Aug. 11, 1942. A. I. ABRAHAMS 2,292,424

ACOUSTIC DEVICE

Filed April 5, 1941 2 Sheets-Sheet 1

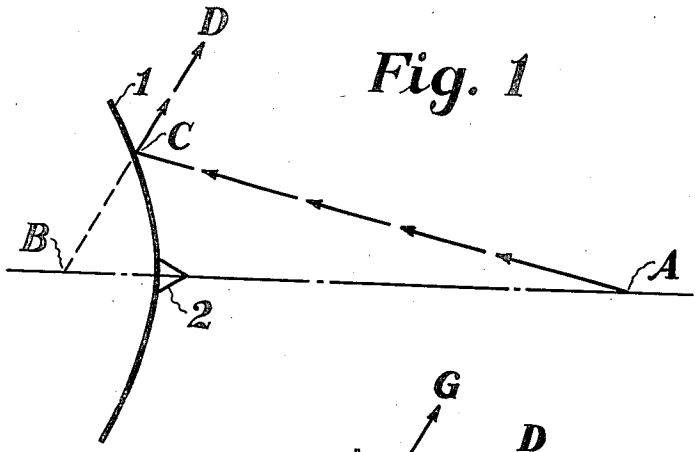


Fig. 1

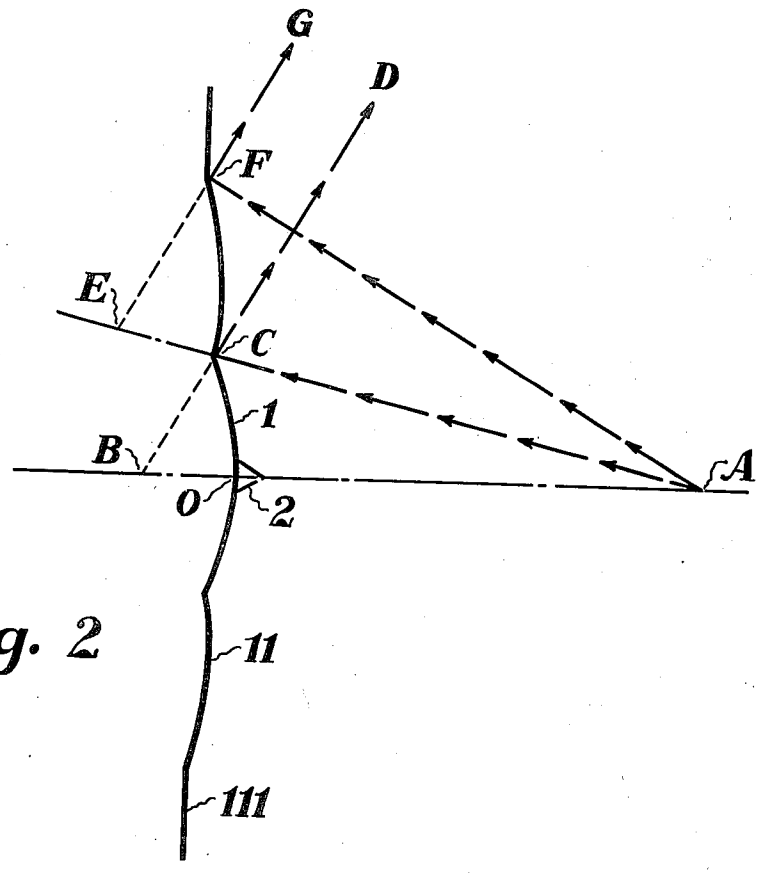


Fig. 2

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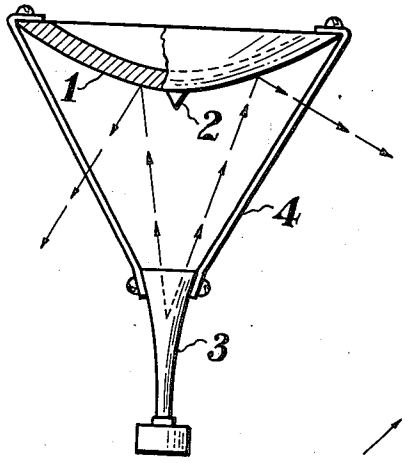


Fig. 3

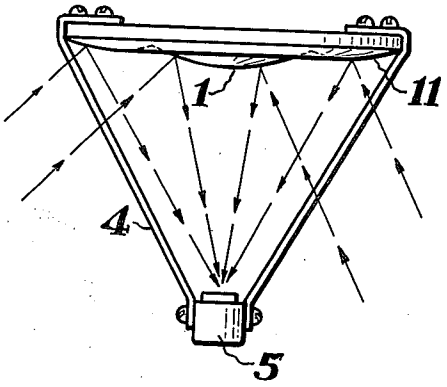


Fig. 4

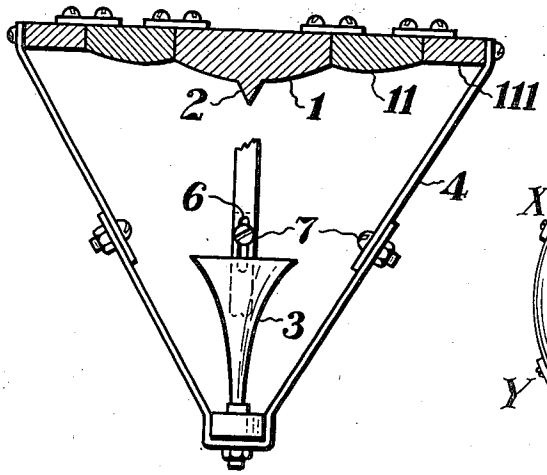


Fig. 5

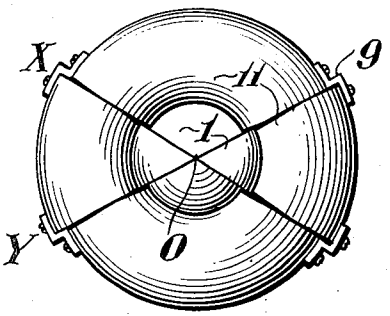


Fig. 6

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ACOUSTIC DEVICE

Alexander I. Abrahams, New York, N. Y.

Application April 5, 1941, Serial No. 387,013

10 Claims. (Cl. 181—0.5)

This invention relates to devices for distributing and collecting acoustic waves and more particularly to the type employing reflecting surfaces.

In certain types of sound distributing devices especially those using horns to generate and amplify sound waves, undesirable directional characteristics are obtained in which the sound is concentrated substantially along the axis of the horn.

In order to widen the angle at which the sound would be projected, it has hitherto been necessary to utilize a plurality of such horn units in a cluster, each angularly displaced from the other.

It is an object of this invention to provide a simple and inexpensive means whereby a single horn unit would provide a sufficiently large angle of coverage.

In acoustic devices of the horn type, the more intense portion of the projected energy is concentrated in a substantially narrow beam and the remaining, weaker portion of the energy is located at the periphery of the beam.

It is another object of this invention to provide a means whereby the intense portion of the acoustic beam may be separated from the weaker portion and both superposed over a substantially wide angle, thus modifying the concentrated beam and providing substantially uniform sound intensity over the entire angle of coverage.

In devices for receiving acoustic waves, especially those employing microphones with highly directional characteristics, it is sometimes desirable to receive sound waves from a substantially wide area.

It is a further object of this invention to provide a means to collect acoustic waves from a wide area and to reflect the said waves in a substantially narrow beam to a microphone.

A feature of this invention resides in that any predetermined angle may be covered with a uniform sound intensity.

Other objects and features will become apparent from the following description and the accompanying drawings in which like numerals indicate similar parts and in which:

Fig. 1 is a diagram of the geometrical relationships involved in reflectors having a simple curved surface.

Fig. 2 is a diagram of the geometrical relationships involved in reflectors having a surface of multiple curvature.

Fig. 3 is a partly sectional view of an embodiment of this invention utilizing a reflector of simple curvature for the distribution of sound waves from an acoustic horn.

Fig. 4 is a side elevation of another embodiment wherein the reflector collects sound waves from a substantially wide area and redirects it to a microphone.

Fig. 5 is a cross section through another embodiment of the present invention utilizing a reflector of multiple curvature for distributing sound waves from an acoustic horn.

Fig. 6 is a view of the face of a reflector, in another embodiment of the present invention, wherein the distribution pattern of the reflector may be adjusted to conform to the physical dimensions of the area to be covered.

In its simplest embodiment, the invention comprises a reflector, in the form of a convex hyperboloid of revolution, and an acoustic device such as an acoustic horn or a microphone at its external focus. Any acoustic ray following a path radial to the external focus of the reflector and impinging upon the reflector, will be reflected in a direction radial to the internal focus of the reflector and vice versa. Thus, although the source of sound waves is at the external focus, the ultimate direction of the waves will be such that the source would appear to be at the internal focus.

In another embodiment, the reflector is made up of a plurality of convex hyperboloids, each having separate internal foci and a common external focus and each disposed to intercept a portion of the rays emanating from the external focal point and to reflect its portion over a predetermined angle so that the reflected rays from all of the hyperboloids are superposed substantially over the same area.

In another embodiment, the reflector is formed with a plane surface surrounding the hyperboloid rings so as to baffle and absorb or reflect stray rays at the periphery of the acoustic beam emanating from the horn.

In Fig. 1, the reflector 1 is a convex hyperboloid of revolution about the axis AB. The hyperboloid has an external focal point A and an internal focal point B. Any acoustic ray or pencil of rays emanating from a radiator at point A and impinging on the reflector 1 at any point C will be reflected in a direction CD radially from point B as though the radiator were positioned at B.

Conversely, any ray approaching the reflector in a direction DB, radial to the internal focal point B, and impinging upon the reflector 1 at

any point C, will be reflected toward the external focal point A.

When the radiator is an acoustic horn positioned at point A, with the mouth of the horn directed toward the internal focal point B, a small area on the surface of the reflector I substantially at the axis of the system will reflect some of the waves back into the mouth of the horn, producing a condition of standing waves at certain frequencies.

To obviate this condition, a conical boss 2 is formed on the hyperbolic surface at the axis of the reflector I, with its apex directed toward the external focus A.

The angle of distribution ABD of the reflector is controlled by the extent of the reflector I which in turn is determined by the beam angle BAC of the horn. Thus, if angle BAC is the angular extent of the beam from the horn, the reflector I may be cut off at C and the distribution angle ABD will include ray CD as the extreme ray.

In Fig. 2 the acoustic beam from a radiator positioned at the external focal point A is separated into a plurality of angular portions having varying intensities of sound. The most intense portion, included in the angle BAC, is intercepted by the portion of the reflector I which is a simple hyperboloid of revolution as described in Fig. 1.

The next adjacent portion of the acoustic beam, included within the angle CAF, is intercepted by the portion of the reflector II which is a surface generated by revolving about the axis AB a hyperbola having its external focus at point A and its internal focus at point E. In revolving the hyperbola II, the internal focal point E is also revolved, generating a circle which lies in a plane perpendicular to the axis AB.

Any sound waves which leave point A, within the angle CAF, will be intercepted by the portion of the reflector II and reflected over the angle AEG as though the radiator were along the circumference of a circle generated by revolving the external focal point E about the axis AB.

The sound waves which are reflected from the portions I and II of the reflector are substantially superposed.

The ray AF was designated, for the purpose of this description, as the extreme ray of the acoustic beam of the horn. However, the edge of the beam may not be so sharply defined and some stray rays may be projected from the horn outside of this ray. To utilize this stray energy, the portion of the reflector III may be made curved as in the portion II or may be a plane surface as designated in Fig. 2. In any case, this portion III of the reflector is intended to baffle the sound waves emanating from the horn so that no waves will continue to the back of the reflector.

In this embodiment, there are several areas on the reflector such as at points O and C which will reflect some sound waves back into the mouth of the horn, thus producing a condition of standing waves at certain frequencies.

To obviate this condition, a conical boss 2 is formed on the hyperbolic surface I at the axis, with its apex directed toward the external focal point A.

At point C, the hyperbolic curve II is distorted slightly so as to direct its reflected energy away from the mouth of the horn.

It will be seen from the diagrams of Figs. 1 and 2 that this system is very flexible and that the optimal dimensions may be selected for greatest efficiency and the reflector shaped to conform.

In Fig. 3, the acoustic horn 3 is attached to the reflector I by means of the supports 4. The reflector I is a hyperboloid of revolution. The acoustic waves emanating from the horn 3 are reflected over a substantially wide angle in accordance with the principles described in Fig. 2. The boss 2 is disposed to prevent the condition of standing waves.

In Fig. 4 the reflector segments I and II are attached to a microphone 5 by means of supports 4. Sound waves impinging on the reflector segments I and II will be directed to the microphone in a substantially narrow beam in accordance with the geometry developed in Fig. 2. For the receiving of sound waves, no boss is required at the axis of the hyperboloids, since no condition of standing waves will occur.

In Fig. 5, the horn 3 is attached, by means of the supports 4, to a reflector having a plurality of convex surfaces I and II and a plane portion III. The boss 2 is provided to prevent the condition of standing waves between the reflector and the horn, in accordance with the geometry developed in Fig. 2.

In some forms of the present invention it is desirable to construct the various convex portions separately so as to make them readily detachable and adjustable. This will allow the diameter of the reflector to be matched to the beam widths of several different horns. It will also allow of standardizing the construction to several prefabricated sections which may be combined for a large variety of conditions.

The supports 4 are made adjustable by means of the adjusting screw and nut 7 and the slot 6.

When the present invention is used with an acoustic horn in an enclosed room of rectangular or oblong shape, it is sometimes desirable to make the angle of coverage, ABD and AEG of Figs. 1 and 2, to correspond to the linear dimensions of the room.

To accomplish this, the reflector may be made up of angular laminations, each segment being designed with its appropriate angle of coverage.

In Fig. 6, the face of the reflector is divided into a plurality of angular sectors, such as XOY, each sector having a portion of a central convex reflector I, and a portion of an annular convex reflector II. All of the convex reflectors have a common focal point forward of the face of the reflector. Each reflector is hyperbolic in any meridianal section in accordance with the geometry developed in Fig. 2. The sectors are held together by means of straps and screws 9.

The reflector may also be constructed so that its surface is a smooth generated surface between any set of meridianal hyperbolas.

It is a well known fact that the radiations of sound, heat and light follow identical physical laws and that any geometry developed for one medium will be equally applicable to the others. It follows that the present invention, with minor modifications as to material and condition of surface, may be utilized with equal facility for any of the media.

I wish it distinctly understood that, although this device has been described as formed by generating a surface from the conic sections, approximate results may be obtained which will differ but little from the exact geometry here disclosed by forming the various reflecting sur-

faces from their approximate spheroidal or ovate counterparts.

Furthermore, while I have particularly described the simplest elements adapted to perform the functions set forth, it is obvious that they could be subject to modifications, and various changes in form, proportion and in minor details of construction may be resorted to without departing from the spirit or sacrificing any of the principles of the invention.

What I claim is:

1. An acoustic device comprising a convex reflector and acoustic translating means; the said reflector being hyperbolic in any meridianal section and having a focal point forward of the convex surface of the said reflector; the acoustic translating means being positioned substantially at the focal point of the said reflector and directed toward the convex surface of the said reflector.

2. An acoustic device comprising a reflector and acoustic generating means; the said reflector comprising a plurality of concentric convex reflecting surfaces with a common focal point; the said acoustic generating means being positioned substantially at the common focal point of the reflecting system and directed toward the said convex reflecting surfaces.

3. An acoustic device comprising a reflector and acoustic generating means; the said reflector comprising a plurality of concentric convex reflecting surfaces with a common focal point, each of the said reflecting surfaces being hyperbolic in any meridianal section; the said acoustic generating means being positioned substantially at the common focal point of the reflecting system and directed toward the said convex reflecting surfaces.

4. An acoustic device comprising a reflector and acoustic generating means; the said reflector comprising a plurality of concentric convex reflecting surfaces with a common focal point forward of the said convex surfaces, the said acoustic generating means being positioned substantially at the focal point of the said reflector and directed toward the convex surface of the said reflector.

5. An acoustic device comprising a reflector, an acoustic baffle and acoustic generating means; the said reflector comprising a plurality of concentric convex reflecting surfaces with a common focal point, each of the said reflecting surfaces being hyperbolic in any meridianal section; the said acoustic baffle being positioned circumjacent to said concentric reflectors; the said acoustic generating means being positioned substantially at the common focal point of the reflecting system and directed toward the said convex reflecting surfaces.

6. An acoustic device comprising a reflector and acoustic generating means; the said reflector comprising a plurality of concentric convex reflecting surfaces with a common focal point; the central convex reflecting surface being provided with a centrally positioned conical boss with its apex directed toward the said acoustic generating means; the said acoustic generating means being positioned substantially at the common focal point of the reflecting system and directed toward the said convex reflecting surfaces.

7. An acoustic device comprising a reflector and acoustic generating means; the said reflector comprising a plurality of concentric convex reflecting surfaces with a common focal point; the said acoustic generating means being adjustably positioned forward of the reflecting system and directed toward the said convex reflecting surfaces.

8. An acoustic device comprising a reflector and acoustic generating means; the said reflector comprising a plurality of separable concentric convex reflectors with a common focal point, the said acoustic generating means being positioned substantially at the common focal point of the reflecting system and directed toward the said convex reflectors.

9. An acoustic device comprising a reflecting system and acoustic generating means; the said reflector comprising a plurality of sectors, each of said sectors comprising a plurality of sectors of concentric convex reflecting surfaces, all of the said reflecting surfaces having a common focal point; the acoustic generating means being positioned substantially at the common focal point and directed toward the said convex reflecting surfaces.

10. In an acoustic device, a reflector comprising a plurality of concentric convex reflecting surfaces with a common focal point forward of the said convex surfaces, each of the said reflecting surfaces being hyperbolic in any meridianal section.

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