Feb. 15, 1955 A. L. DVORSKY 2,702,318

UNIDIRECTIONAL MICROPHONE

Filed Jan. 10, 1951 2 Sheets-Sheet 1

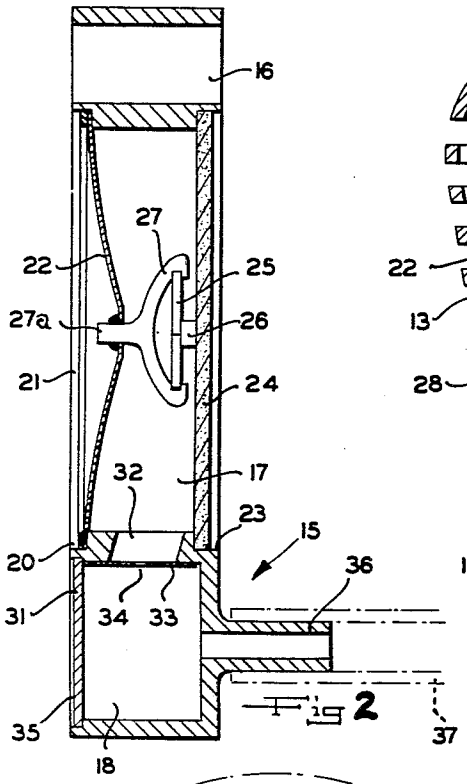


Fig 2

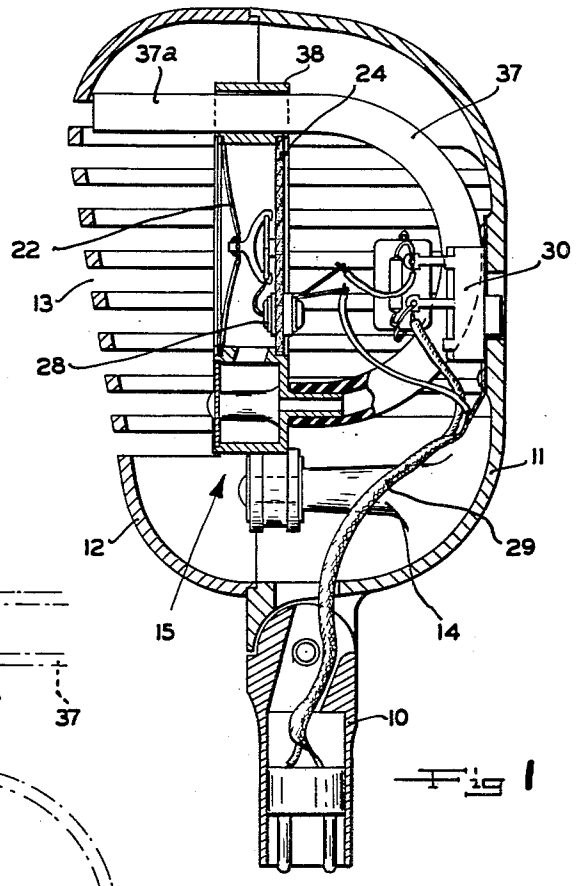


Fig 1

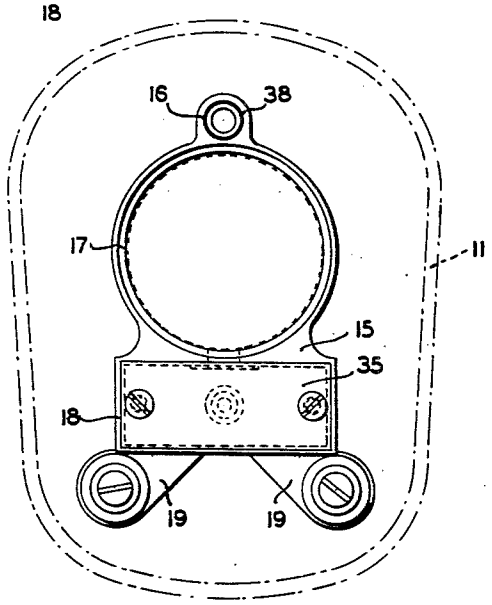


Fig 3

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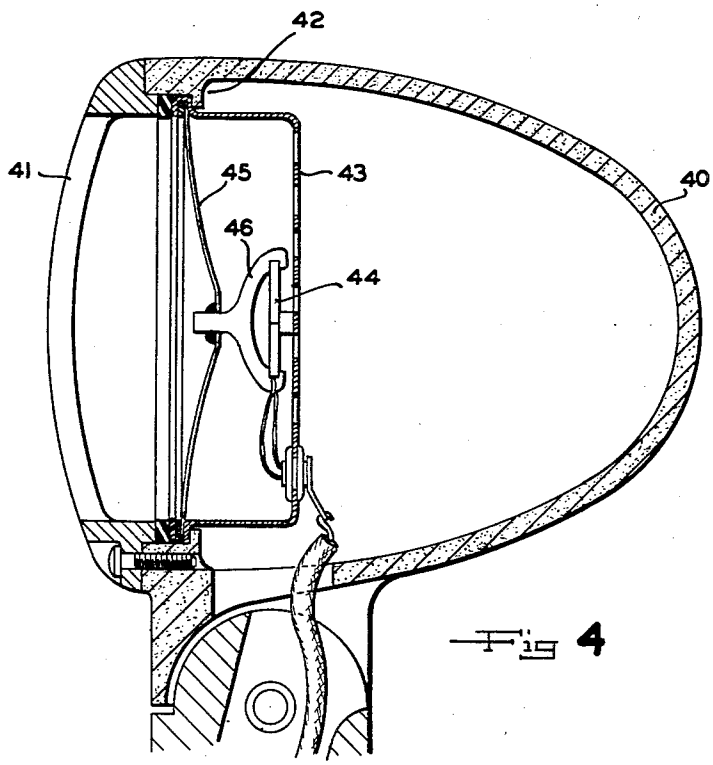


Fig 4

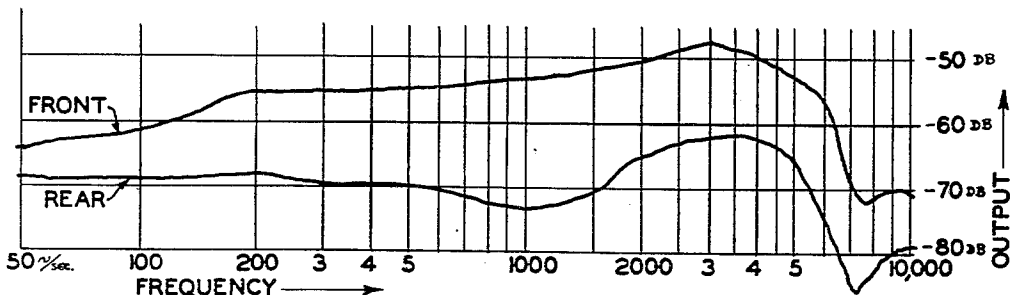


Fig 5

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UNIDIRECTIONAL MICROPHONE

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3 Claims. (Cl. 179—121)

This invention relates to the art of converting acoustical wave energy into electrical energy and more particularly to practical apparatus of an improved nature for accomplishing this general object in a directionally-favored manner. Obviously, conversion systems of this nature require an energy accumulator for the application of sufficient mechanical power to a practical electrical generator and the most common and most economical type of collector is a pressed diaphragm of a relatively inelastic metal such as soft aluminum. To obtain directionality while using a simple structure having but a single diaphragm it has been heretofore proposed to shift the phase of the acoustical waves impinging on the rear surface of the diaphragm in such manner that when the waves are propagated in a frontal direction, for example, the effect of the phase shift or delay is to augment the driving motion of the diaphragm while upon the waves being propagated in other directions the movement of the diaphragm is attenuated. It has been heretofore proposed to accomplish this operation by enclosing the rear face of the diaphragm with a chamber having a suitable acoustical impedance in the opening thereinto for the passage of the acoustical waves. Proper correlation of the volume of the chamber, the character of the impedance, and the linear distance between the front face of the diaphragm and the point of entry into the chamber results in an instrument having fairly good uni-directional qualities.

It is, however, the primary object of the present invention to provide an acoustical-electrical converter of the general character outlined above which is substantially improved as to practical structure and which has better characteristics in regard to uniformity of response throughout the whole of the audio frequency range. For permanency of structure and extended stability of operation as well as for economy in manufacture I have found that the use of a sintered material has no equal. This sintered material may be readily fabricated in any desired form by heating a compressed mass of pellets of the base material in a suitable furnace or induction heating apparatus as will be readily understood by those familiar with the art. I preferably employ bronze as the base material as the same is readily formed into a rigid strong structure while yet allowing rather large voids to remain to give the desired impedance throughout substantially the whole of the audible range of acoustical frequencies. In the simplest form of complete apparatus this sintered impedance material may be in the form of a single disc which closes off the back of the chamber in the rear of the diaphragm while in other applications of the invention the material may be employed for a portion of the housing or casing for the complete microphone instrument. In the latter adaptation the housing or casing itself forms the required closed chamber to the rear of the diaphragm and in this manner an extremely economical and yet effective uni-directional microphone may be produced.

Another object of the invention is the provision in a uni-directional microphone of simple and practical design of an improved arrangement or increasing the uniformity of response throughout the whole of the audible frequency range. In uni-directional microphones of the prior art and of the kind employing but a single diaphragm and transducer with an acoustically impeded path to the rear surface of the diaphragm as explained above the base or lower frequency response has been poor, particularly if the acoustical parameters have been

properly chosen for sharpness in directional effect. I accomplish increased base responses while yet retaining sharp directionality by providing, in addition, to the normal impedance-furnishing material at the rear of the closed chamber in back of the diaphragm, a secondary inlet into said chamber in the form of a curved tube of appreciable cross section which has a straight entering-end portion directed to the front of the microphone instrument. While the length of this tube may be substantial the same is nevertheless insufficient, impractical apparatus, to delay the acoustical wave propagation to the extent necessary to properly augment mechanical energization of the diaphragm and I accordingly provide a second impedance element between the discharge end of the tube and the closed space behind the diaphragm. This second impedance element may conveniently take the form of a small aperture in a damped barrier wall. The advantage of making the conduction tube of large diameter is, however, that it supplies a sufficient mass or volume of the wave-front compressions to insure uniform and proper operation of the orifice in the barrier.

The above and other objects and advantages of the invention will become apparent upon consideration of the following detailed specification and in the accompanying drawing herein there are disclosed certain preferred embodiments of the invention.

In the drawing:

Figure 1 is a vertical section through a microphone constructed in accordance with the principles of my invention;

Figure 2 is a vertical section, on an enlarged scale, of a portion of the apparatus of Figure 1;

Figure 3 is a front elevation of the internal structure of the apparatus of Figure 1;

Figure 4 is a vertical section through a modified form of microphone embodying the principles of my invention;

Figure 5 is a chart showing the performance characteristics of a microphone constructed in accordance with Figure 1.

In Figure 1, reference numeral **10** designates a microphone stand on which is mounted a housing **11** having a removable front cap **12** having slot openings **13**. Housing **11** is preferably a die casting and, as shown, it is provided with a pair of forwardly extending bosses **14** to the outer free ends of which is detachably secured a casting **15** which has a small top aperture **16**, an enlarged central aperture **17**, and a lower compartment **18**. For supporting the housing **15** on the bosses **14** lugs **19** are cast integrally with the body member **15**. An annular recess **20** is formed in the front face of the casting **15** concentric with the aperture **17** and held within this recess by means of a ring **21** is the diaphragm **22** which, as explained above, is preferably pressed out of a sheet of dead aluminum. A similar recess **23** is former in the rear face of the casting **15** to receive the impedance disc **24** which, as stated above, is preferably a sintered product made of bronze pellets. While the disc **24** has an appreciable degree of porosity it is a substantial and rigid member which I may utilize as the anchor for the fixed portions of the transducer. For such transducer I preferably employ a piezo-electrical crystal **25** and as indicated in Figure 2 portions of this crystal are rigidly cemented to the disc **24** through pads **26** while other portions of the crystal are engaged by a driving yoke **27**. Yoke **27** has a forwardly extending shank **27***a* which is suitably secured in a rigid manner to the center of the diaphragm **22**. Disc **24** may also support terminal connectors **28** and these in turn may be connected to the lead cord **29** through a terminal block or switch **30** housed in the casing section **11** and there may be associated with this terminal block certain desired circuit modifying components which are sometimes employed to further level out the response of the microphone assembly. A wall **31** having an enlarged aperture **32** therein separates the compartments **17** and **18** of the casting **15** and in accordance with the present invention I overlay the bottom surface of the wall **31** with an inert sheet of soft metal or cloth **33** having a small aperture **34** therein which registers with the aperture **32** as shown in Figure 2. To enable the sheet **33** to be replaced or the aperture **34** to be enlarged during calibration of the in-

strument I provide a removable cover **35** for the compartment **18**.

Cast integrally with the member **15** is a rearwardly disposed and apertured boss **36** which communicates with the compartment **18** and slidably connected onto this boss is a C-shaped tube **37** which curves upwardly and forwardly of the compartment **17** to a straight portion **37***a* which is directed to the front of the microphone above and ahead of the diaphragm **22**. The entering end of the tube **37** is positioned as far forwardly of the diaphragm as is possible in a microphone casing of practical design. To support the upper portion of the tube **37** in the casting **15** the tube is drawn through the aperture **16** from rear to front thereof. The lower end of the tube **37** is, of course, supported on the boss **36**.

By referring to Figures 1 and 3 it will be evident that the casting **15** together with the diaphragm **22** and the disc **24** is widely spaced from the peripheral and back walls of the casing section **11** so that acoustically the space behind the disc **24** may be considered as being entirely in the open. The sintered metal disc **24** provides a porous or cellular passage for the sound waves to the rear surface of the diaphragm and the porous or cellular mass has the effect of delaying the intermission of the wavefront compression as is well understood in the art. This, together with the axial interval between the front face of the diaphragm and the rear face of the disc and the volume of the compartment **17** serves to delay the application of frontal sound waves to the rear face of the diaphragm by approximately 180° to thereby accentuate or augment the movement of the diaphragm when sound waves are directed to its front. The phase displacement is such that when sound waves are propagated from the rear the compressions reach the front and back faces of the diaphragm at approximately the same time so that the activation of the diaphragm is at a minimum.

To make the microphone of practicable size the acoustical parameters are such that better directional and response characteristics are obtained in the upper portion of the audible frequency range. This is desirable, of course, particularly in the avoidance of acoustical feedback in public address systems, for example, but for fidelity of reproduction I have found that augmentation of the base response is also required. I accomplish this by the use of the tube **37** in combination with the resonance chamber **17** and the variable gate **33, 34**. The long passage in the tube **37** accounts for substantial shift in the phase of the lower frequency sound waves so that good directionality is achieved for these longer waves, allowing adjustment of the size of aperture **34** to be available primarily for raising and lowering the response level of the microphone at lower frequencies. In this manner I am able to provide a microphone of simple yet practical construction which has improved qualities as regards directionality and uniformity of response over the whole audible frequency range.

By referring to Figure 5, where the upper curve shows the output resulting from sounds originating at the front of the microphone and the lower curve the output resulting from sounds originating from the rear of the microphone, the persistency of the directional discrimination is at once apparent as is also the uniformity of response over the various frequencies.

In the embodiment of the invention shown in Figure 4 the microphone housing is comprised of a principal rear section **40** and detachable front cover section **41** which later is, in accordance with usual practice, formed with suitable grille openings to allow unimpeded entry of the sound wave. Casing section **40**, however, is formed of sintered metal similar to the material used for the disc

24 in the first described embodiment. Secured against an annular shoulder **42** in the casing section **40** by the cover member **41** is a perforated cup **43** which mounts the fixed portions of the transducer crystal **44**. A diaphragm **45** has its outer edge rigidly secured in a peripheral bead of the cup **43** and the center of the diaphragm is rigidly secured to a driving yoke **46** for the crystal **44**. While the microphone of Figure 4 is inferior to the microphone of Figures 1–3 as regards uniformity of frequency response it is, nevertheless, advantageous as being directional while yet being of extremely simple and economical design.

In either of the embodiments herein specifically disclosed directionality of response is achieved in an instrument which may be made quite small in size, which is trim in design, rugged in construction, and permanent in adjustment and operation.

Since certain of the specific features of the microphone structures described above are conventional in the art and since many changes may be made in the structures illustrated and described without departing from the spirit or scope of the invention reference should be made to the appended claims in determining the scope of the invention.

I claim:

1. In a microphone having a casing with a rear wall formed of porous sintered metal providing acoustical impedance for the transmission of sound waves into said casing, a diaphragm secured to and spanning the open front end of said casing, a mechanical-electrical transducer housed in said casing and having a driving connection with a vibratile portion of said diaphragm, a closed chamber adjacent said casing, a removable barrier member having an orifice therein separating said chamber and the space within said casing, and an elongated tube having an entering end portion extending forwardly of the open face of said diaphragm and a discharge end connected with the space in said chamber.

2. Apparatus according to claim 1 further including a removable cover plate for said chamber whereby access may be had to said barrier member.

3. In a microphone having a housing with a grilled front wall for the unimpeded entry of sound waves, a unitary member positioned centrally in said housing and having a first chamber closed at its rear with a porous sintered metal wall providing acoustical impedance for the transmission of sound waves and closed at its front by a diaphragm, a mechanical-electrical transducer in said first chamber having a driving connection with a vibratile portion of said diaphragm, a second chamber in said unitary member, means providing a restricted passageway between said first and second chambers, and an elongated tube supported on said unitary member and having its discharge end in communication with the space within said second chamber, the entering end of said tube projecting forwardly of the open face of said diaphragm.

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