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ACOUSTICS

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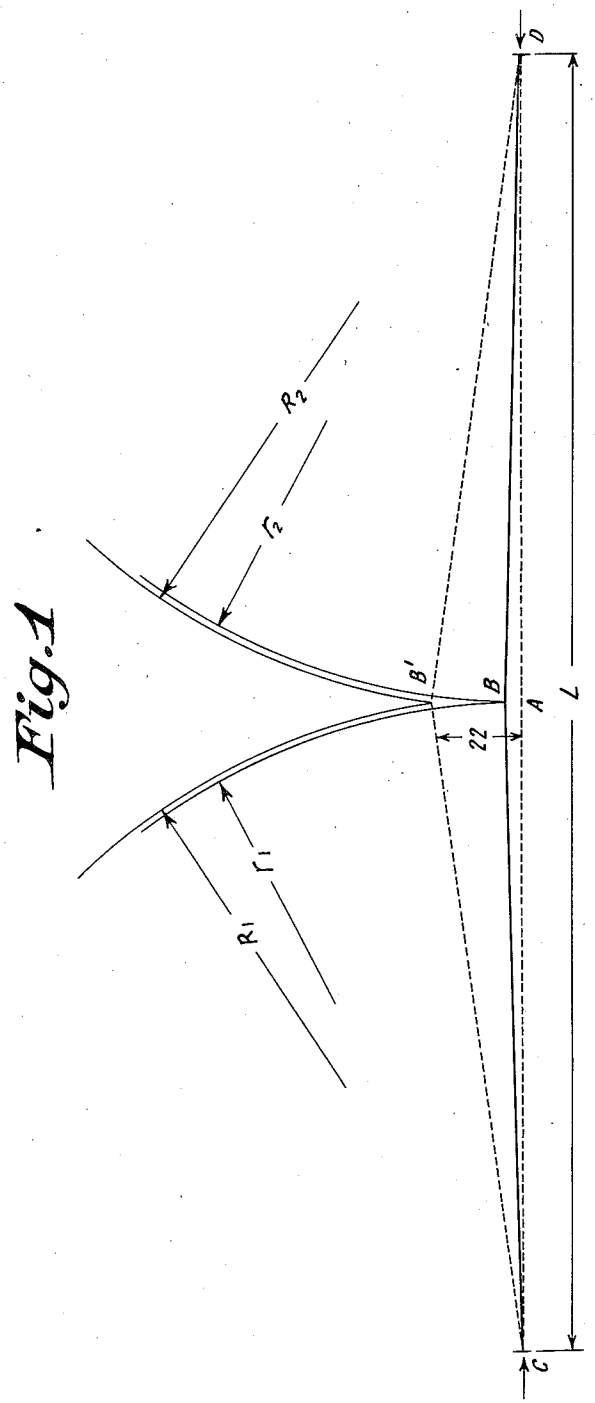


Fig. 1



Fig. 2

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ACOUSTICS

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This invention relates to means adapted to convert motion into acoustic energy. According to this invention a large volume change in a gas space is produced by imparting a small motion to the edge or edges of a diaphragm or membrane surface in a direction substantially along the plane of the diaphragm surface, or, in other words, by causing a small alteration of a solid body. Fundamentally speaking, the invention concerns all acoustic energy converters or all absorbing devices which operate to transmit sound into the air from a solid body or to convert sound waves into vibrations of a solid body. The problem always involved is that of producing large volume variations in a medium of lower density by means of a small motion of or volume change in a medium of great density. According to the disclosure of the present invention, this is attained by a diaphragm or membrane slightly protruding beyond its plane so that all pressure changes of the diaphragm take place consecutively upon pressure influences or actions.

One object of this invention is to provide means whereby a large volume variation in a medium of low density will be caused by a small volume change in a medium of great density.

Another object of this invention is to provide means whereby a large volume variation in a medium of low density will cause a small volume change in a medium of great density.

The first object is accomplished by the use of a diaphragm or membrane, slightly convex, that protrudes beyond a plane through its outer periphery so that all pressure changes of the said diaphragm or membrane take place consecutively upon pressure influences or actions being applied to the said diaphragm or membrane along a line or lines in the said plane. In other words, by causing the diaphragm to protrude beyond the plane through its outed periphery, an application of pressure to the edge or edges of the diaphragm always causes the diaphragm to move in the same direction.

The second object is attained by causing sound waves to be directed on the convex surface of a membrane or diaphragm, part of the periphery of which is fixed, other parts of which rest against the member to or in which it is desired to impart a small movement.

Other objects and advantages will become apparent from the specification when read in connection with the accompanying drawing in which:

Fig. 1 is a diagrammatic view showing the means and method by which a small movement of a solid body causes a large volume movement in a body of less density.

Fig. 2 is a view showing how movement of a large volume of small density causes movement of a small volume of greater density.

Referring to Fig. 1 of the drawings C B D represents a diaphragm of length L bent up from the plane C A D, at its center an amount of AB equal to, say, 5 mm.

If, upon both sides of the diaphragm, a slight change in pressure is produced in the direction of the plane of the diaphragm so that by the action of said pressure an elongation of amounting to, say, 2 mm. occurs in CD, this means that the diaphragm in its middle, (radius r^1 and r^2) in Fig. 1 will also be extended by 2 mm. (R_1 and R_2), which, in turn, means that point B, by the extension of the radii, and by virtue of the deflection of the diaphragm, will come to be placed at point B′; in other words, on account of the 2 mm. extension on either side, the diaphragm has changed its form marked by C B D into the form marked C B′ D and that a change at C of 2 mm. has caused a change BB′ of approximately 22 mm. On account of the displacement of B to B′, there is also produced a change in volume, that is to say, in the volume of the mass of air acted upon, which, on the one hand, is proportional to the length L, and, on the other hand, to half the height BB′. Assuming, for instance, that the thickness of the diaphragm at CD is 1 mm., and the width of the diaphragm, say, 5 cm., then the volume which is altered by the pressure at CD in the solid body amounts to $50 \times 2 \times 1$, that is 100 sq. mm. (each), but this causes an alteration of volume in the gas space BB′ sev-

eral hundred times larger than the change in the solid.

Such conversion of motion by the aid of a diaphragm fixedly connected with a solid body may be used in widely varying ways for technical and musical purposes. The fundamental condition is that the diaphragm should be raised somewhat above the plane C A D so upon an application of pressure the diaphragm will always move in the same direction, i. e. from B to B'. In order that restoration to the original position of rest may always be insured, it is a convenient plan to make the diaphragm elastic in nature and to provide the diaphragm at the ends CD with a little tension.

The absorption or delivery of energy by the arrangement may be increased by providing a plurality of such diaphragms or by connecting several diaphragms with the same longitudinally oscillating body or bodies.

The vibrations of the solid body may often be suitably produced in the solid body itself. For instance, to build a loudspeaker, the most convenient and simplest arrangement will be to produce the longitudinal oscillations in the solid body by using an iron core which is acted upon by an audio frequency alternating current by means of a coil. Instead of an iron core, it will often be sufficient to use a body with iron lining. In this case, the diaphragm may likewise be conveniently made of an iron lamina, the latter then forming a part of the magnetic iron path.

It will be understood that by applying sound energy against the convex surfaces of C B' D in a direction B' B movement of the membrane C B D will cause movement in or of a solid or solids at C and or D.

According to another feature of the invention, the arrangement may be so built that the absorbing or yielding solid bodies, for instance, as illustrated in Fig. 1, are secured only at C, while at the opposite end D, the diaphragm is merely made to bear upon some other solid body, or else the diaphragm is tensioned between two sound-absorbing or sound-delivering bodies, in other words, at C and D are the solid bodies in question which give off or absorb longitudinal oscillations.

The basic idea of the invention will be found very useful either as a telephone or loudspeaker, or else as a substitute for standard microphones. The microphones heretofore used and operating with pressure, that is, the ordinary carbon microphones, are generally characterized by that the diaphragm subject to the action of sound waves directly yield or pass on the received or incoming acoustic pressure upon the carbon particles or contacts varying resistance by changes in pressure, whereby variations in resistance of the electrical system are occasioned.

Now, the fundamental difference of this invention resides in that the acoustic pressure is not brought to act directly upon the resistance systems, but that the energy generated by the sound is first converted into motion of a solid body. The sound energy after conversion, is made to propagate at a higher pressure over a shorter path, with the result that the pressure coming to act upon the electrical system is intensified, while the amplitudes of motion are diminished. This is important for example when working with carbon contacts where the pressure plays the chief part. Strictly speaking, no greater path or displacement would be required in order to realize greater resistance changes but the larger path causes greater mechanical losses, for instance, in the diaphragm.

Referring to Fig. 2 of the drawings, if the sound is caused to act upon the entire diaphragm M, it follows that there will be variations in pressure in the surface of the diaphragm or along its edges. These pressure changes in the diaphragm will be over shorter distances or paths than they were in the air, but they will be at higher pressure. Now, these pressure changes are transferred to the electrical system E. The cover *e* for the electrical system, acts as a mere piston and it has no other function but that of taking off or absorbing internal pressure amplitudes of the diaphragm M and to pass them on. All losses of internal friction which are ordinarily set up in the customary fixedly tensioned and clamped microphone diaphragm, are here avoided since *e* can be made very small.

Again referring to Fig. 2, M is the sound absorbing or receiving surface consisting of a tensioned curved surface made of any suitable material. The surface M may be clamped and tensioned at the ends *a* and *b*. It may be convex as shown, or it may also be curved in the opposite direction. A combination of several diaphragms may also be employed.

The curved diaphragm as illustrated is a very useful device for the conversion of sound from a medium of lower density such as air, into a medium of greater density such as any solid body. The large motional volume in air is converted into a correspondingly smaller motion of a solid body but the pressure is increased greatly. The sound energy is transferred to the carbon granules which are here to be considered solids in comparison with air. Hence, we are here dealing with a suitable transmission of sound from air into a solid body. In microphones built according to the old practice, a fundamentally wrong physical principle has been used for the purpose of transmitting sound energy from one medium to the other. The sound motions occuring at the rate of 330 meters per second in air are here converted by the deflected diaphragm into acoustic motions in the diaphragm body where they propagate at a ve-

locity of sound between 2000 to 3000 or 4000 meters per second.

The basic idea of the invention results in quite a number of other solutions, especially in the construction of musical instruments, for in these cases also the problem is mostly conceived as involving the transmission of pressure from a solid into a gaseous body.

It will be understood that the arrangement may be so designed that it is not the diaphragm itself which, as shown in Fig. 1, is made, to act as the lever system, but that by the longitudinal vibrations a lever system is set in motion, by which, in some direct or indirect manner the sound-producing diaphragm is caused to undergo transversal motions or vibrations, the lever system being disposed in a transverse direction for the object of enlarging the distance and volume transformation.

Having fully disclosed my invention and the operation thereof, I claim:

1. A microphone comprising a member having a non-planar surface, means for supporting an edge of said member, and a second member whose electrical resistance varies proportionally to its pressure changes connected to another edge of the first mentioned member whereby sound waves impinging upon said first mentioned member cause changes in the electrical resistance of said second member.

2. A microphone comprising a member having a curved surface, means for fixedly supporting an edge of said member, an electrical system including a container of carbon particles positioned adjacent a point on an edge of said member which is opposite the edge supported by said means, and a piston like member connected to said point for transmitting pressure to said carbon particles.

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