and a tubular passage extending in the spherical cavity of said resonator, and opening frontwardly.

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