Jan. 7, 1941. A. I. ABRAHAMS 2,228,024

DIRECTIVE ACOUSTIC PICKUP

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Fig. 1

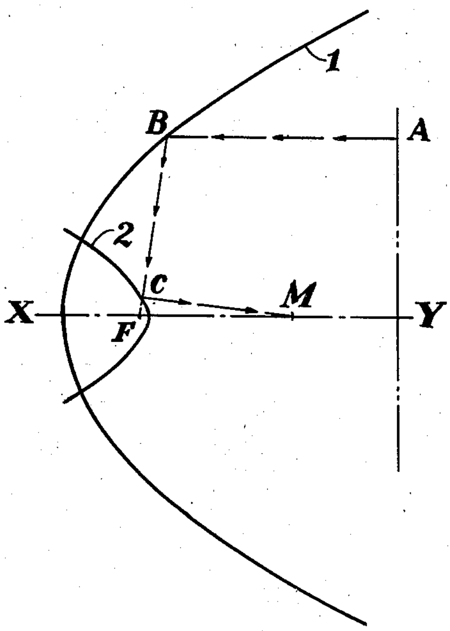

Fig. 2

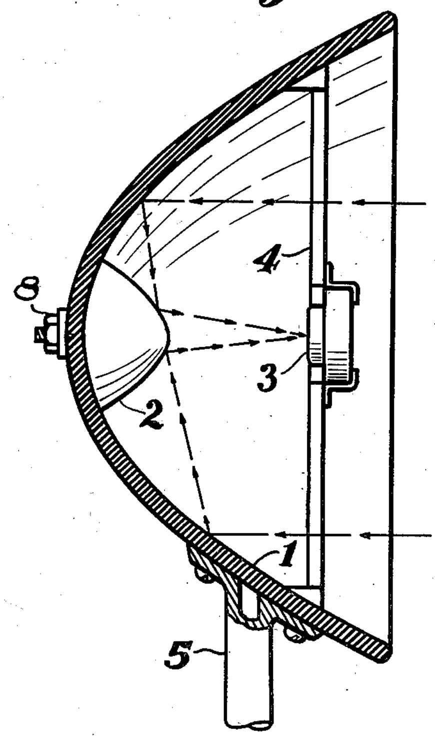

Fig. 3

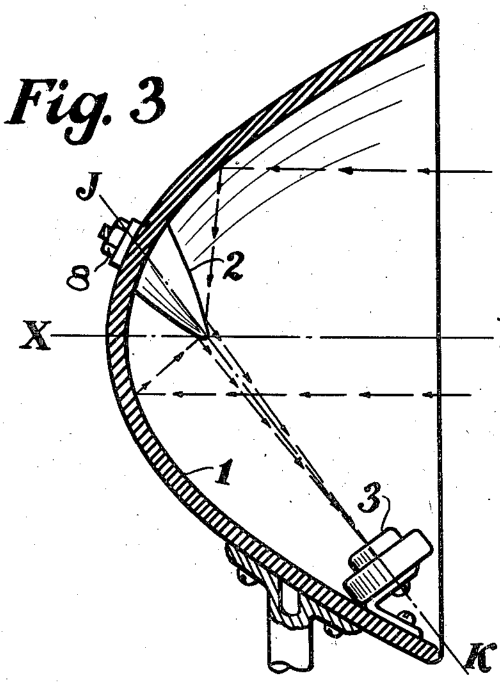

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Fig 4

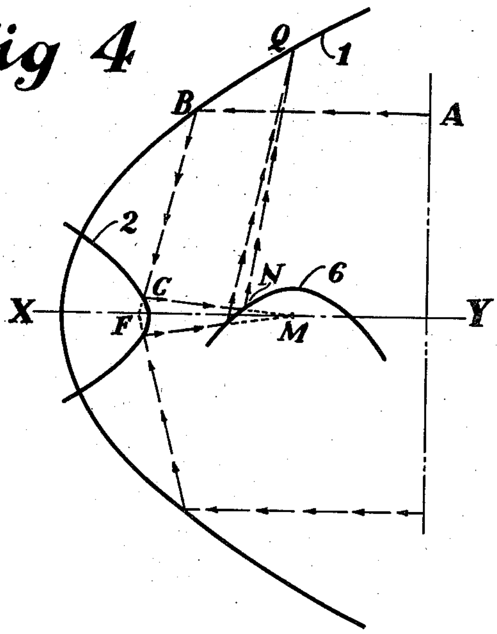
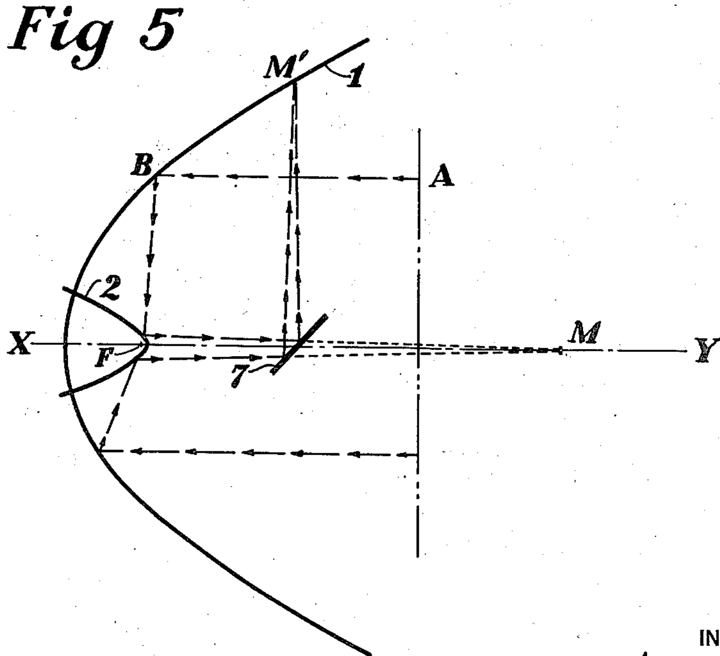


Fig 5



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DIRECTIVE ACOUSTIC PICKUP

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

Application February 1, 1940, Serial No. 316,715

7 Claims. (Cl. 181—26)

This invention relates to directive acoustic pickups and more particularly to the type employing multiple reflecting surfaces.

An object of this invention is to provide a means for eliminating acoustic cancellation in deep reflectors due to phase differences at the microphone, thus producing a deep reflector of higher efficiency.

A feature of this invention resides in the combination of concave and convex reflecting surfaces to direct the acoustic rays to the microphone.

Another feature of this invention resides in the shape of the reflecting surfaces.

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 of double reflection involved in the present invention,

Fig. 2 is a longitudinal section through the preferred embodiment of my invention, based on the principles expounded in Fig. 1,

Fig. 3 is another embodiment of my invention, wherein the microphone is not on the primary axis,

Fig. 4 is a diagram of the geometrical relations involved in triple reflections for the purposes of the present invention,

Fig. 5 is a diagram of another type of triple reflector in another embodiment of my invention. The construction of the parts and the manner of assembly will be similar to the preferred embodiment shown in Fig. 2.

Essentially, the apparatus comprises a concave primary reflector, formed so as to concentrate the collected acoustic rays toward substantially a point, a convex secondary reflecting system of one or more reflectors, formed so as to intercept and re-reflect the said concentrated acoustic rays toward a microphone at a second or third focal point.

One of the difficulties heretofore encountered in using deep reflectors has been the large angle with which the acoustic rays converged at the focal point of the primary reflector. A microphone placed at the said focal point would receive the said acoustic rays on both faces. This would result in acoustic cancellation, at the microphone, of rays which approach the said focal point from diametrically opposite directions.

The advantages of this invention reside in the fact that optimal proportions may be selected for the concave primary reflector. Through multiple reflection, all of the acoustic rays received by the said concave primary reflector will be directed to one face of the microphone in a substantially narrow angle. This allows the maximum utilization of the acoustic energy by the microphone.

In Fig. 1, 1 is a parabolic reflector with axis X—Y and focus at F. 2 is a hyperbola on the same axis X—Y with one focus at F and a conjugate focus at M. The dashed line A—B indicates an acoustic ray entering the reflector and impinging on the parabolic reflector 1 at B. The said ray is necessarily reflected by the parabolic reflector 1 toward its focal point F.

Before reaching the focal point F, the reflected ray impinges on the hyperbolic reflector 2 at C and is reflected toward the conjugate focal point M.

From the definition of a parabola, all rays, entering the parabola parallel to its axis and reflected to its focus, are equal; or, in Fig. 1, AB plus BF is a constant. From the definition of a hyperbola, the difference between two focal radii drawn from a point on the hyperbola is constant; or, in Fig. 1, CM minus CF is a constant. If we consider the length of a completely reflected ray from A to M we have AB plus BF plus CM minus CF is always a constant.

In Fig. 2, the concave paraboloid reflector 1 and the convex hyperboloid reflector 2 are surfaces of revolution about the axis X—Y. The microphone 3 is placed substantially at the conjugate focus of the hyperboloid reflector 2 and is held in place by the spider 4. The entire unit being supported on a standard 5. All rays which enter the paraboloid reflector 1 parallel to the axis X—Y will be reflected toward the microphone 3. The rays will arrive in the same phase since the time of traverse will be constant regardless of the position of the entering ray.

The screw and nut 8 at the rear of the concave reflector 1 which are attached to the convex reflector 2 are used to adjust the position of the convex reflector to secure proper focus of the sound waves upon the microphone.

In the embodiment where the concave and convex reflectors are constructed integrally, the screw and nut 8 are omitted.

In Fig. 3, 1 is a concave paraboloid reflector which is a surface of revolution about axis X—Y. 2 is a convex hyperboloid reflector which is a surface of revolution about axis J—K. Axis J—K intersects axis X—Y at substantially the common focal point of the paroboloid and the hyperboloid reflectors. The microphone 3 is substantially at the conjugate focal point of the convex hyperboloid on the axis J—K which may be on the periphery of the convex paraboloid reflector 1, or in any other convenient position. The screw and nut 8 may be used to adjust the position of the convex reflector. The improvement of the embodiment over that of Fig. 2 resides in the convenient position of the microphone and in the fact that the said microphone is away from the path of the acoustic rays entering the concave primary reflector.

In Fig. 4, is indicated the geometry of a system employing triple reflection. The acoustic rays enter and impinge on the concave paraboloid reflector 1 which reflects the rays toward the focal point F. The convex hyperboloid reflector 2 intercepts and re-reflects said rays toward a second focal point M. A second convex hyperboloid reflector intercepts and again reflects the said acoustic rays to a third focal point Q which may be at any convenient position.

It will be seen that the number of reflections may be increased without limit, except for the attendant losses of energy due to absorption, and the expedient position of the microphone. The time relationships of the rays arriving at Q will remain unchanged. The total length of the completely reflected ray AB plus BF plus CM minus CF plus NQ minus NM is a constant.

In Fig. 5, is indicated the geometry of another system employing triple reflection. The acoustic rays enter and impinge on the concave paraboloid reflector 1 which reflects the rays toward the focal point F. The convex hyperboloid reflector 2 intercepts and re-reflects said rays toward a second focal point M. Intermediate said convex hyperboloid reflector 2 and point M, a plane reflector is placed to re-reflect the said acoustic rays to point M'.

It should be noted that the geometry of Fig. 5 is identical with that of Fig. 1, except that the plane reflector has rotated the conjugate focus M to a new position M'.

For simplicity of construction, the concave primary reflector 1 and the convex secondary reflector 2 may be formed in one operation so that the respective surfaces will be the continuation of one another.

I wish it distinctly understood that, although the device has been described as formed by revolving the various conic sections about their respective axes, approximate results may be obtained which will differ but little from the exact geometry here developed, by forming the reflecting surfaces 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. In combination, an acoustic pickup comprising a concave primary reflector to gather and focus incident sound waves, a secondary reflecting system positioned within the cavity of the said concave reflector, the said secondary reflecting system disposed to intercept and refocus the sound waves substantially to a point forward of the focal point of the said concave reflector, and a microphone positioned substantially at the focal point of the said secondary reflecting system.

2. In combination with a microphone, an acoustic reflecting system comprising a concave primary reflector for gathering and focusing incident sound waves, and a secondary, convex reflector facing toward the source of the said incident sound waves and positioned within the cavity of the said concave reflector to intercept, re-reflect and focus the sound waves in a direction substantially toward the source of the incident sound waves; the microphone being positioned at substantially the focal point of the system.

3. In combination with a microphone, an acoustic reflecting system comprising a concave primary reflector for gathering and focusing incident sound waves, and a secondary, substantially smaller convex reflector facing toward the source of the said incident sound waves, adjustably supported within the cavity of the said primary reflector and positioned with one of its foci coinciding with the focus of the primary reflector and disposed to intercept, re-reflect and focus the said sound waves in a direction substantially toward the source of the incident sound waves; the microphone being positioned at substantially the focal point of the system.

4. In combination with a microphone, an acoustic reflecting system comprising a concave primary reflector of the deep paraboloid type for gathering and focusing incident sound waves, and a secondary, substantially smaller convex reflector of the hyperboloid type with reflecting surface facing toward the source of the said incident sound waves, positioned within the cavity of said concave reflector with one of its foci coinciding with the focus of the said concave reflector and disposed to intercept, re-reflect and focus the said sound waves in a direction substantially toward the source of incident waves; the microphone being positioned at substantially the conjugate focus of the said convex reflector.

5. In combination with a microphone, an acoustic reflecting system comprising a concave primary reflector for gathering and focusing incident sound waves, said microphone being positioned at substantially the periphery of said primary reflector, a secondary, substantially smaller convex reflector facing toward the source of the said incident sound waves, positioned within the cavity of the said concave reflector with one of its foci coinciding with the focus of the said concave reflector and disposed to intercept, re-reflect and focus the said sound waves in a direction susbtantially toward the source of the incident waves, a third reflector disposed to intercept the sound waves from the said secondary reflector and to re-direct them to the microphone.

6. In combination with a microphone, an acoustic reflecting system comprising a concave primary reflector for gathering and focusing incident sound waves, and a secondary, substantially smaller convex reflector facing toward the source of the said incident sound waves and positioned within the cavity of said concave reflector, to intercept, re-reflect and focus the sound waves in a direction substantially toward the source of the incident sound waves, the microphone being positioned at substantially the focal point of the said convex reflector; the said primary and secondary reflectors being of integral construction.

7. In combination with a microphone, an acoustic reflecting system comprising a concave primary reflector for gathering and focusing incident sound waves, a secondary, substantially smaller convex reflector facing substantially toward the source of the said incident sound waves

and positioned within the cavity of said concave reflector to intercept, re-reflect and focus the sound waves in a direction substantially toward the source of the incident sound waves, one of the foci of the said secondary reflector coinciding with the focus of the said primary reflector, the axes of the two reflectors being inclined to each other so that the conjugate focus of the said convex reflector will lie adjacent the periphery of a forward portion of the primary reflector; the microphone being positioned at substantially the conjugate focus of the said secondary reflector.

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